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Forty-first North American Wildlife and Natural Resources Conference

Commemorating the U.S.A. Bicentennial

Conference Theme:
Status and Future of Resources Management

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Natural Resource Capabilities, Population Needs, and Quality of Life

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Formal Opening

Daniel A. Poole
President, Wildlife Management Institute
Washington, D.C.

Good morning ladies and gentlemen. Welcome to the 41st North American Wildlife and Natural Resources Conference. Welcome from the many conservation organizations and professional societies that have joined the Institute in sponsoring this bicentennial meeting.

In 1790, when the first census was taken, we numbered less than 4 million persons. Our national population center was 23 miles east of Baltimore. A typical American had seven children and a life expectancy of 35 years. Historians do not suggest relationship in those two statistics.

Our 1970 population numbered 203 million. The average American had two children and a life expectancy of 70 years. The population center was in St. Clair County, Illinois. Today, our population is increasing at an annual rate of 1.3 percent. We are expected to add about 86 million more people by the year 2020.

It took 100 years after signing of the Declaration of Independence to reach a national population of 50 million. It took only 20 years to add the most recent 50 million. Our 1790 population density was about 4.5 persons per square mile. It exceeds 57.5 today.

Only in recent times have the awesome implications of population expansion come to public attention in any significant way. The situation long has been of concern to conservationists, because the first manifestations of people pollution became locally evident in diminished fish and wildlife populations. Social unrest, poverty, and environmental degradation are secondary manifestations which now confront man with the extravagance of his numbers and ways.

This year's meeting, while number 41, actually is the 62nd. It began with the National Conference on American Game Breeding, held in New York City in 1915. The meeting name was changed to the National Game Conference in 1919, with the conferees adopting the goal of covering all phases of game conservation and administration. In 1931, it became the American Game Conference, a name then thought to express the meeting's international character.

With President Franklin D. Roosevelt's call of 1936, the meeting became the 1st North American Wildlife Conference. This shift assured concern about all animals, not just those regarded as game. And finally, in recognition of the interplay between man and all resources, including fish and wildlife, the meeting name was expanded to the North American Wildlife and Natural Resources Conference in 1960.

The history of this Conference richly records the ripening of wildlife conservation concern in this country. Discussion of game bird breeding and stocking and organizing sportsmen's clubs occupied conferees at early meetings. There was little field organization to enforce the few protective regulations and to follow wildlife population trends. Little was known about wildlife in any organized way.

Water pollution's harmful effect on wildlife was first mentioned in 1920. Aldo Leopold reported on the game situation in the Southwest. And conferees intent on stemming the tide of America's disappearing wildlife proclaimed that same year that the "foundation of all game protection is the dickey bird." It was contended that alliance of individuals interested in wildlife for whatever reason would produce the laws and funding necessary to launch adequate conservation programs. The American Game Policy was stated in 1930.

Later, ecological considerations received increasing attention and continue to do so today. Speakers covered such interlocking subjects as human population, water pollution, soil erosion, land use planning and environmental analysis. Throughout, the realization runs that fish and wildlife are an early detection and warning system of the implications of all this to man. This is made evident in the North American Wildlife Policy, published in 1973.

In this way, for 62 years, the Conference has been a focal point for identifying and discussing the forces that bear on the environment and on those resources and resource situations both needed and treasured by man.

Attaining an undiminished flow of resources yields and benefits is a complex and controversial undertaking. Social goals and aspirations may not fit neatly with economic aspirations. Political and philosophical objectives cut still other tracks. None may coincide with resources capabilities.

Population's impacts on renewable natural resources daily become more pervasive. Difficulties deepen with enlargement of population, here and abroad.

Songbird habitat in the Dakotas is destroyed by poor crop yields in Russia. Chinese hunger means fewer wetlands in Canada. The charge that North American agriculture must feed the world raises the prospect of more soil erosion, more siltation, more drainage, more water contamination, and less wildlife. Mideastern petroleum politics hasten inroads in North America's coastal marshes and estuaries, the nursery grounds for marine food and sport fisheries. Third World aspirations collide with the need for tighter management of continental shelf fisheries. On and on it goes.

Despite the world's differing social, political and economic objectives, people, by their presence and needs, are the root cause of resources problems. And only people can ease or resolve them.

It is a purpose of this Conference to assist in that undertaking. In this forum, resources professionals, conservation-minded citizens and government officials annually assemble to discuss resources trends and issues and to consider pertinent programs and policies.

Rising criticism of professional resources management is a paramount conservation issue in the United States today. There is frustration with the professional manager's inability to guarantee without exception an undiminished flow of resources and resources values for all interests for all time. There is suspicion of the professions' ability to respond to changing social conditions and attitudes. Foresters contradict foresters. Wildlifers assault wildlifers. And a vocal contingent of environmentalists, including old and young, nourished by the controversy, pick and probe, looking for opportunity to advance cherished hopes and ambitions.

We suffer from internal strife and distraction. I caution that there are so few of us—of all of us—compared to the forces that are unmindful of our mutual concern. Change can come as necessary and with greater effect and less loss of public support and confidence, if we would work together rather than apart. If, in this Bicentennial Year, we establish better working relations and understanding, we will have accomplished a great deal.

Let me cite some examples. In the wildlife field, the wildlife profession regularly is charged with insensitivity. Agencies are criticized for acting too slowly, if they are credited with acting at all, in areas of nongame and threatened and endangered species. Management efforts, with all that management entails, are dismissed as having purely a consumptive purpose.

How wasteful of scarce human and financial resources. How thoughtless to try to tear down time-tested managerial systems rather than to strengthen them. While resources talent in the federal and state agencies is occupied by lawsuits, the national wildlife refuge system has accumulated a $60 million maintenance backlog. Scarce dollars are spent in courts rather than in the field. Philosophical victories are accorded greater importance than program accomplishment.

The Administration seeks again to cut off Water Bank funds so essential to wetlands preservation. No money is sought for the vitally important federal-state cooperative authority of the Endangered Species Act. While the Fish and Wildlife Service frankly acknowledges that the endangered species program cannot achieve momentum without active state participation, the Administration looks the other way. Some argue that the states should provide the funding for nongame and endangered species programs. Yet these are the same persons who helped to wrest this managerial responsibility from the states and vest it in the Federal Government, which accepted the responsibility it now declines to discharge.

In late 1974, the Wildlife Management Institute, on request of the Council on Environmental Quality and the Department of the Interior, undertook a national study of the levels of investment in nongame fish and wildlife by state and federal agencies and universities and colleges. The assignment required recommendation of a new national program catering to the needs of nongame species. We also were asked to identify potential new sources of income to support such a program. With the assistance of many of you here, the report was filed in early 1975.

Legislation to authorize a cooperative federal-state program for nongame species of fish and wildlife and to provide a reliable and adequate means of financing it has been developed by staff of the Senate Commerce Committee. It will be introduced shortly. By committing themselves to winning congressional approval, wildlife groups can aid this essential cause. Both state and federal agencies need the energizing flow of authority and funding. I call upon wildlife enthusiasts everywhere to join in this undertaking. Nonparticipatory criticism buys no lands, finances no research or law enforcement, and pays no salaries.

Destruction, contamination and occupation of habitat are the obstacles to maintaining North America's and the world's fish and wildlife. The purpose of management is to strive to maintain a role and a reason for fish and wildlife in face of humanity's use and misuse of the land. Questions of consumptive and nonconsumptive use can be resolved in the design of management and regulatory programs.

An amendment of the Fish and Wildlife Coordination Act is needed and long-overdue to help safeguard fish and wildlife habitat in federally constructed and permitted water resources projects. S. 1727 in the Senate Commerce Committee proposes vital amendment of the Act. A modified and improved version should be introduced soon. It seeks to elevate consideration of fish and wildlife to the earliest stages of project siting and planning. It would include the TVA and the Soil Conservation Service, not covered by current law, and would require purchase of lands and waters to replace those lost to projects in step with project construction. The choice is obvious: do we want still more Garrison Diversion and Cache River projects, or do we want intelligent use of water resources? The proposal was developed by the National Coordinating Committee on Fish and Wildlife in Federal Water Resources Projects, a creature of cooperative federal, state and private conservation interest.

Another example of where cooperative effort is needed involves the Bureau of Land Management. In some circles, it is popular to kick the BLM around. Inept, unresponsive, and user-oriented are the usual charges. Among the agency's severest critics, oddly, are some who most need BLM for wildlife, wilderness and aesthetic purposes.

A bill, S. 507, the so-called BLM organic act, recently passed the Senate for the third time in the last five years. The House has yet to move, and likely will not move, unless it receives much more stimulation than at present. The Senate rejected an amendment that would have given its old friends—the public lands livestock grazing industry—a special consideration. But they will try again. BLM's 1975 national grazing study report should have convinced even the hardiest skeptic of the sad results of disregard for the public range.

How much more productive and sensible it would be for everyone interested in fish and wildlife to insist that Congress give BLM the legal authority, the funding and staffing needed to properly manage its lands. It is pointless to criticize BLM employees for the agency's failings, when the Administration and Congress have failed thus far to give the agency the tools it needs.

Another case in point is the hassle generated by the Monongahela decision, a decision that limits Forest Service use of clearcutting. This practice has been under fire for some time and, with reason, in some areas. Congressional action seeks to conform present-day national forest management approaches with present-day realities and expectations.

One school of thought supports legislation precisely setting forth practices and procedures to be followed by the Service. This is the thrust of the Randolph-Brown bills, S. 2926 and H.R. 11894.

State fish and wildlife administrators should give close attention to this issue. National forests provide key fish and wildlife habitat in 43 states. Experienced biologists say the great specificity of the Randolph bill threatens the fish and wildlife interest. Groups desiring to limit clearcutting are suggesting actions that, if written into law, will harm fish and wildlife.

I do not suggest universal satisfaction with the national forest fish and wildlife habitat program. This work has been understaffed and underfunded for years. Timber management has received the lion's share of Administration and congressional support. Word of the Service's multiple-use mission has not reached everywhere, including to some of its own staff and personnel of the dollar-oriented Office of Management and Budget. Timber too long has been king.

Forcing balanced national forest management, including that for fish and wildlife, involves more than limiting the Forest Service's options or substituting congressional judgments for those of resources managers. On the one hand, the Service must be insulated from those political and economic pressures that lead to program imbalance. But on the other, flexibility must be retained to accommodate the hundreds of variables that exist on the land. But unless the state agencies participate directly and actively in shaping the legislative solution, the future of national forest fish and wildlife will rest largely in the hands of individuals and groups inexperienced in fish and wildlife ecology.

A more workable approach is needed than the identical Randolph-Brown bills; an approach perhaps that ties it to the Forest and Rangeland Resources Planning Act. This 1974 Act requires periodic resources assessments and planning. Under it, the Congress, the Administration and the Forest Service, for the first time, will be operating from the same blueprint.

Senator Humphrey, author of the Resources Planning Act, has a bill, S. 3091, that would fold the present issue into that comprehensive Act. The bill is not as specific as some believe necessary, but it avoids reserving all national forest management wisdom to Washington. A variation of the Humphrey bill in the House of Representatives is H.R. 12503, by Congressmen Johnson and Sisk, both of California. House Agriculture Committee hearings are being held this week; Senate hearings began a week ago. I suggest that state fish and wildlife agencies examine these proposals and make their recommendations known promptly to both the House and Senate Committees. Your agencies have the experience and knowledge. Unless your agency participates, your interest will continue to hinge on decisions made by others. In the present legislative situation, the voice of fish and wildlife professionals could be decisive.

The willingness and ability of the professional forester and professional fish and wildlife manager to deliver what the public wishes within the constraints of resources capability is being tested. In earlier and simpler times, the goals and results of this work were accepted without question. The old order has passed. How well the forestry and wildlife professions will do in the new order depends mostly on themselves.

If they react with the same invective and bellicose indignation with which they are confronted, they will fail. If they sit in their temples and preach and pray, then they deserve to fail. But if they accept the call and the challenge, if they react with skill and diplomacy and with persuasion, they will assure the professional management of this country's public resources for years to come. But more important than their personal and professional fate, they hold in balance the resources values they have rebuilt out of the wasteful extravagances of those hardy and single-minded persons who created this country.

Population, Food and Energy—the Need of New Policies for Our Future

Georg A. Borgstrom
Professor Department of Food Science and Human Nutrition and Department of Geography
Michigan State University
East Lansing

Give me your tired, your poor
Your huddled masses yearning to breathe free
The wretched refuse of your teeming shore
Send them, the homeless, tempest torned to me.

These are the often quoted words carved into the base of the Statue of Liberty. They depict well the driving force in this great epic of Western Man. Never before had man undertaken such a massive migration, and yet, it was across the vast ocean expanses of the Atlantic. The broad cemetery swatches across the water where millions found their grave are generally not taken into account in measuring the human toll of this great venture into the promised lands and the creation before long of an immense new nation.

Our 200 years are justifiably described in terms of great accomplishments registered in flourishing industries, booming cities, and a forthwelling cornucopia of food. But it behooves us on this solemn occasion to place all these impressive feats into the perspective of human history as it expands over the millennia. It is truly a new world, created within a brief period indeed. The reverberations of this unique event have been truly global, but let us remind ourselves that never in history did a group of men get a greater booty in land, forests, and minerals. Judged in retrospect we have, however, paid a very high price in squandered resources. Almost half our forestland is gone, many lakes and rivers are ruined or in jeopardy. The Carolina parakeet, passenger pigeon, the heath hen and many other invaluables are extinct—the list of endangered animals and plants has been constantly lengthening. Eighteenth century travellers raved about the dense forests of the east, presumably the finest our earth ever had, so dense that a squirrel was said to be able to move from Maine to Kentucky without ever touching soil. This green marvel has now largely vanished—covered up with concrete and asphalt in the emergence of vast megalopoli.

It was nonetheless the land that made America, and the farmers were the prime pioneers. From the humble harsh start evolved one of the world's greatest bread baskets, hewn out from the vast forests and prairies behind an ever expanding frontier. Railways were finally spanned across a continent of no less than 2 billion acres. This grand operation was crowned out West in the marshalling of the forest and fish reserves of the north and the transformation of California into an eldorado—no longer a pawn to recurrent droughts and at the mercy of ambitious rulers of the distant farflung empires of Spain and Russia.

Tribute should be given to those great pioneers of the plant kingdom—the American Indians—who not only through millennia of immense tenacity scanned the plant riches for edibles but also became impressive agrarians. Fully four-sevenths of our total crop production of today originates with plants they domesticated. The new state born in 1776 was a young agricultural giant with 90 percent of its people on the farm. All along the western fringes of the eastern farmlands were colonial cowboys tending to the beginnings of what was to become a mighty cattle industry—a true novelty but well suited to exploit the vast grassland expanses—a pampas counterpart in the north.

Clearing timber was a laborious task for the homesteaders in the wilderness of the east. They were overwhelmed by the forest oceans, but by 1840 the human flow emerged from the timber lands into the plainlands. Breaking of the tough prairie soils was a major challenge to man, animals and machines. Water emerged as another major challenge transforming many regions into windmill landscapes. The tenacious mule deserves a special tribute. She was a major ally in this great agricultural conquest, later also of the south.

We might in the technical sphere single out for credit the McCormick reaper, the John Deere steel plow, the combine harvester, the steam traction engine, soon driven by gasoline, to which was wedded the indispensable trucks. More land could thus be cultivated and the cereal grain crop increased 10 to 14 fold.

In man's lengthy quest for food and feed spanning over some eight millennia no single event had greater dimensions than the opening up of the North American continent to tillage and livestock. When the 13 continental colonies declared independence their inhabitants numbered less than 3 million. More millions gradually trickled in, but the great human tidal wave—history's biggest migration—was yet to come, reaching its peak in 1910-12. Towards mid-twentieth century some 100 million had left overpopulated Europe. Between 1830 and 1950 some 50 million reached this continent of North America—some 15 million swarmed into other parts of our Western hemisphere. No less than 500 million acres were added to man's cultivated domains to accommodate this avalanche. Europe in this grand operation not only lifted off one-fourth of its peoples but doubled its tilled land, trebled its pasturelands and manyfolded its forest lands and thus temporarily resolved its food and population dilemma.

In the 100-year period 1860-1960, U.S. population grew from 31 to 185 million, but this does not reflect the true size of the feeding task, when taking into account the livestock of all categories expanding from 0.5 billion to 1.34 billion PE units. Today this figure has reached 1.54 billion (together with pets, 1.73 billion). This mirrors the true biological dimensions of our U.S. feeding burden.

We passed the 200 million mark in human numbers by 1970, but China attained that number towards the end of the 17th century. It doubled that figure and attained 400 million by 1800 A.D. with yet another doubling to reach 800 million in the 1960's. India reached the U.S. level of 200 million only in 1870 but is now three times more numerous. Europe reached this point in 1810, but broke open in its seams. Despite the big lift-off, it doubled up by 1953. The U.S.S.R. attained 200 million by 1955.

China and India have paid a very high ecological price. Despite extensive cultivation of new lands they now have only one-third to one-fourth of the tilled land the U.S. has to feed each inhabitant, but in that process forest and pasturelands have been squeezed down to wholly inadequate levels. In the wake of that process, erosion, desertification, waterlogging, and salinization are jeopardizing the tilled land itself—and have only partially been compensated by doublecropping. Besides their huge dams are quick-filling through silting at a rate 10 times larger than anticipated.

How does the U.S. fit into such a long-range scenario? Are we or will we be up against similar ecological constraints? How does our brief 200 years of cultivating history stand up in relation to the basic resources of land, water, energy, and minerals? How have we fared as a recipient, primarily of the excess millions of Europe? Seemingly very well, as we have—not the least in recent years—since 1965 accelerated our sprightly climb up the ladder of nutritional prodigality to reach the world pinnacle of an average intake of 72g. of animal protein per person per day. This is three times more than any nutritionist would consider necessary. Besides, a well composed diet can well be put together entirely on the basis of plant protein. No wonder the world only counts some 480 million people who can afford to eat on our level. If all food now available on the globe were distributed equally it could feed 970 million people at our level—only one-fourth of the present world population. If food crops were substituted for feed crops in world agriculture, *all* persons now living could get an adequate diet but on a far more modest level. But this would not be true for very long as the world is now adding more than a billion (five U.S. populations) in less than ten years. We seem to fail to comprehend the magnitude and the dynamics of what now is happening on the world scene and we overlook the historical perspective. We have become so accustomed to a flashlight picturing of the world, forgetting that *now* is only a very brief episode.

Statistics may vouch for the success of the great westward epic. Yet an ecological post-audit piles up large debit accounts. Our guardianship does, in this regard, not deserve a high rating. That spectacular western drive culminated in one of the three major ecological disasters of our globe, the Dust Bowl catastrophe of 1935 when the topsoil of the Great Plains were carried by the winds as far as Washington and New York. China 3000 years ago and the Mediterranean at the time of Christ were the two prime forerunners of this prairie disaster. Using a paraphrase it can be claimed that never in history was so much destroyed to the benefit of so few. Commendable efforts have since then been made to mend our ways. Soil conservation became an integral part of land management, although what happened in 1974 and again in 1975 is a double reminder on one hand of how poorly we learned our lesson and on the other of our great delusion that technology had firmly moved us out of dependence upon the climate and its vagaries.

We constantly encounter entirely misleading notions about our relative standing in the world. The U.S. together with Canada is claimed to be feeding the world. Other times the statement is made that we are feeding the hundreds of millions of China and India. This is very far from the truth. We are at the very best providing a few percent of the annual consumption of these countries—far less than filling in the huge hunger gaps that exist in that world. Also in this area we need to look into the balance and recognize the paradoxes that the U.S. now is the world's top importer of beef as well as of fish and fish products. We are attaining a leading position in the net importation of dairy products.

Our biopotential is considerable and its strength is best mirrored in our bloated average food standard and world top-ranking in use of water, forest products, and many more. But we seem to overlook our great fortunes in the big lottery of mankind. Each American can draw his daily food from three times more tilled land than major nations in the developing world. Both China and India have far smaller acreages of pasture and forestlands than the U.S.

As a rule we permit discussion of our future forest needs in restricted national terms, seemingly forgetful of our big Canadian colony, from which we receive two-thirds of our newsprint to underpin our world dominance. With little above 5 percent of the world population, the U.S. consumes 30 percent of the world's output of industrial wood and 44 percent of the global output of newsprint. We have in this regard clearly transcended our national limits and made ourselves vulnerable in a future world which will be forced to a more equitable distribution and a less extravagant standard of living. Increased forest production is feasible but it translates into land and water in severe competition with agriculture, industry, and urban settlement. Some 350 gallons of water are devoured by the trees to produce the lumber and paper required to satisfy on the average what we think we require per person per day.

Fisheries share with forestry the dubious distinction of no longer sustaining selfsufficiency to our nation. Every since the 1950's more than half of our consumption comes from other nations. The intricacies of this issue cannot be covered here, but suffice it to say that the ocean and inland aquatic resources also have shaped the history of this nation, both in the northeast, northwest and around the Great Lakes. The Indians, ever since they crossed the Pacific land bridge, were pioneers in trapping these resources. The cod empire and the farflung whaling of New England for about two centuries was lost through the Civil War. The U.S. remained top ranked among the world's fishing nations until the 1930's. Since then we have declined to a point that by the late 1960's we were holding only fifth place. Our fish catches have stagnated in volume. Many rich coastal waters have been jeopardized through pollution.

We are now faced with a tremendous double-edged challenge, on one hand to restore the productive capabilities of our waters wherever jeopardized by pollution and coastal intrusion. We are faced with fisheries management on a scale we never dreamt of and far out over our entire continental shelves. On the other hand we are confronting the no less onerous task of wisely using these resources also to the benefit of the millions of the world.

In a finite world it is not a question of living more lavishly and exhibiting growing extravagance, it is a matter of economizing by using energy, land, water and food more wisely. Our feast is not only getting obnoxious, it is too costly for the world at large as well as ourselves. It is high time we exhibit greater national as well as global responsibility. This is the only road toward a better future.

Furthermore, the U.S. is today, with 2.8 times more people, withdrawing nine times more water than at the turn of the century. Yet this does not take into account how much more of the rainfall is used up by our larger crops, both totally and per acre. This varies by region from 2 inches to 10 inches. Nor does it indicate the degree to which we have accelerated the runoff by placing large areas under asphalt and cement for cities, roads, industries, airfields, sportsfields, and similar items. We generally overlook that our floodings mean net losses in available water. A major Mississippi River spring flood may well in a few weeks carry down to the Gulf of Mexico one-third of the basin's rainfall. This is detrimental to crops and groundwaters. Besides it upsets the salt balance in the coastal regions of Louisiana directly affecting shrimp reproduction and reducing catches.

Food is center stage in the water equation not the least due to irrigation, which accounts for more than 80 percent of our consumptive water use. Our great feats in this sphere are evidenced by the sevenfolding of this volume since year 1900.

Around the globe a ferocious battle for land is surging. Tilled land is currently right in the center of a four-pronged attack. Forestry and agriculture are grabbing each other's domains and prognoses about the future do not jibe. Besides these two, urbanization and industrialization constitute a forceful menace and to the degree that their spokesmen are so unaware to the essentiality of tilled land and the basic parameters of life that they anticipate the day when all surface traffic has moved underground and agriculture has been transferred to the oceans, eventually supported by food growing platforms.

The urbanization process has in many ways been our most disruptive force, gobbling prime farmland, tapping, wasting, and polluting water and unloading growing amounts of pollutants. The number of people in towns and cities have 15-folded since 1900 compared to a trebling of the total population. The per capita water consumption from the faucet has risen from 25 to 175 gpd. Strains and outlays have mounted with the growing distances between the farming lands and the consumers' tables. Industries have emerged as major transformers on this lifeline. We dumped our sewage through various devices in adjacent waters. At the same time we did our very best to reduce available water through ascending withdrawals and we reduced the charging capabilities by the release of huge quantities of wasted energy. The flow of minerals from the field was partially compensated by the fertilizer industries serving the farms not only filling in the voids but in some regions raising the operational levels of the soils.

Sewage aggravated the water pollution and contributed to a second fertilizing, this time of the waters (lakes, rivers and coastal regions) engendering a second organic crop. We failed in time to realize the ecological disruptions of this system. Nature knows no dumps. Most Asian civilizations have well understood this. We now have to create a viable urban ecosystem in order to save our waters and cities. The organic wastes will be the foundation of major supplementary food producing centers or in some cases new energy sources.

Water is looming as the next major crisis to erupt on the world scene. The International Hydrological Decade calls for almost total mobilization prior to year 2015 and the following management measures will be imperative. It goes without saying that groundwater tapping needs to be placed under firm control and regulation in order not to create vast new deserts and thus deprive future generations of land and survival facilities. The further prescriptions are vigorous and upsetting. More than 250 million hectares (625 million acres) additional irrigated lands are needed on top of the 500 million acres now projected or under development. Evaporation losses in irrigation need to be brought below 10 percent. U.S. losses in irrigation on a large scale rarely gets below 40 percent and frequently reaches 75 percent.

The mounting volumes of wastewater will gradually force a drastic reversal. Alternative and cheaper ways of disposing of sewage and industrial pollutants will be needed. Water can no longer be looked upon as a technical matter. The world is rapidly moving towards contaminating an amount of water approaching all the world's freshwater flow. Pollution is the most crucial matter also in the immediate future of the U.S. We can only in this regard accommodate around 50 million more people as our runoff could not satisfactorily handle more pollutants. We need to put a damper on further growth in human numbers and stop the ongoing acceleration in per capita pollution. Major portions of our continent are currently living on grace time by further emptying the groundwater accounts. This audience needs no reminder that wastewater is both for industrial and municipal use a key matter jeopardizing potable water as well as inducing critical environmental abuses.

One could place any major resource, whether land, water, energy, or food in center stage and show how profoundly it interacts with all the others. I have chosen energy as it operates through the back doors. Our whole technical civilization justifiably prides itself of its many accomplishments but it took the energy crisis to make us realize that so many of our feats depended on major energy inputs.

Such subsidies into agriculture and forestry, chiefly via fossil fuel, are largely a phenomenon of this century. Few realize that food originating with agriculture and fisheries, the great collectors of solar energy, have in this manner joined the ranks of supplementary thievery of energy. We know that the car runs on fuel, but we are less aware of the fact that the same is true about food. Each U.S. food calorie carries already at the farm gate an energy subsidy of three calories, and at the consumer's table of 12 to 15 calories. The U.S. has been leading the world in creating an agriculture so costly that it cannot be copied on a global scale. If implemented it would earmark 80 percent of the world's current energy account. Ecologists, economists and historians have failed to notice in time how dangerously we were travelling along in a fire balloon, constantly refueled with more and more, for the dubious advantage of flying at a higher altitude.

Per capita energy consumption is constantly looked upon as an indicator of national wealth and influence. Even the relative state of civilization is frequently measured this way, even defined in such terms. But we need to ponder the fact that in the period 1920-65, we were progressively more efficient in our use of energy. This trend turned around in 1965, reflecting waste or less productive use of energy. We are also in this regard at center stage in world economy. Even if we stabilized our energy consumption, it would take the world outside 120 years to catch up. This more than anything else explains the myopia with which we judge global matters. Energy is still another area where we have vastly transcended our limits and despite our riches made ourselves not only increasingly dependent on outside sources but indulged in a growth based on inefficiency.

Ecological factors and environmental values received a boost in the wake of the so called ecology crisis. Yet a major further step is called for. On the whole there is an urgent need not only to bring these issues more distinctly into the formulations of policies for future land use as well as water development. The coordination is faltering or in many regards totally lacking. The same basic considerations need to be incorporated into agricultural as well as silvicultural pursuits. Our failure to do so can primarily be inferred to the fragmented way in which we judge all these areas. This is most clearly mirrored in the fact that we fail to recognize that the sequence of crises we are living through are intimately tied together. They are all symptoms of the growing discrepancy between the harsh realities of our globe and the makeshift world we live in. On almost all counts we look at the world piece-meal. Everyone knows that our food production is broadly attached to a growing energy input. But few seem to consider that water availability is also dependent on energy.

Despite a multiplicity of Federal Acts, Presidential Commission Reports, a great number of regulating bodies as well as innumerable symposia on rural and urban issues, our action pattern is faltering. We are involved in commendable repair works on all accounts. We seem to have recognized the urgency of salvaging operations as to prime land, rivers, lakes, marshes, wilderness, coastlands, etc. But our accomplishment record is paltry. Inventories reveal that we have taken care of approximately one-tenth of the total U.S. needs as to flood control, at the most one-third of the soil erosion is checked. If we are to avert vast sprawling metropolitan swaths to cut further into the landscape, we must build 100 brand new towns within 25 years. In recent decades such towns have taken the more immediate forms of suburban sprawls and are only now transforming into more compact space-saving settlements.

Our national parks are crowded. To keep up with today's ratios of people to public space we at least need a doubling before year 2000 of both the present national parks and recreation areas as well as of accessible national forests. It is vital we realize that so far we have been active in all these costly endeavors chiefly as repair squads. We react to emergencies but we need to get ahead of the happenings. Band-aid operations and ambulance services may render relief but we cannot continue along a road of persistent accidents. Removing symptoms is no clever device when we should tackle the causes and still more vital yet is to move our so called development into sounder channels.

Ecology has too often retrenched behind seemingly imperative demands of conservation, but failed to recognize adequately its basic steering responsibilities. This key function was discovered far too late when abuses and irreversible destruction were rampant. In man's quest for food and feed he became an ecological superfactor in nature but only too late to retrench. On a global scale it has amounted to a transcendence of limits of almost colossal dimensions. For some time man truly believed he was the supreme ruler of Nature, living and nonliving. We are in great trouble due to this misconception and need to ponder the deep wisdom in Francis Bacon's words that we "can only rule Nature by obeying it" and act accordingly. We have to restore the balance by creating functioning ecosystems and arriving at a far better conception of the true and complete costs.

Economy therefore carries equal and concomitant responsibility in the balancing act and must take the blame for measuring programs and endeavors in equally short-range perspectives. A complete accounting is long overdue, but preemptory to all future planning. By arbitrarily choosing credit accounts and forgetting or concealing debit accounts mankind has not in time seen its limits.

A whole series of studies counted from the Parley Report of 1950 to the Report of the President's Commission on Population Growth (1972) have clearly focused attention on our shortcomings in and our lack of consistent policies to meet our future. Far too many have been shelved. Despite many admonitions and still more forebodings we have not taken measures to guide our destiny. It is a most alarming fact that we have not formulated national policies or even agreed on guidelines as to food production, nutrition, water, energy, land use, population, settlement or industry location. We have allowed all this to develop in a haphazard and inconsistent manner, detrimental to future generations. Applying emergency brakes here and there is a very poor substitute for changing the speed of our ride into the future. But more importantly we may be speeding along outworn tracks. Everything points to the urgent need of building entirely new tracks and roads into our future.

Two overriding demands are facing the U.S. in its guardianship of its resources. We can no longer allow ourselves merely to think in terms of the future needs of our own people. We carry an immense responsibility to the world's billions, similar to that of the oil sheiks. There is, however, one major difference. Food carries the advantage of being a renewable resource in contrast to oil. But this places our future handling of the resource prerequisites for sustained agricultural production smack in the center of prime concern. This may sound farfetched but it should be seriously considered that we as a nation formulate a world food policy and make this a part of the comprehensive national programs discussed earlier.

Let us return to where we started out—the emergence of a small nation of around 3 million born into a world of 810 million which was to reach its first billion only in 1820, the second billion in 1930 and then the third and the fourth in 1960 and 1975 respectively. From less than 4‰ (promille) we ascended to a grand power among nations—the fourth in size—and are moving quickly, maybe too rapidly, up to and past a quarter billion to a population anticipated at 265 million by year 2000. Can we accommodate 50 million more people? The customary approach is to visualize the many added demands for schools, hospitals, libraries, universities, cars and sewage plants, also the greater quantities of food, fuel, timber, paper, etc. The ecological repercussions are not taken into account.

We have a multi-faceted debate on environmental issues and land use matters. But there is a shocking lack of coordination in programming, as well as legislating, but most importantly in our thinking around these issues. We have not managed to formulate guidelines that coordinate the key areas of population, water, and energy, nor have we grasped the urgent need of coordinating agriculture and forestry with urbanization and industrial development. Each of these areas are by and large both judged and adjudicated as separate entities. Our future as a nation and as a world partner hinges upon our capability to put a stop to this fragmentation in our thinking. We have reached the critical juncture in our history when vested interests alone no longer can be allowed to determine our future course. It is a question of our collective survival. What benefits future Americans and the world community will be the determining factors.

Our rich heritage has been squandered for far too long—but we still hold such abundant resources that we can go back to the drawing boards and make America a functioning ecosystem. It is not a matter of writing history ahead of time. It is a question of safeguarding a livable future. President Jefferson in his first inaugural address visualized Americans as possessing a chosen country with room enough for our descendents "to the thousandth and thousandth generation." Only ten generations later we clearly discern our limits. By prudent accommodation we can make this land of ours a truly livable abode for many future generations, but only if we show restraint and start recognizing the historical and biological dimensions of our existence as a nation.

This is our greatest shortcoming—that we so badly eclipse our time scale by shortening our field of vision to the horizon of the next election, or that of the upcoming decade. At the very best we look towards the start of the next millennium—why not at least to the next 100 years of our nation? Our generation is in this regard faced with a colossal educational challenge. We cannot continue to mistake trends for destiny. We will have to shape our destiny within the ecological rulings for life as we know them.

Discussion

CO-CHAIRMAN ALLEN: This paper is now open for discussion. While we await questions, I am going to say that as an ecologist, and I know that many of you in the audience feel this way, it is certainly refreshing to hear a good scientist, whose past works we are all familiar with, talking in the terms that we hear Dr. Borgstrom express. He knows that his area of greatest interest has an intimate relationship with all of the conditions affecting mankind on this planet and he understands it. Too often we hear public statements by specialists who do not understand those relationships and Dr. Borgstrom is a great and notable exception.

DR. RICHARD WARNER [University of Florida]: I was especially interested in Dr. Borgstrom's comments concerning our marine resources exploitation patterns. In relation to this exploitation, do you see a peaking out of the productivity potential of our marine resources due perhaps to overexploitation and some destruction of habitat? Or is this due to a lack of focused national policy concerning the maximization and optimization of marine resources yields? Also, is the potential actually much higher in terms of productivity?

PROFESSOR BORGSTROM: I am glad you raised that question even though I cannot give a definitive response. The potential of our fishing waters within the Continental Shelf undoubtedly is very great but an increasing percentage of it, as you well know, has been taken by foreign nations, both on the East and West Coast and in Alaska.

It appears from present indications that the joint fishing interest is reaching a reasonable level. Therefore, in relation to the total product, as we take it from our waters, there is no stagnation involved. However, if we examine the total, then we will find we are reaching a plateau where we say, "For God's sake, let's take all this over." Then it becomes our responsibility to go back and see to what degree we have jeopardized the stocks. There is no question but that it is this threat which has reduced the casualties.

All of this, together with pollution, has produced these excessive pressures that we are currently witnessing and this is what we all now have to take into account in order to abate this loss.

Let me say, with regard to the jeopardy of these stocks, that it worries me a great deal. The point we are considering is whether or not we are going to take over all of this catch and use it all for ourselves. Goodness knows, we may not need all of these fish, so what are we going to do with them? Are we, for example, going to convert them into fish meal and get additional supplements in relation to our animal production, not to provide for the world, but to have us eat still more meat?

If we take that irresponsible attitude and do not see our world responsibility in protecting these resources, then we will be in difficulty.

MRS. COTTRELL FREE: I am a member of the Board of Directors of the Albert Schweitzer Fellowship. I would like for you to elaborate a little more on what you were talking around in a most skillful way. That is in relation to this wasteful use of water and land in raising every type of animal, which is really, in the final analysis, getting us nowhere. It would seem to me that this is what you are saying and also that raising grain for the support of the Soviet Union to feed its livestock is also getting us into something of a vicious circle. I will not expound in further detail on this but I would like to ask you if you think that vegetarianism might be part of the answer to the dilemma we are in today?

PROFESSOR BORGSTROM: Well, you have just mentioned a topic that would take a whole economics course to answer, but I will state it this way, as I hope I did in my presentation: the fact that there is immense waste involved in a great deal of our animal production, does not mean that we should save all of this by becoming vegetarians.

Let us remember one or two basic points which have been poorly understood, by anthropologists, historians and, I am afraid, all nutritionists. When one depends on the resource, it first requires processing. I refer to the early gathering of food seeds. Now, in the final analysis, this would not have provided much food.

Getting back to the fundamental point, however, if you take the livestock of the world today, it represents, in types of consumers, the needs of 14 billion people. Therefore, by combining all of our resources, we can feed some 14 billion more people, but this overlooks the fact that almost 10 billion of those animals are ruminants that have been great helpers of mankind.

Also, with regard to feed stock, a lot of it is a question of the basic utilization of our grasslands. As a matter of fact, in raising our food stock, these animals are provided with much better control of their amino acids and minerals and vitamins than we are giving to our own children.

I think that we still need to create a new urban ecosystem in which all of our animals may become a part of it, hogs, rabbits, quail, geese, etc. Insects may also very well be a part of this new food-producing environment, which we have not yet created. However, we have to do something like this to bring our consumption to a reasonable level.

Of course, the consequences of this excessive use of animal production on a world level involves excessive use of energy and excessive use of all the supplements in feeding. For example, we could feed all the world's people today if we used the tilled lands now used for feed crops and used them for food crops. This is where the essential feature will be.

I trust these more or less ramblings of mine have tended to answer your questions, at least in part.

CHAIRMAN FLEMING: Thank you, Professor Borgstrom, for that excellent and thoughtful analysis of the problem.

I suppose, put in larger terms and as one relates it particularly to the Bicentennial and perhaps those of us in the world of education, one repeatedly raises the question these days of whether, in a democracy such as we have, you can actually persuade people to forego some of their past practices in the interest of the future and, of course, as one looks around the world, that question is increasingly being raised. It is a very great challenge to the future.

Scientific Resource Management: An Historical Perspective

Susan L. Flader
Department of History, University of Missouri, Columbia

Between invasions by British forces in the depths of the American Revolution, Thomas Jefferson, then governor of Virginia, began writing a description of the environment and institutions of his state. It has become a literary and scientific classic under the title, *Notes on the State of Virginia.* His task was not unrelated to the fortunes of war, as he was writing to reassure the French government, our wavering but essential ally, about the viability of the American experiment.

For over a quarter century, ever since the noted French naturalist Buffon began publishing an unfavorable assessment of America in his multivolume *Natural History*, European intellectuals had been suggesting that the American environment was not fit for nurturing human civilization. As evidence of the unwholesome quality of the earth and atmosphere in America they pointed to the savage state and sparse population of the native Indians. They also contended that there were fewer varieties of animals in America than in Europe, that the native animals were smaller, and that domestic animals transported from Europe had degenerated on the American continent. Some writers went so far as to charge that even European settlers degenerated in the new world.

When the colonists declared their independence and fought for the right to establish a new nation, Jefferson felt compelled to answer the charges. He provided exhaustive lists of species and tables of careful skeletal measurements that included even the bones of a mammoth, a species he thought might yet be found roaming the American wilderness. (In the century before Darwin, it was commonly assumed that the perfectly ordered "chain of beings" created in the beginning was still intact.) His observations of weather indicated that the climate had improved in recent years, owing he thought to the clearing and cultivation of land and draining of swamps; and his table of colonial population increase revealed a doubling every 27 years, surely evidence of the productive capacity of the American land and people. *Notes on Virginia*, then, is a testament to the quality of the American environment, its promise of further improvement, and its capacity for nurturing a healthy, happy society.

Today's concern about natural resource capabilities, population needs, and quality of life did not originate in the media blitz of the 1970s nor even in the movement for scientific resource management in the Progressive Era at the turn of the century. Such concerns have been imbedded in the fabric of the nation from its inception, though their import has changed through time. This bicentennial overview will point to continuities as well as changes in our definition of resource problems, goals, and priorities. Though I have been asked to focus particularly on management of forests, fisheries, and wildlife, I believe that the limitations of our narrow approach to management of these resources can best be understood in terms of our historical responses to the changing needs and circumstances of the nation's development. Americans were managing resources long before they worried about preserving them, and many still think more in terms of managing discrete resources than in terms of preserving the system of which we are all a part.

Eighteenth Century Optimism

Thomas Jefferson, Benjamin Franklin, and other statesmen-architects of the new nation were also philosophers and scientists, men of the American Enlightenment. With their counterparts in Europe, they shared implicit faith in a perfectly ordered, mechanistic universe. They were confident that man as a rational being could attain complete understanding of the immutable laws governing the system and use this knowledge to shape his environment to his own advantage. That they were optimistic about the potential of scientific management is abundantly clear in their personal correspondence, diaries, and publications, which abound in discussions of environmental alteration and agricultural improvement.

Jefferson, for example, thought it was equally dangerous to clear too much forest land as to preserve forests uncut; he called for scientific investigation of the proper pattern of clearings in order to allow soil to dry out while maintaining trees to absorb miasmas, or "gross putrescent effluvia," from marshes and millponds. Like Washington, Madison, John Taylor and others, he experimented with new techniques of plowing, fertilization, and crop rotation to restore soils exhausted by the careless cultivation of tobacco. And to a correspondent in France he once suggested, half in jest, a plan for massive environmental manipulation worthy of the Corps of Engineers: simply make an opening through the Isthmus of Panama so that the westward-flowing tropical current could force its way through. Thus the gulf stream along the Atlantic seaboard would cease, ending hazards to navigation, and the fogs on the Banks of Newfoundland would disappear. The effect on the fisheries, he admitted, might be "problematical."

These were not people who were afraid of altering their environment. With their eighteenth century faith in a mechanistic universe perfectly knowable through science, they were largely free from doubt about unintended consequences of their actions. Nevertheless, one humble appeal to caution with a subtle rebuke to scientific arrogance comes to us in a parable from the pen of early America's greatest scientist, Benjamin Franklin (1753):

> Whenever we attempt to amend the scheme of Providence, and to interfere with the government of the world, we had need be very circumspect, lest we do more harm than good. In New England they once thought *blackbirds* useless, and mischievous to the corn. They made efforts to destroy them. The consequence was, the blackbirds were diminished; but a kind of worm, which devoured their grass, and which the blackbirds used to feed on, increased prodigiously; then, finding their loss in grass much greater than their saving in corn, they wished again for their blackbirds.

Management of land, in the view of the founding fathers, was not a proper function of government. It was the prerogative of the individual. As heirs of the protestant reformation, the founders of our nation shared a belief in the essential dignity of all human endeavor, economic as well as contemplative; and as followers of John Locke they assumed it was the function of government to provide broad opportunity for the release of men's creative potential by securing their rights to life, liberty, and property—or, as Jefferson put it, "the pursuit of happiness." In a nation of rich and abundant land, they believed the best guarantee of individual liberty and the happiness and health of the community was the practice of self-sufficient husbandry, fostered through the widest possible dispersion of freehold tenure in land. Hence the presumption in our national land policy until the end of the 19th century that all land in the public domain would eventually be disposed of to private individuals for family farms. The individual farmer was sole manager of his own freehold, and it was he who would have to willingly accept and apply whatever old traditions or new scientific techniques would maintain the productive capacity of his land.

That was the ideal—a self-sustaining community of husbandmen living in harmony with their land—and there were groups of farmers here and there in the nation who approximated it. But the more sober reality was compounded of America's unclaimed natural abundance and chronic shortage of capital and labor, which created a tendency to capitalize on cheap land. Thomas Jefferson understood it well, from personal experience with his own exhausted soil:

> The indifferent state of [agriculture] among us does not proceed from a want of knowledge merely; it is from our having such quantities of land to waste as we please. In Europe the object is to make the most of their land, labor being abundant; here it is to make the most of our labor, land being abundant.

Nineteenth Century Production

The attitudes and institutions that had fostered environmental manipulation and degradation in 18th century America were applied even more enthusiastically and less thoughtfully in the 19th century. A frequent explanation for the rampant exploitation of the 19th century is that government abdicated responsibility by adopting a hands-off policy. But the eminent legal historian James Willard Hurst focuses our attention instead on the extent to which public policy positively encouraged and facilitated the headlong pace of exploitation by establishing a framework that put a premium on productiveness. American policymakers shared a deep faith that rapid growth in material production was socially beneficial, that the release of individual energy in the pursuit of economic gain would redound to public good. (Of course, in releasing human energy by exploiting abundant resources we were actually mining biotic capital, but no one seemed to worry about that at the time.) Hence our increasingly liberal public land disposal policies, our use of law to protect risk capital and foster transportation facilities and national markets, and our reluctance to interfere in any way with the private productive process.

It is in this context that we should view 19th century efforts at natural resource conservation and management. The early promise of a science-based management embodied in the deliberations of Jefferson, Franklin and others barely survived the headlong conquest of the continent. Interest in nature and natural history did persist throughout the century, as revealed in the writings and paintings of Audubon, Wilson, Cooper, Cole and Catlin, Emerson and Thoreau, Melville, Whitman. These were individuals disturbed by evidence of conflict between nature and civilization, who identified America's uniqueness and our health and character as a nation with our nurturing in wild nature, who feared for the future of a civilization built on crass materialism, and yet who felt powerless before the juggernaut of progress. By mid-century the devastation of forests, pollution of streams, and eradication of fish and wildlife had progressed so far that more people became concerned and, after the Civil War, began to organize in interest groups to press for remedial action. In the 1870s they managed to spur government activity in two areas of resource management—fish culture and timber culture. But the very term *culture,* meaning cultivation or rearing, suggests that these efforts harmonized with prevailing attitudes by emphasizing production rather than trying to prevent exploitation. Let us examine the two activities in turn.

Fish Culture

Fisheries investigations began with the report of a Massachusetts fish commission in 1856. Later that same year the Vermont legislature appropriated $100 for a study, and George Perkins Marsh, highly regarded today as one of our first ecological thinkers, was appointed to the task. His report to the legislature of Vermont *On the Artificial Propagation of Fish* (1857) is a minor classic that foreshadows ecological concerns elaborated in his highly influential *Man and Nature, or, Physical Geography as Modified by Human Action* (1864).

Marsh knew exactly what the problem was. Fish habitat had been devastated by removal of forest cover and subsequent irregularities in run-off and stream flow, water temperature, condition of spawning areas, and nutriment availability. Add to this the proliferation of sawmills and factories along streams, their dams obstructing stream channels and their sawdust, dyes, and other refuse polluting the waters. Yet he concluded, with deference to the demands of progress, that these unfavorable influences could neither be removed nor controlled. "Our main reliance, in this, as in all other matters of economical interest," he wrote, "must be upon the enterprise and ingenuity of private citizens." Accordingly, he recommended legislation to protect private industry and capital employed in the artificial propagation of fish, by allowing fish culturists to appropriate certain public waters to their own exclusive use. Marsh's analysis of the problem of fish depletion was soundly ecological, but his solution capitulated to 19th century priorities.

Private fish culturists numbered nearly 200 individuals by 1870 when a group of them formed the American Fish Culturists' Association, now the American Fisheries Society. By that time 11 states had established fish commissions and begun stocking programs. In 1871 Congress established the U.S. Commission on Fish and Fisheries, and its major proponent, Spencer Fullerton Baird of the Smithsonian Institution, was named commissioner and charged with investigating the depletion of foodfishes on the coast and inland lakes. Baird, who has been called the father of fishery science in the United States, originally envisioned a wide ranging program of scientific research at the federal laboratory at Woods Hole, incorporating oceanography, meteorology, ecology and other disciplines in order to unravel the vexing phenomenon of fluctuations in species abundance. But he was also an astute politician who realized the popular and political appeal of fish culture. When the American Fish Culturists' Association successfully petitioned Congress in 1872 for an appropriation for the establishment of federal hatcheries for shad and salmon, Baird responded enthusiastically, thus launching the U.S. Fish Commission on what was to be its major endeavor until World War II. By that time federal hatcheries had reared more than 70 species. Expenditures for fish culture in the early years averaged about $70,000 annually as compared with less than $4000 for scientific research. State commissions also engaged heavily in fish culture, stocking vastly more fry than the federal government. Yet, despite the magnitude and popularity of federal, state and private programs, "it is now recognized," according to J. L. McHugh (1970), "that fish culture as practiced until recently was largely a sheer waste of energy and funds."

One species was successfully propagated, depending of course on one's definition of success. Carp. The program was Spencer Baird's brainchild, launched in 1877 with a special congressional appropriation and authority to construct fish ponds on the grounds of the Washington Monument. Master politician that he was, Baird was able to report to Congress in 1882 that he had distributed carp to 298 of the nation's 301 congressional districts.

Fish farming is coming into its own today as a valuable source of protein, and fish stocking efforts are far more sophisticated than they were in the 19th century. Yet we may still question the values of a society that defines management success by the percentage of trout, for example, caught before they can run the gauntlet of anglers standing shoulder to shoulder downstream from where the fish have just been dumped from the can.

Timber Culture

Nineteenth-century America's flirtation with timber culture, though not so extended as our affair with fish, was equally abortive. Proponents of timber culture argued that trees not only provided wood but also ameliorated the climate and caused increased rainfall. These were potent arguments for a people filling in the midcontinent prairies and anxious to extend their agricultural system westward onto the dry and windswept plains. The notion of forest influences on climate reached back at least to the eighteenth century Enlightenment, as we have seen. Alexander Von Humboldt advanced the concept in his enormously influential work, *Cosmos* (1844), and George Perkins Marsh elaborated it in *Man and Nature* (1864). Neither Humboldt nor Marsh asserted that forests actually caused an increase in rainfall, but their readers who promoted timber culture as a panacea for sub-humid lands were not so discreet.

For an insight into mid-century attitudes and exigencies, consider a report commissioned by the Wisconsin legislature in 1867 and prepared by a committee headed by the state's leading natural scientist, Increase Allan Lapham: *Report on the Disastrous Effects of the Destruction of Forest Trees, Now Going on so Rapidly in the State of Wisconsin.* With the advantage of hindsight we might expect the report to recommend measures to regulate the cutting of timber in the great northern pineries just then beginning to feel the bite of ax and saw. But virtually nothing is said about restraining cutting. After all, says the report, wood, cheap and abundant wood, is fundamental to the nation's growth and prosperity. Rather, the report recommends tax incentives to encourage individuals in the more heavily settled agricultural portion of the state to plant and preserve belts of timber between their fields, and it provides extensive details on the characteristics of tree species that might be planted. Drawing heavily on the notion of forest influences in Marsh's *Man and Nature,* but stepping beyond it, the Lapham report warns that without trees Wisconsin would revert from farmland to cattle range and eventually to desert:

> The small farm with its neat house, orchard and garden, its fields of yellow grain and tall corn,—the home of the happy family, will become part of a cattle range, for these alone can retain a foothold, until that other more distant day shall come when the winds and droughts shall reduce the plains of Wisconsin to the condition of Asia Minor. Trees alone can save us from such a fate.

Sufficiently impressed, the Wisconsin legislature in 1868 enacted a tax exemption and bounty to encourage farmers to plant protective tree belts. Apparently no one ever qualified for benefits under the law, with the possible exception of a central Wisconsin farmer who planted 1876 white pines to commemorate the centennial of American independence.

If the agricultural productivity of Wisconsin was thought to be tied to the maintenance of tree belts, how much more important was it to plant trees on the plains of Kansas, Nebraska, and Dakota Territory in order to increase rainfall and render the area suitable for family farms. Joseph Henry, head of the Smithsonian Institution, was one of the earliest and most vigorous proponents of timber culture on the plains. Ferdinand V. Hayden, director of the U.S. Geological and Geographical Survey of the Territories, went so far as to describe the luxuriant vegetation of the Tertiary epoch in Nebraska and suggest that forestation could restore such conditions. The commissioner of the General Land Office, Joseph Wilson, was ecstatic about the potential for increasing rainfall and proposed amending the Homestead Law to encourage tree planting.

Congress obliged in 1873 with the Timber Culture Act, which provided an additional quarter-section to homesteaders who would plant 40 acres to trees and cultivate them for 10 years. Although some settlers apparently did plant a few trees and several groves survived, the Timber Culture Act, under which over 40 million acres were entered and 10 million acres patented, was a notoriously abused land law because it expected the impossible given the state of forest science at the time. It was finally repealed in 1891, ironically in the same bill to which was fortuitously attached the famous rider authorizing the President to withdraw lands from the public domain for public retention as forest reserves—the start of our national forest system.

Timber culture and fish culture won enthusiastic support in the nineteenth century because they did not pose any threat or hindrance to private exploitation of the sort that would have been entailed by attempts to stop the pollution of streams or regulate the cutting of timber. Rather, they were perceived as positive actions government could undertake to encourage production, whether of fish or of agricultural crops. That some of our leading natural scientists so readily accepted and even promoted these programs may tell us something about the state of science at the time and the pressure on scientists to produce or at least promise immediately visible results. The impatient confidence in productivity so characteristic of 19th century America afflicted resource management just as surely as it afflicted resource exploitation.

Conservation as Protection and as Efficient Management

Though fish culture and timber culture were the major resource management programs to win political support in the post Civil War era, they were by no means the only concerns of the naturalists, sportsmen, and other citizens who joined together to protest heedless exploitation and promote resource protection. The late 19th century was the golden age of citizen conservation associations, not again rivalled until our own time. Over 300 sportsmen's clubs were organized in the 1870s alone, undoubtedly spurred by several national outdoor periodicals founded in that decade, such as *American Sportsman, Forest and Stream, Field and Stream.* Loosely allied with these were the fish culturists' associations, the American Forestry Association (1875) and the numerous horticultural societies, the Boone and Crockett Club (1887), the American Ornithologists' Union (1883), Audubon societies, and other ornithological and natural history clubs, and groups dedicated to preservation of particular areas, such as the Appalachian Mountain Club (1876) and the Sierra Club (1892).

The conjunction of interests of these diverse groups is suggested in the lengthy subtitle of *Forest and Stream*: "A Weekly Journal Devoted to Field and Aquatic Sports, Practical Natural History, Fish Culture, The Protection of Game, Preservation of Forests, and the Inculcation in Men and Women of a Healthy Interest in Outdoor Recreation and Study." The new movement was devoted to protection of resources and to improving options for the enjoyment of leisure time, goals which diverged from the dominant emphasis of the century on releasing human energy for material production through rapid exploitation of resources.

The innocent faith of an earlier generation that rapid material production would automatically redound to the benefit of society was belied by the unimaginable pace of change and unrestrained concentration of wealth and power in private and corporate hands in the post Civil War era. The early conservation associations were just a small part of a much broader movement of protest and reform that included farm and labor organizations, women's suffrage, temperance, health, and civic improvement groups, a number of which achieved modest political successes earlier than the movement for conservation of natural resources. Moral outrage was difficult to arouse when natural resources were perceived as inexhaustible. But toward the end of the century that assumption began to change. In a single generation Americans witnessed the decimation of bison from 15 million to 500 animals, the devastation of the Lake States pineries, the virtual extinction of the passenger pigeon, and the near-demise of sea otters and fur seals, plume birds and shorebirds.

In contrast to the production-oriented, nonthreatening approach of the earlier fish and timber culture programs, the new conservation associations by the 1880's became more concerned about protecting the remaining resources from exploitation by market hunters, the millinery trade, and lumber and fishing interests. They showed a new willingness to circumscribe individual freedom and entrepreneurial activity by promoting restrictive state fish and game laws, supported at the federal level by the Lacey Act of 1900, which prohibited interstate shipment of birds taken illegally for the market and the millinery trade. (We may note that Congressman Lacey's original version of the bill had avoided offending the market hunting and millinery interests and proposed instead to counter the problem of game scarcity by enlarging the duties of the U.S. Fish Commission to include propagation of game birds. But most citizen groups were no longer satisfied with such temporizing.) To the early conservation groups we also owe most of the impetus for the reservation of national forest lands, parks, and wildlife refuges, beginning in the 1890's. The new policy of retaining certain lands in public owership for conservation purposes marked a significant departure from the dominant assumption that all lands in the public domain would eventually be transferred to private individuals.

We tend to think of the creation of national forests, parks, and wildlife refuges and the passage of protective legislation for wildlife as an outgrowth of the movement for scientific resource management spearheaded by Gifford Pinchot during the administration of Theodore Roosevelt (1901–1909). But the record suggests that citizen groups had built up substantial momentum for protection of resources and recreational opportunities well before then, and that the sources and aims of the two movements were somewhat different. Part of the achievement of Pinchot and his associates lay in capitalizing on the pre-existing moral fervor for resource protection and channeling it into support for their programs of scientific resource management. The result was certainly a stronger base for federal resource management agencies, especially the Forest Service, but this co-opting of the citizen movement may well have sapped its vitality and led to the fractioning of interests, petty squabbles, and minimal influence characteristic of the movement down to recent times.

The movement for scientific management in the early Forest Service and other federal agencies, however closely allied to the citizen movement, had somewhat different roots and priorities. Like the citizen movement, it was a response to the excesses, waste, and social costs of unrestrained economic expansionism in the post Civil War era. But its dominant concern was not so much to preserve our remaining natural heritage as to rationalize the production system and manage it in the public interest. Among Gifford Pinchot's intellectual progenitors were government officials of the late 19th century like John Wesley Powell of the U.S. Geological Survey and his associates, Lester Frank Ward and W G McGee, who sought to introduce scientific expertise and rational planning in government. It was McGee, secretary of the Inland Waterways Commission in the Roosevelt administration, whom Gifford Pinchot called "the scientific brains of the conservation movement."

These men, sometimes called "reform Darwinists," argued that the ultimate end of the evolutionary process was the evolution of intelligence in man. Man as a rational being with technology and institutions of social control had the capacity and responsibility to restrain the competitive impulse of his animal nature and reconstruct the physical and social environment in line with the needs of the entire human community. As Gifford Pinchot (1910) put it, "The first duty of the human race is to control the earth it lives upon." The progressive faith in the possibility of intelligent control was not unlike the Jeffersonian faith in man's capacity to improve his environment, though it was premised on evolutionary possibility rather than immutable order and it relied less on individual initiative and more on the rational guidance of a managerial elite.

The conservation idea was potentially a challenge to the American economic system, yet Pinchot and his colleagues emphasized its compatibility with the system. Though the forests would remain in public ownership, Pinchot insisted that conservation meant development, and even described a forest as "a manufacturing plant for the production of wood." In establishing what he called "scientific forest management," Pinchot drew in part on his familiarity with the sophisticated techniques of sustained-yield silviculture developed in Germany and introduced to the United States by Bernard Fernow. But he relied perhaps even more on the sort of "scientific management" propounded by efficiency experts for American industry such as Frederick Winslow Taylor. The Forest Service administrative organization became a model of efficiency under a President, Theodore Roosevelt, who proclaimed (1909) that "in this stage of the world's history, to be fearless, to be just, and to be efficient are the three great requirements of national life."

Thus "scientific forest management" emphasized managerial science more than biological science, and sustained production of commodities more than preservation of the resource. Though the biological basis for forest management by the early 20th century was not quite as vulnerable as it had been at the time of the Timber Culture Act, it was still woefully inadequate. Yet such research money as there was went overwhelmingly to investigations of wood utilization and other aspects of commodity production rather than to basic understanding of forest ecosystems. In its emphasis on the positive role of government in fostering commodity production, scientific forest management remained squarely in the American tradition.

A similar emphasis came to dominate the U.S. Biological Survey and also the Bureau of Fisheries, which were merged to form the Fish and Wildlife Service in 1940. The forerunner of the Biological Survey was an office of economic ornithology and (later) mammalogy established in 1885 within the Bureau of Entomology in the Department of Agriculture to develop methods for controlling agricultural pests. But its first chief, the noted zoologist C. Hart Merriam, led the agency more into biogeographic survey and taxonomic biology. By the early 20th century, however, congressional pressure forced a return to the original economic emphasis on controlling predators, noxious rodents, and exotic pests for the benefit of farmers and ranchers. The agency was also given regulatory authority over migratory waterfowl and the federal refuge system, but these were secondary functions.

The Bureau of Fisheries, after 1903 a part of the Department of Commerce and Labor, accelerated its programs of artificial propagation, hoping thereby to aid the fishing industry. In the much studied case of the Alaska salmon fishery, for example, about 15 times as much was spent on hatcheries as on scientific research. When the futility of the hatchery program began to be recognized in the 1920's and emphasis shifted to regulatory activity, Commerce Secretary Herbert Hoover applied his philosophy of rationalizing production by cooperative arrangements with industrial trade associations. The total pack of canned salmon continued upward and the industry was satisfied, but the fishery continued down the road to depletion.

Preservation of the System

The gradual transition to a fundamentally different orientation to resource management can be viewed in the thought of Aldo Leopold (1887–1948), who began his career as a forester, used forestry as a model in developing the new profession of game mangement, and then became one of the nation's most effective expositors of an ecological and ethical attitude toward man and land.

During his career in the Forest Service, Leopold was very much imbued with the notion of efficient management. As chief of operations in the Southwest during the early 1920's, he devoured books on scientific management and personnel administration by Frederick Taylor and others and threw himself into the details of fire control organization, financial management, and forest inspection techniques for 20 million acres of national forest. Yet he chafed under the prevailing emphasis on methods, procedures, and output of commodities—what he termed "machinery standards"—and sought to develop management criteria related to the qualitative condition of the forest environment. In this he was vastly ahead of his time, for the ecological research to support such an effort had barely begun.

Curiously, however, when we examine his approach to game management at this time we find him more in step with the traditional Forest Service emphasis on commodity production. Leopold began his campaign for wildlife conservation in the Southwest by organizing local game protective associations to promote enforcement of game laws, the eradication of predatory animals, and the creation of wildlife refuges. His aim was to restore deer and wild turkey to huntable populations and only incidentally to provide protection to other less commercially valuable species.

By the early 1920's he had begun developing principles of scientific game management modeled on concepts and techniques of sustained-yield forest mangement, but still his emphasis was on the production of shootable surpluses. "The most important single development which the last ten years have brought forth is implied in the word 'management,' " he told the National Game Conference in New York in 1924. "We have learned that game, to be successfully conserved, must be positively produced, rather than merely negatively protected. In short," he continued, "we have learned that game is a crop, which Nature will grow and grow abundantly, provided only we furnish the seed and a suitable environment." This emphasis on the importance of creating favorable habitat was a major advance over the prevailing practice of artificial propagation by private operators and government agencies. Yet this important new emphasis on habitat management should not blind us to the limitations of a too-exclusive focus on commodity production, even if it is production in the wild.

When deer populations mushroomed and destroyed their range on the Kaibab Plateau and in the Gila Wilderness, Leopold interpreted the population increases as testaments to the effectiveness of management, which however now required more scientific techniques of control. That there were forces operating in the system independently of the conscious efforts of the managers, forces that caused substantial environmental changes and hence affected deer populations, he scarcely appreciated at the time. As a commodity-oriented manager, his focus was on the species more than on the environment. (One may note that such exclusive focus on the species and the consequent failure to consider broader ecosystem relationships is now considered to be even more of a problem with respect to fisheries and forms much of the scientific basis for the current challenge to the concept of maximum sustainable yield in fisheries management.)

Leopold's faith in the possibility of ultimate environmental control through scientific management, a faith he shared with the Jeffersonians and the progressive conservationists, is clearly evident in the preface to *Game Management* (1933) and even, somewhat surprisingly, in his first formulation of the land ethic concept, a 1933 speech titled "The Conservation Ethic." Though many passages in the speech reveal his groping toward a new formulation of the role of scientific management in the man-land relation, he ends with an assertion "that the idea of controlled environment contains colors and brushes wherewith society may some day paint a new and possibly a better picture of itself." This faith in the potentialities of control would undergo transformation in the next few years.

The 1930's were years of conceptual reorientation for Leopold and other leaders in the biological sciences and management professions. These were the years, according to historians of science, when various strands of evolutionary and ecological theory, separated during the furor over Darwin's *Origin of Species* (1859), began almost suddenly to merge into a broad unified theory, as indeed the ecological and evolutionary strands had been merged in Darwin's own thought. From this fusion came the ecosystem concept—the notion of soils, waters, climate, plants, and animals, including man, functioning in an integrated system of material and energy. The system has a time dimension—the evolutionary process—through which it tends to increase in diversity and organizational complexity and hence in its capacity for sustained functioning and efficiency in energy use.

The new conception, as Leopold (1939) viewed it, had important implications for the management professions. The old approach of economic biology sought to give a competitive advantage to those species deemed useful to man, such as deer or pines or corn, as against those deemed harmful or expendable, such as predators, rodents, or insects. But the new approach, as Leopold put it, "lifted the veil from a biota so complex, so conditioned by interwoven cooperations and competitions, that no man can say where utility begins or ends." The new conception engendered in him a profound humility about the prospects for understanding the functioning of ecosystems well enough to exercise intelligent control. The objective of management, as he now viewed it, was primarily to preserve or restore the capacity of the system for sustained functioning and self-renewal—what he termed land health—by encouraging the greatest possible diversity and structural complexity and minimizing the violence of man-made changes. Only secondarily was management concerned with producing a harvestable surplus.

In his presidential address to the Wildlife Society in 1940 Leopold looked forward to "an almost romantic expansion in professional responsibilities" as a consequence of the new approach. Wildlife men, he suggested, might be helping to write a new definition of the purpose of science. Most definitions dealt almost exclusively with the creation and exercise of power—or the notion of environmental control. "But what about the creation and exercise of wonder, of respect for workmanship in nature?" he asked. He was looking toward the day when the "senseless barrier" between science and art would blow away, and he hoped that ecologists might help do the blowing.

Although few ecologists were as effective as Leopold in illuminating the esthetic dimension, many contributed to enlarging our understanding of basic ecosystem relationships. Leopold's own research emphasis in the late '30's shifted from efforts to increase the supply of harvestable game by simple manipulation of habitat to what he termed "deep-digging" research into the enigmas of animal population mechanisms. Similarly in the field of fishery research, the 1930's saw new efforts to understand and measure fluctuations in fishery stocks and to comprehend the dynamic relations of total communities. And in forestry these were years of increased attention to the role of fire, insects, disease, and other factors of natural disturbance in forest ecosystems, only now coming to fruition.

This is not to say that all scientists and resource managers immediately adopted the new ecosystem concept or that those who did all drew the same implications from it. Quite the contrary. Among those who did identify with the ecosystem concept, many retained a reductionist stance. Far from adopting an attitude of humility toward man's capacity to understand and control the system, they argued that man, as an exceptionally powerful factor in the ecosystem, had the capacity not only to upset equilibria but also, through science, to create new ones of vastly different character better suited to his own needs and purposes. This biotic arrogance was buttressed by the wartime mobilization of science and the spectacular pace of change in post World War II America, when industrial foresters developed new techniques for efficient harvest and artificial regeneration of trees, commercial fishing fleets with new technologies more than tripled world catches of finfishes, and the new chemical pesticides like DDT promised complete control over insects and insect-borne disease.

The technological optimism represented by such developments finally began to meet more effective challenge from scientists and citizens alike, beginning around 1962 with the publication of Rachel Carson's *Silent Spring*, continuing through the organized citizen campaign for the Wilderness Act to the anti-pollution crusades of the late '60's and the energy consciousness of the '70's.

To a greater extent perhaps than at any time since the founding of the nation we are questioning the economic, social, and environmental basis of our civilization. In 1972 a leading survey researcher, Daniel Yankelovich, identified a new complex of attitudes among students on college campuses that he termed "the new naturalism." At the heart of the movement is a stress on the values of community as opposed to competitive individualism. Along with this goes a search for what is sacred in nature and a concomitant tendency to devalue scientific rationality, technological mastery over nature, and economic growth. While we may be disturbed by elements of apparent anti-intellectualism and distrust of science, especially on such emotion-laden issues as clearcutting or the values of hunting, we ought to recognize this phenomenon as at least in part a reaction to the insensitivity and limited perspectives of the established management professions. If Yankelovich's prediction is correct that the new naturalism will become "a powerful force, nationwide in scope" before the decade has passed, this cultural revolution presents an enormous challenge to scientific resource management and lends support to the ecosystem approach humbly conceived.

More recently, the Council on Trends and Perspective of the Chamber of Commerce of the United States issued a report on economic growth intended to convey to the American business community the reality, the depth and the import of required changes in technology and patterns of living if the scenarios projected by the "prophets of doom" are not to become reality. "The ecological approach is not a 'noneconomic' way of looking at the world," the report states. Rather, it is a much broader view, focusing as it does on social and environmental costs, distributive inequities, and non-market claims on resources. The report concludes that "the ecological approach will become increasingly influential as a basis for economic calculation." While such statements should not be taken to imply acceptance of an ecosystem view of man, culture, and environment, this report by business leaders corroborates the student view that the dimensions of the environmental problem extend far beyond the bailiwicks delimited by professional resource managers earlier in the century.

The implications for scientific management of our rapidly expanding outlook are tremendous. To begin with, we need to appreciate that though the biological basis for management remains inadequate, biological science alone is not a sufficient basis for management. If we grant that man is a part of the ecosystem, we must realize that his institutions, attitudes, and values are also a part of the system and subject to change through time. It is an open question what sort of balance will be struck between the weight of our historical expectation of material growth and faith in technological control, on the one hand, and on the other our new understanding of the dramatically different and changing environmental context in which we function. One of the most important contributions of ecosystem research to date is the dawning realization that naturally functioning homeostatic mechanisms or "biological controls" in a basically healthy environment are more reliable in the long run than attempts at total control through eradication of "enemies." We have to learn to encourage diversity and accept a degree of risk and uncertainty in biological relationships and also in human affairs.

If we move toward a more healthy, self-sustaining economy, the so-called "renewable" or "flow" resources such as forests, fisheries, and wildlife, which utilize energy more or less directly from the sun, become increasingly vital. It has been suggested (Abelson 1976) that the United States could, in the future, maintain "an austere but satisfactory economy" based on trees as a principal energy source, much as we did until well into the 19th century. Such considerations, of course, can serve to justify ever more intensive management and utilization of renewable resources. But let us remember, as we tout the energy and material advantages of these resources, that the ecosystems of which they are a part are also the habitat of man.

We return to the question Thomas Jefferson addressed during those dark days of the Revolution: What is the capacity of the American environment for nurturing a healthy, happy society? No longer can we take refuge in easy optimism engendered by faith in an immutable universe perfectly knowable through science. We know that we are part of a complex, dynamic, and unpredictable system. Nor can we continue to evade the responsibilities of interdependent community life by continued expansion to new land or ever-increasing material production. We are being brought up short against the reality of limits. But paradoxically, the challenge of coming to terms with limits on scientific understanding, material resources, and individual freedom of action may make the Jeffersonian ideal of a healthy, happy, self-sustaining community more viable for us than it was for Americans of the Revolutionary generation who were spurred toward exploitation by the challenge of a vast, unclaimed continent.

As we contine our search for a better adjusted, more viable economy and society, we must find new avenues to human fulfillment and happiness, new ways to release creative human energy that do not result in continued drain on biotic capital. The opportunities for resource managers to encourage creativity in these new realms are endless, but in the process they may become something other than resource managers. As Aldo Leopold suggested as early as 1934:

> In the long run we shall learn that there is no such thing as forestry, no such thing as game management. The only reality is an intelligent respect for, and adjustment to, the inherent tendency of land to produce life.

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Toward Legal Rights for Natural Systems

Christopher D. Stone

Professor
University of Southern California School of Law
Los Angeles

Ladies and gentlemen, although I come before you as a lawyer to advocate new forms of lawsuits, I do not want to suggest that the law is the solution to our environmental problems. What the law can do is limited. By the time a problem gets to the courts, the underlying harm will often be far advanced, if not irreversible. For significant changes, we need not so much law, as advances in technology—for example, energy conservation—and a development in human awareness.

Then, too, as one who teaches law, I am acutely concerned that lawsuits are a very poor way of communicating value. When someone sues someone else, the immediate reaction is hostility and the creation of certain very elaborate defense mechanisms. When industry is sued in an anti-pollution suit, for example, resentment is engendered exactly where some shared understanding and common sense of values is most called for—if there is going to be a long-range adjustment to our environmental needs.

Consider, for example, that no legal system can possibly police what every factory or nation state is dumping into the waterways in the dark of night. A long-range adjustment has to be made, based upon, first, a moral awareness, then changes in consciousness, and changes in perception.

Secondly, there have to be changes in technology. We need purer forms of energy, utilizing sources such as solar and geothermal. We need waste recycling and energy conservation. Those things we need more than law, which we probably rely on altogether too much in the Western World.

Even though I have misgivings about the reach of the law, in this less than the best of all possible worlds, law is not to be discarded lightly. In fact, the law can be one of those necessities that mothers invention. It is indeed remarkable how often, in human history, industry has said that some task was economically impossible, "out of the question," but when commanded by law, found the task and technology not only possible but a money saver. For example, when pasteurization was first ordered by law, the dairy industry claimed it would put them out of business; but only later did they discover that the practice, by increasing the shelf life of milk, was actually a boon to the industry.

The law can also help bring about the development of the sort of social conscience society needs, and that brings us a step closer to the basic theme I want to discuss today.

As some of you know, I have gained notoriety in the past few years by advocating that environmental objects—I think I should prefer to say natural systems—be accorded their own legal rights. This is a statement which is easily misunderstood. To say, for example, that the natural environment should have rights is not to say anything as silly as no one should be allowed to cut down a tree. Human beings have rights but, at least at this time, they may be executed. Corporations have rights, but they cannot plead the Fifth Amendment. Also, the case of *in re Gault* gave 15-year-olds certain rights in juvenile proceedings, but it did not give them the right to vote. In the same way, to say that the environment should have rights is not to say that it should have every right we can imagine, or even the same bodies of rights as human beings. Nor is it to say that everything in the environment should have the same rights as every other thing in the environment. What, then, does it mean?

First, for a thing to be a holder of legal rights, nothing is more basic than that there be in the social structure some authoritative body prepared to review and call to question the actions of those who threaten it.

But that isn't all. As I shall use the term, "Holder of Legal Rights," each of three additional criteria must be satisfied. All three, one will observe, go towards making a thing count jurally—to have a legally recognized worth and dignity in its own right and not merely to serve as a means to benefit "us," whoever the contemporary group of rights-holders might be. They are as follows: First, that the thing can institute legal actions at its behest—to have what the lawyer calls standing: Second, that in determining whether to grant legal relief, the court must take its injuries into account; Third, that relief must run to its benefit.

To illustrate, let us consider two hypothetical societies, each of which condones slavery. Let us call one of them S-1 and the other S-2.

Suppose now that under the laws of S-1, if someone beats a slave, the slave's master can, if he chooses, go to court, and the court will make the defendant pay him the reduced value to him of his slave's lost labors. If, for example, the slave has lost the use of an arm, the damages will be measured by the reduction in his productive worth to the master.

Now, on the other hand, contrast this with the laws of S-2, in which the slave can institute the proceedings himself, whether his master approves of the lawsuit or not, for his own recovery, the measure of damages including, say, his pain and suffering.

Please notice that neither society is so structured as to leave wholly unprotected the slave's interests in not being beaten. However, in S-2, as opposed to S-1, there are three operationally significant advantages that the slave has and these make the slave in S-2, albeit a slave, a holder of rights.

Consider now how these special legal features of slavery parallel our treatment of the environment. Take the common law's posture toward the pollution of a stream. True, courts have always been empowered, in extreme circumstances, to issue orders that will stop pollution, just as the legal system in S-1 is so structured as, incidentally, to discourage beating slaves. But the stream itself is fundamentally rightless, with implications that deserve careful reconsideration.

The first sense in which a stream is not a rights-holder has to do with standing—the power to institute legal actions when its interests dictate. The stream itself is legally voiceless. So far as the common law is concerned, the polluter's actions are not going to be challenged unless and until a lower riparian (the law's term for the owner of the land abutting the stream) is willing and able to show an invasion of his own human rights—to demonstrate that he is suffering.

This conception of our legal system—that it is the riparian who holds the right to bring suit—has more than theoretical interest. It means, for example, that the pollution may go unchallenged. The lower riparians may simply not care about the pollution upstream. They themselves may be polluting and not wish to stir up legal waters. They may be economically dependent on their polluting neighbor. They may not want to pay the cost of clearing all the doctrinal hurdles the law lays in their way.

Now, the second sense in which the law denies "rights" to natural objects has to do with the way in which the merits of the case are decided. The question here is, even in those controversies in which someone is competent and willing to establish standing, how significantly are the injuries to the environment going to weigh in the final judgment? The answer is, very little.

The balance courts strike are fundamentally aimed to adjust the competing human interests rather than the interests among humans and the environment. In other words, judges weigh the economic hardships on the upper riparian (or dependent community) of abating the pollution vis-a-vis the economic hardships on the lower riparian of continuing to put up with the pollution. What does not weigh in the balance, however, is the damage to the stream itself as a system comprising fish, turtles and lower plant and animal life. As long as the natural environment is rightless, these are not matters for judicial cognizance.

The third way in which the common law makes natural objects rightless has to do with whom it regards as the beneficiary of a favorable judgment. Here too, it makes a considerable difference that it is not the natural object that counts in its own right. Even if someone wins a water pollution suit for damages, all the polluter has to pay is what the pollution was costing the plaintiff—the reduced resale value, say, of his land. No money has to be paid to the benefit of the stream itself to repair its damages. This omission has the corollary effect that the potential damages the law confronts a polluter with—our threat to make him stop—may not be so much as to force him to desist, even where the total injury he is causing, injury to the stream included, outweighs what the polluter's production is contributing to the society.

As I stated at the outset, this rightlessness of the natural environment can and should change. Indeed, it already shows some signs of doing so. It is not inevitable, nor is it wise, that natural objects should have no rights to seek redress in their own behalf. It is no answer to say, for example, that streams and forests cannot have standing because streams and forests cannot speak. Corporations cannot speak either, nor can states, estates, infants, incompetents, municipalities or universities. Lawyers speak for them, as they customarily do for the ordinary citizen who has legal problems. What I advocate, is that we handle the legal problems of natural objects as we do the problems of legal incompetents—human beings who have become vegetable. If a human being shows signs of becoming senile and has affairs that he is not competent to manage, those concerned with his well being make such a showing to the court, which can invest a guardian with the authority to manage his affairs. Courts make similar arrangements when a corporation has become "incompetent"—they appoint a trustee in bankruptcy or reorganization.

On a parity of reasoning, we should have a system in which, when a friend of a natural object perceives it to be in danger, he can apply to a court for the creation of a guardianship. If there were indications that some redress was called for on the environmental system's behalf, let us say a stream, for example, then the guardian would be entitled to raise the system's rights in the system's name, without having to make the round-about and often unavailing demonstration that the "rights" of some environmental club's members were being invaded. By doing so, we in effect make the natural object, through its guardian, a jural entity competent to gather up these otherwise unrepresented damage claims and press them before the court even where, for legal or practical reasons, they are not going to be pressed by traditional class action plaintiffs.

Indeed, one way (the anthropocentric way) to view what I am proposing so far is to view the guardian of the natural object as the guardian of unborn generations, as well as of the otherwise unrepresented but distantly injured, contemporary humans.

By making the lake itself the focus of these damages and incorporating it so to speak, the legal system can effectively take proof upon and confront the polluter with a larger and more representative measure of the damages its pollution is causing than is possible under the law as it now stands.

But even beyond this, I favor a system in which the guardian would urge before the court injuries not anthropocentric and not presently cognizable—the death of eagles and inedible crabs, the suffering of sea lions, the loss from the face of the earth of species of commercially valueless birds, or the disappearance of a wilderness area.

One might, of course, speak of the damages involved as "damages" to us humans in the derivative way, for the widespread growth of environmental groups testifies to how many humans feel these losses.

This leaves open the problem that if damages are to be imposed on someone who has intruded upon these values, how are the costs, the actual monetary worth, to be calculated? When we protect given property rights in relation to an invention, there is at least a basis in market demand for it by reference to which damages against a patent infringor can be computed. However, the lost environmental values of which we are now speaking lie outside what any market is prepared to bid for, and they are, in this sense, priceless.

One possible measure of damages suggested earlier would be to assess the wrong-doer the cost of making the environment whole; namely, putting it in the position it was in or would have been in had the wrongful injuries not occurred. When a man is injured in an automobile accident, for example, we impose upon the responsible party the injured man's medical expenses and lost salary. A comparable award to a polluted river would include the costs of dredging, restocking with fish, etc.

Threatening despoilers with legal penalties does not mean putting a "freeze" on progress. Often compromises can be worked out.

For example, in the debate over the laying of the Trans-Alaskan pipeline, the builders proposed at one time to meet conservationists' objections half-way by re-establishing wildlife away from the pipeline so far as was feasible.

One reason for making the environment the beneficiary of a judgment in its own right is to prevent it from being "sold out" in a negotiation among private litigants. Should a decree enjoining despoliation be entered between human interests alone, there is nothing to prevent them from agreeing, at a price, not to enforce their legal rights. The natural object can be protected from this only if it itself is made a party to the injunctive settlement.

Even more importantly, we should make it possible for the natural object itself to be a beneficiary of monetary awards. If, in making the balance of interests requisite to issuing an injunction, a court decides not to enjoin a lake polluter who is causing injury to the extent of $50,000 annually, but to have the polluter pay damages instead, that the lake ought to be entitled to its share along with the riparian humans who are going to have to suffer. The natural object's portion should be put into a trust fund to be administered by the object's guardian. Guardian fees, including legal fees, would then come out of this fund. More important, the guardian would draw on the available monies to preserve the natural object as much as possible, purchasing new stock, installing aeration systems, or doing whatever seemed most appropriate.

The idea of assessing damages as best we can and placing them in a trust fund is far more realistic than a hope that the total freeze can be put on the environmental status quo. Nature is a continuous theatre, in which things and species are destined to enter and exist. In the meantime, co-existence of man and his environment means that each is going to have to compromise for the betterment of both.

Some pollution of streams, for example, will probably be inevitable for a long time. Instead of pretending to set an unrealizable goal such as enjoining absolutely the discharge of all pollutants, the trust fund concept would help assure that pollution would occur only in those instances where social need for the polluter's product was so great as to enable the polluter to cover all homocentric costs, plus some estimated costs to the environment per se. The fund would, if necessary, be a corpus for preserving monies while the technology developed to a point where repairing the damaged portion of the environment became feasible.

The prospects for such changes in the law are not as far-fetched as they may sound. In fact, I do not think it would be a misreading of several recent developments, and the National Environmental Policy Act is one, to say that we are already on the verge of assigning some such rights, even if we have not faced up to it in those terms.

Shortly after this proposal was originally published in the USC Law Review, then Supreme Court Justice William O. Douglas endorsed my position in his dissent in the case of *Sierra Club vs. Morton,* with the apparent concurrence of two other justices. While the majority of the court has not yet squarely faced the issue, they may soon have to. Across the country, a small group of lawyers is already beginning to pick up the idea. For example, a suit challenging inhumane methods of livestock slaughtering was brought in the name of "Helen E. Jones, as next friend and guardian for all livestock animals now and hereafter awaiting slaughter in the United States."

Recently, when the government planned to realign a road through a town common, a Massachusetts lawyer drafted a complaint in the name of, among others, "Plaintiff the Billerica Common, a small park in the center of the Town of Billerica." In the face of this threat, the government decided to back down.

In late 1974, a suit in the United States District Court for the District of Connecticut named the Byram River, which forms a portion of the boundary line between Connecticut and New York. The judge denied the defendants' motion to dismiss and the case has been transferred to the Southern District of New York, where it is presently pending. Also, in January of 1975, a New York lawyer listed No Bottom Marsh and Brown Brook among plaintiffs seeking relief in an anti-pollution suit, filed in the same Federal Court. It, too, is presently awaiting disposition.

Most recently we have had the suit instituted in Federal Court by the Sierra Club in the name of Death Valley. This involves an attempt to make the Department of the Interior, which administers the Valley, tighten up its control in relation to the mining companies who are scarring it.

While this theory is thus gaining a modest momentum, it has also presented a lot of problems. There are, for example, problems in administering it, which I can probably discuss during the question and answer period.

Discussion

CO-CHAIRMAN ALLEN: Surely this paper will stimulate some discussion.

As I go back home from this Conference and come in for a landing at the airport, I will pass over the Wabash River, in which I caught my first fish a few years ago, and I will wonder how clear that river has a right to insist upon being. You most certainly have brought up some very interesting points here.

MR. ROBERT DENNIS [Zero Population Growth]: I wonder, if ecosystems can have a standing; what about future generations?

PROFESSOR STONE: That question is presently being worked on by several people. There is some concern, for example, with getting environmental impact statements out of the agencies in charge of development of nuclear plants.

In relation to this concern about future generations and to what extent the rights of the future generations ought to be admitted into evidence, I believe that once you open up the question of environmental standing in relation to the law, there will not be much difficulty in bringing into court evidence of the long-term effects of some of these practices on humans and the environment. These areas are presently being worked on.

MR. WILMOT [University of Chicago]: Mr. Stone's comments were very challenging.

There are three comments I would like to make.

In your statement, you indicated that the individual pursuing these complaints should be a lawyer. Well, as a biologist, this worries me. Having been involved with a number of environmental impact activities, I find they are handled in the usual legal tradition where, for example, you can protect your client, sometimes even without regard to the facts. I am concerned, in other words, that most of these mechanisms do not distinguish between preservation and conservation. They are not without mutual interchange activities, but they also avoid two very important things—time and the solution. How long do we have to allow something to recover? Also, on what time basis should repayment of fees be made?

With the cost of the environmental impact statements, their preparation time, and the enormous activities going into them, I don't think we can continue along this route.

We have looked at these problems at great length, particularly in the case of the Arctic Pipeline coming down from Canada and we suggest that the biologist, in counsel with the preservationists and conservationists, explore the environmental aspects, although I also have feelings about that, at least from an environmental side, just as the engineers and others involved have from their sides.

There is a Code involved and as long as you perform within that Code, you are all right. But, on the other hand, if you fall outside the Code, then it ends up in court and your legal concept of protecting the environment stands.

MR. BRUCE MacBRYDE [Office of Endangered Species, United States Fish and Wildlife Service]: You have mentioned the matter of protection, I believe, of endangered species. Does the question of ownership of these endangered species come into the question of whether there can be a request for guardianship? Another factor I have heard discussed, is whether there needs to be any balance in relation to human rights versus the rights of these endangered species. For example, it has been said, on a legal basis, that the endangered species have no priority over any of us. Therefore, do you see that as a legal problem in connection with these activities?

PROFESSOR STONE: In relation to your first question, if you have a stand of trees, let us say, that are on private land, the landowner can choose, under traditional methods, to go to a neighbor who is endangering that stand of trees by any private practice and talk to him about it. The classic example here, of course, involves the various forms of rust that can go from one tree to the other.

Sometimes international fishery treaties also make allowances for some degree of standings of this type.

I believe your second question has to do with the priority given to endangered species under the Endangered Species Act, which has come into conflict with other values in society at some points. Here I see the problem largely as a social one. I have spoken thus far of being in favor of giving the environment legal rights because I think it should be in court. This does not mean, however, that I think the environment should always win. I, too, am concerned about delays regarding environmental impact statements on our procedures. They are very costly and I don't know that they are doing very much good, either for human beings or for the environment. I am also concerned about protecting the environment to a degree where a freeze is put on the economic development we need.

I will use an analogy to the law recently passed by Congress with regard to the purity of water. This called for complete purity of water by 1985 and, of course, is nonsense, because no one is going to get complete purity of water. Further, the costs with regard to getting absolutely pure water far exceed the human benefits, so I don't see it being done.

The same is true of the protection of endangered species. It is going to impose enormous costs on the population and the rest of society. However, as a lawyer, I do believe you get a better society by bringing these things into court.

For example, there is the question of whether or not Mineral King should be developed by Walt Disney. Now, I believe that Disney may do a good job of developing it because they are very qualified and capable but, on the other hand, what are the other environmental questions in relation thereto? Getting the controversy into court helps define and resolve them.

Also, the statement is often made that the environmental movement is an elite movement. In other words, it is only the well-to-do who can take a weekend in the mountains and it is the poor people in our society who need low-cost fuel and low-cost housing. It is hard for me to accede to the claim to keep the wilderness pure without realizing the costs you are exacting on other segments of the society.

If you get things to court, what ultimately happens is not necessarily someone wins and someone loses. What happens in relation to procedures is that there is a pleading stage—someone objects to the pleadings—they have a demurrer. Further, if the case gets beyond the pleading stage, they go over into another room and somehow settle.

I suspect, for example, in relation to Mineral King, that Walt Disney will develop it to some degree. I also think the development will be a better one than it would have been had there not been a lawsuit.

I think that this sort of style, of compromise and negotiation in relation to these environmental lawsuits, will produce some form of compromise but it is not going to maintain pristine purity of water.

MR. KEITH BACHOUSE [Wisconsin]: There is one weak point in Mr. Stone's presentation. That is the question of who is going to decide who is going to be the spokesman for this so-called "voiceless resource?" Will it be a judge, perhaps a biased judge if the case were to be tried in a particular part of the United States? We all know of situations, where this might be the case.

For example, there can be the situation where an interested party would go before the court asking for guardianship of this voiceless resource, and the right to speak for it. On that basis, is there a provision in the law which allows that right to be granted to any interested party?

PROFESSOR STONE: There are several examples where lawyers have applied to the court in the name of the object without requesting a guardianship first. Therefore, it isn't necessary to get a guardianship.

Secondly, if there is an application for a guardianship, it is discretionary and, of course, there has been a whole body of law that has grown up in relation to guardianships. You must remember that in connection with human beings you have the same problem.

For example, you have the situation of a senile millionaire and, in that case, there are generally a lot of people who would come to court and ask for that guardianship. A judge who knows all about this can handle it very diplomatically.

Most of the cases, thus far, have taken the direct route, going directly in the name of the object without asking a court of local jurisdiction to grant a guardianship under state law or local law for appointment of guardians.

CHAIRMAN FLEMING: Thank you very much.

We come now to our final speaker of the afternoon, who is Mr. Patrick F. Noonan, President, The Nature Conservancy, Arlington, Virginia.

The Nature Conservancy, during the last two years has preserved some 450 natural areas throughout the country, saving something over 500,000 acres, a substantial portion of which, I am pleased to tell you, is in the State of Michigan.

Private Sector Programs to Maintain Critical Habitats

Patrick F. Noonan

President, The Nature Conservancy
Arlington, Virginia

Any time I am the last speaker on a program, I remember some advice that a person once gave me—which was to stand up tall so that all could see you, speak out so that all could hear you and keep it damn short so that all would appreciate you. I will try to do just that.

When I learned I would be talking about private sector programs, I was filled with three emotions—one of humility, recognizing what so many in this room have done across the nation over many years in efforts to protect critical habitat throughout this beautiful country. Secondly, one of pride, because we do have the greatest country in the world. Thirdly, one of enthusiasm for getting on with the future because these critical habitat areas will only be saved, will only be protected to the extent we all get directly involved, individually and collectively.

I must say at the outset that I am not a biologist, that my primary focus and background is in real estate economics and I am going to be addressing my remarks to that area—that of real estate economics.

We live in very exciting times. There is maximum environmental awareness today and there is also maximum environmental deterioration. Yet, as we all in conservation know, this is not new.

I would like to share with you a little quotation that goes as follows: "The conservation of natural resources is our fundamental problem. Unless we solve this problem, it will avail us little to solve all of the others. To solve it, all Americans must undertake the task through their organizations and associations."

The author of this statement was Theodore Roosevelt, in 1907. It was made at an historic conference of state governors on conservation which, to many, is the formal beginning of the conservation movement in this country. Yet, where are we some 70 years later?

You have heard many statements here. You are familiar with the fact, for example, that an estimated 3,000 acres per day are being lost to development and that millions of acres will be lost between now and the year 2000. There is the fact that there will be more people tomorrow and they must live somewhere. So thus, we have a conflict between a limited supply of land and an escalating demand.

We have to consider that almost every major river in the country is polluted, and why is this? There are many reasons. We can, of course, recognize that land use planning has been single purpose and, in the past, growth oriented. We can also recognize that ecologists have been looked upon as freaks and many still are, I guess.

We have looked upon land as a commodity, to be bartered and sold and, unfortunately, our landscape, which was once the scene of unparalleled natural beauty, has been desecrated. The great problem in many ways, is the fact that open space has been taken for granted.

We have some situations, on the other hand, where haphazard conservation, which we have in many instances, is just as bad as haphazard development.

Yet, today, activities across this country reflect a new awareness to land use, in terms of land being a scarce and valuable resource and the realization that we belong to two worlds, the natural world and the man-made world. It has been said that what we need is a little more humility in dealing with nature and a little less engineering ingenuity.

It is not very difficult when we begin to look at habitats and wildlife——and we know, of course, that the quality of wildlife is a direct function of the quality of its habitat—that the good Lord planned this earth and it is all relatively simple and with the key being, in the final analysis, common sense.

We all know, for example, that there are fragile areas, there are wetlands and marshlands and once they are manipulated they have a very long and indefinite recovery rate. Yet, tragically enough, the real estate entrepreneuers in this country and, by the way, it is estimated that 90 percent of all millionaires made their money from real estate, have encouraged unwise developments. I am not sure what causes this, but, in many ways I think it is because it has been a field where the tax laws have been lax and these laws, as well as others involving overutilization, have encouraged unwise developments.

Look for example, at New Mexico where there recently was a developer who had painted the desert green and was planting plastic trees and taking pictures of a lush, green development and selling the land through the mails. Tragically enough, we still have some of those people in the business who are still involved in that type of selling syndrome.

We need legislation to protect these critical areas and we also need positive legislation to channel growth in accordance with public investment decisions. In some cases, we need real estate transfer taxes because, in the final analysis, it comes down to economics. When you talk about the purchase of a piece of habitat, you are talking about the purchase of a piece of real estate, pure and simple. You are talking about the bundle of real estate rights and the great tragedy is we are still paying today, at the federal, state and local levels, in development values for land that is located in critical areas, such as wetlands and flood plains.

I speak from a dollar standpoint on this when I say we have been paying up to $35,000 an acre for floodplain lands which will be continually flooded for many years to come but, unfortunately, the zoning there is industrial. Therefore, we don't have priorities.

Unfortunately, in terms of real estate, land-use dynamics and land use planning, if you came out of school in the early 1960's, you learned that open space for conservation was something which, was entered on our planning maps after we had put in everything else, such as provisions for industrial, for residential and commercial uses. Then, everything else, as a matter of fact, was painted in green. This, in essence, was what was left over. Unfortunately, in most cases, this was done without any consideration to the natural landscape and its characteristics.

We in the field of conservation, especially those involved in the private sector, have an obligation. We have an obligation to make conservation and critical habitats come first in land use decisions both in terms of regulation and in terms of development.

We have a further obligation to identify those fragile areas, to map them and to make the maps public so that, when the speculator from Boston goes to Vermont and purchases a tract of high elevation land and tries to cut it into small lots, he has been forewarned he will probably go bankrupt because he may not get financing and because of the fact it has been declared a critical habitat area whose highest and best use is conservation for the public good, not development.

While we have lost time in relation to conservation needs, we must recognize that the private enterprise spirit in this country is still very strong and it is expanding. For example, we know that the various insurance companies today loan money all over the country and, tragically enough, on their loan applications, if you see one, you will find few, if any, environmental questions. That is a tragedy because what is happening is they are putting fuel into the hands of the developer who, in turn, can turn around and use that fuel to go forward with haphazard development plans.

Many of you, I am sure, are now aware of the problem in relation to second-home developments, where land values have been pyramided up. Then, when the market wasn't there, they realized that they had, somewhere, made a mistake and an oversupply had been created.

It is my humble opinion that we, as conservationists, have an obligation to begin to reach out to the appraisal profession and the planning profession, to begin to develop guidelines and, using a common language, begin to use terms that we all understand because, in the final analysis, the developers and speculators, while not currently, should be vitally interested in fragile areas.

For example, I know of a case on the East Coast where a man bought a beautiful island at an inflated value, something which he cannot develop which was sold to him by appraisers. Again, unfortunately and tragically, the appraisal profession has not had the educational background, has not been talking to the biologists and ecologists which they hopefully, in the future, will be doing.

These habitats that I am talking about in terms of biological diversity are really critical to many multiple use values and whether you are a birdwatcher, hiker, gunner, whatever it may be, we all share one common interest and that is the protection of this critical habitat. Whether we wish to shoot ducks or whether we wish to go birding for eagles, the quality of the habitat determines the quality of our experience. Unless we control these development rights with regulations, whether through fee acquisition or through easements, we are going to face more extremely difficult problems and conflicts.

So then, what is needed by all of us, regardless of our professions is to realize that the out-of-doors and critical habitats are all a part of the great heritage of this country which we likewise are a part of. The key to the future protection of many of these habitats must be regulation for the public good which can be based on the economics of conservation.

In the past, you know, we have not treated our clean air and water as conservation benefits, but now we must begin to apply external economics in order to learn the value of nature and, based upon those values, to defend it where it needs defending.

We are all, I am sure, familiar with the work done by Dr. Eugene Odum and others, documenting the value of an acre of salt marsh in terms of dollars; the value of an acre of salt marsh in terms of nutrients per acre. Yet we know very little of our plant world.

Probably Aldo Leopold said it best when he said that conservation is a state of harmony between men and the land and by "land" he meant all of the things on or in the earth. Harmony with the land is like harmony with a friend—you cannot chop off his right hand while loving his left hand.

I recently read a statement which is very timely in terms of the crisis that faces us right now, in 1976—the fact that unless we continue to do something about it, concentrate more of our energies, we are going to lose these valuable areas. The statement goes like this:

"These areas are the things which other nations can never recover. Should we lose them, we could not recover them either. The generation now living may very well be that which will make the irrevocable decision whether or not America will continue to be, for centuries to come, the one great nation which had the foresight to preserve an important part of its heritage."

If we don't preserve it, then we shall have diminished by just that much the unique privilege of being an American."

Now, in order to protect those areas, in order to know more about habitats, we have a tremendous obligation to the private sector and to the public sector, both individually and collectively, in relation to education.

You know, it is just amazing the lack of knowledge that exists in terms of the logic of protecting habitats and channeling growth away from those fragile areas.

There is little, if any knowledge of the economics of conservation. We don't have enough dollars to buy all of these areas. It is estimated there is over a $1 billion backlog at the federal level in relation to purchase of parks, wildlife refuges, and national forests. We are, as a matter of fact, nowhere near appropriating the funds to acquire those in holdings, let alone the new areas that are being created.

Therefore, we have a tremendous challenge ahead of us in terms of building a constituency that will reach out to protect these areas.

There are many exciting developments taking place and I think we all have an obligation also to become more knowledgeable about them. Such techniques as a Land Transfer Tax, which is beginning to penalize speculative development of land. The same principle can be used for habitat protection.

We talk about the funding of nongame species programs. A transfer tax can be used to apply tax on the development of any nongame species habitat designated as critical. Therefore, if somebody wishes to go in and develop those areas, just levy a transfer tax and see how quickly speculators learn where the critical habitats are. Again, in relation to the economics and conservation, transfer taxes must be used wisely because we do not want to turn off completely the private sector.

The private sector has to have the opportunity to build, to provide more housing, but first let us identify the critical habitats and consider the passage of legislation so that we will have funds to purchase the key tracts.

Here I think of the State of Maryland, which has, I feel, the ideal situation, probably the best in the nation. They get close to $10 million a year for land acquisition. From what source? From a real estate transfer tax. It is an ideal situation, for it provides an annual source of revenue.

Also, we have various counties thinking of environmental impact taxes, which impose a tax on development.

Yes, we have the problem of finding dollars, especially in this economy, but we must be innovative in identifying funding sources. We have the same logic in relation to public investments which create value, such as highways and utilities. Highways and utilities are paid for by public dollars and, in terms of windfalls, when those occur, we should think about legislation to begin taxing back to the public those revenues that would provide again for land acquisition programs.

You know, it was only recently that it became more difficult to get insurance for building in flood plains. Fortunately, now, if a house is built in a flood plain, it is extremely difficult to get a loan from the bank to reconstruct the house in a flood plain. However, until recently, this could quite readily be done. Again, the logic of conservation is just really beginning to take hold in the real estate sector.

When we are dealing with habitat, the biologist, the ecologist and the lawyer, let us also think about the investor—the person who owns that property. It was recently stated in an article that the average investor in real estate is generally not interested in making the city attractive for the sake of making it attractive. However, if he is old enough and successful enough, he may reach a point where he would like to build monuments to himself but, in general, his interest is really in making money, dollars and cents.

In recent years, the average investor has lost the expectation of rising land values and eventual profit through further concentration of economic activity in central cities and the result of this, of course, is that we are seeing increasingly active development in the suburbs and rural areas. Yet, unfortunately, our pricing system, the heart of our supply and demand economy, is ineffective when it comes to preserving natural areas and critical habitat, as long as the life support and other socio-economic values of the environment are not considered in making land use decisions.

Unfortunately, our pricing system generally considers only man-made values and completely ignores life-support values. However, I believe we are seeing a major change in this attitude. In turn, this has tremendous possibilities in terms of habitat protection. Therefore, to the extent we begin to understand the free works of nature and work as a team with lawyers, biologists and economists, we have a real chance to protect critical habitats based upon their inherent natural value to the general public. What we need to do is to extend economic accounting to the free works of nature. Real estate appraisers must come to understand that the value of one acre of marshland is not solely determined in terms of real estate development potential, but value is determined by the so-called "natural" processes equally well. Importantly, we are making progress in this area. There was a recent statement for example, by the International President of the Society of Real Estate Appraisers which reflects this new awareness. Realize now he was addressing the real estate appraisal profession who, as you know, appraise and make decisions in relation to most real estate investments. He said: "Ecological awareness can be the difference between profit and loss, success and failure and, in some instances, be responsible for averting financial ruin." What a breakthrough! All of a sudden, we have an obligation as conservationists to begin working with appraisers and planners and to begin attending their seminars. Many appraisers are coming to us now and asking us what areas should and shouldn't be developed.

Unfortunately, there has been no course work in ecology or biology or land use required for the professional appraisal designation. Therefore, we have a great challenge before us and, more importantly, a great obligation to educate the other professions involved in land use. The hope being that out of this they will come to understand that there are natural areas that are fragile and critical based upon biological processes and these areas must be protected in the public's interest. Therefore, development should be channeled away from them. Conservation must come first and not last with regard to making land use decisions because if it doesn't, then there is no way we can continue to try to protect those habitats which are so critical to so many species.

In terms of value logic, I read recently where the Corps of Engineers had concluded, in certain cases such as the Charles River in Massachusetts, that they will acquire the flood plain and leave it alone rather than channelize it. This likewise is a major breakthrough. After all, natural processes do a lot for us for nothing and we are only now beginning to understand this. We are only now beginning to put in that common denominator, dollars, which everyone seems to understand.

The private sector needs to become more knowledgeable, in relation to the activities of other professions. We need to know what they are doing and what positions they are taking particularly the National Association of Real Estate Boards and also the various legal areas affecting conservation.

I would urge all of us to try and stay simple when we are discussing these matters with other professions, keep it basic if you can, and work from pure logic. It is a lot easier to proceed on this basis and you get better results.

In addition to education and the stick in connection with regulation we finally, of course, need the carrot. We need more dollars coming in to protect the habitat at federal, state and local levels and, in connection with all of those, the private sector has an obligation to perform better. These are many, many unprotected critical areas. As a result the private sector has an obligation to work hand in hand with the public sector toward their protection.

In 1976, we are faced with tremendous economic problems. We are faced with increasing problems with inholdings and protection of habitat. Thus, we have an obligation to set priorities—undertake inventories and then get on with protecting those lands using both regulation and dollars.

In the area of dollars and cents, we in land conservation are tremendously poor at accruing private philanthropic support. It is estimated, for example, that less than 1 percent of all philanthropy in America goes to conservation and environmental programs—less than 1 percent of giving in this country. This is a tremendous challenge for conservationists to begin to correct. It is a big market, especially in the corporate field, where less than 1 percent of corporate profits are given away each year. The law provides up to 5 percent.

In the recent Filer Commission Report on philanthropy in America it is recommended that by 1980 corporations be required to give away 2 percent of corporate profits for philanthropic purposes. This is an area where the private sector and public sector, state and local officials, have a tremendous potential, not only in terms of dollars but in gifts of land—gifts of critical areas for habitat protection—because the economics of giving away these areas does work out favorably.

Corporations can make, in some instances, more money by donating a piece of land than by selling it. When you can show this to financial experts, I can assure you that the response and reception received will be a very strong one.

Changes are happening—new ideas and programs are coming and, as we look for the dollars and the good legislation for the wise use of our limited resources, I urge you to interact more and learn from other countries and other states and other professions. Educate people in your communities and make them aware of what your programs are doing because people do have good ideas and you can have an even greater impact and broader public support.

In conclusion, there is one thing I would like to alert you to. Next week an exciting two-year land conservation program in the private sector will be announced, hopefully one in which the entire conservation sector will participate. The program, known as the American Land Trust and directed by a group of 35 distinguished Americans will be challenged by a major gift from a major corporation, Weyerhauser—a gift of 12,000 acres of outstanding habitat in the Dismal Swamp of North Carolina which we have long sought to protect—a multimillion-dollar gift. This program, again working with conservation organizations and indivduals around the country, will seek to protect 200 outstanding critical areas in this country and draw broader attention to the need to protect critical habitats.

And so the solution comes down to you. The problem is not going to be solved in Washington, it is not going to be solved in the various state capitols—it is going to be solved by you working as individuals and working collectively for the organizations and objectives you and they support.

Thank you very much.

Discussion

CO-CHAIRMAN ALLEN: We now invite discussion and to give you a little time, I will say that I have known The Nature Conservancy since as long ago as 1951, when a small group of distinguished scientists calling themselves The Ecologists Unions first started on this program that has now become The Nature Conservancy, the world's most effective private agency in the preservation of natural areas.

MR. RICHARD WARNER [University of Florida]: One of the hats I wear is that of County Extension Director for the Florida Keys. I would like to ask the speaker whether he can supply me with information about the region I am dealing with. The Keys have recently been declared an area of critical state concern and hence the process of evolution of the things you have been referring to has been accelerated. Nonetheless, there is a very serious review of all the needs within the entire Keys Community of the kinds of questions that you have been raising today. Therefore, on that basis, I am wondering if you can give me any advice on how we might, in a most effective and efficient and integrated way, ask these questions and seek the answers for each specific region?

For example, I know that we can perhaps work towards ordinances. I, for example, helped in relation to the shoreline protection ordinance, which relates to the kinds of things you are talking about. However, in terms of preservation and endangered habitats or manipulation of real estate systems and so on, which you alluded to, there must be some best way of going about this for a particular system like the Florida Keys. I am curious about that aspect of it.

MR. NOONAN: The same problem applies in almost any geographical area.

We must try all of the techniques we have tried in the past in terms of new laws, regulations and funding possibilities. One we would like to see tried, for example, would be to have these areas declared critical habitat districts or some similar name in which very tough development regulations would apply and then work with the lending institutions in that state in terms of state lending requirements to see if we cannot cross the bridge with them about the need for protection of these areas and the logic of why investment in those areas is a bad decision, both in terms of the individual project and of its impact on the welfare of the state, region or locality because, believe me, if a particular area or developer cannot borrow the money from a lending institution, then that development is not going to proceed. He may get funding from other sources in connection with his purchase of land, but when it comes to the secondary need for construction loans, he will not be able to find those funds.

Therefore, it comes back again to the other point I made in relation to real estate economics—that if these areas are that critical and that important, do that much for us in terms of the free works of nature both short run and long run, then maybe we have an obligation to let the lending institution know more about it and become involved.

MR. CHARLES MESLOW: I think my comments are really in support of your answer to the first question. The comment I wish to make is that the informed public, one that understands, can do a lot on its own.

This last year, for example, we completed the first land review study for the Portland District Corps of Engineers. Here we first went out and developed the area of critical ecological concern scientifically, and then we determined what the social values of this particular geographic area were. Then we brought the facts of why these are critical areas to the attention of the public, institutional groups, comprehensive planning groups and, after we had completed all of this, everyone involved agreed that these truly were areas of ecological significance and that they should be protected. Therefore, right now, the Corps of Engineers has a basis for refusing permits in critical areas because everyone recognizes that they are critical. I think more understanding and education as you have indicated will solve a lot of our problems.

In the final analysis, it has to be attacked on the basis of presenting the facts to the people and to the decision-makers and having them all agree.

MR. NOONAN: I concur. The beauty of our message is the fact that everything involved here is in our favor. When one begins to look at the biological factors and what they do for us, the facts are in our favor. The ecologists tell us that. If they can translate that into economic terms and we can then, in turn, begin to educate the public, I believe we will have a true balanced use of resources.

FROM THE FLOOR: I would like to know if you would make some suggestion, from your experience, as to how professionals in the natural resource field could present this to other professionals in fields like engineering, planning, real estate, and fee appraisals. Do you have any ideas on this or could you give us some suggestions?

MR. NOONAN: It all comes down to a matter of communications. The real estate profession, for example, is organized just like many other professions, with chapters in every major city, in counties, and particularly metropolitan areas. They have a need for speakers. Many of them, I am sure, have never heard of the logic of wetland protection—believe me, they haven't. Therefore, this is one way of getting your message across—finding out who the professional organizations are in your communities or at the state level, get on their agenda for possibly an annual meeting or conference. Having a wildlife biologist, for example, on an appraisal conference, or even an ecologist talk about the free works of nature is a message I believe they would welcome and begin gaining an understanding of it.

Also, perhaps you may become involved in writing a short article for some of their monthly or quarterly newsletters or even their magazines. I think you will find yourself welcome on this basis also because, in relation to the three major appraisal organizations in this country, we are now finding that they are requesting speakers from the environmental field to come to them and to talk to them and try to translate these ecological values and ecological systems into dollar and cent values. Therefore, I would urge you to begin to interact with other professions through various forms of communication.

MR. JACOBSON [Virginia Tech]: As a biologist, I am somewhat concerned about placing economic values on natural systems and I wonder if you would care to comment on that.

Aldo Leopold said there were three measurements of productivity—economic, aesthetic and biological. I wonder if you would care to comment in relation to not neglecting the other two values, the aesthetic and biological, rather than merely considering the economic factor.

MR. NOONAN: I did not mean to take away from the other two values because, in my estimation, they also must be taken into consideration. All I am saying is that while we should continue to use aesthetic and biological measurements, we must begin to emphasize the economic approach, which I think we have been doing in the past. After all, all three of them interact and all three appeal to different emotions.

People do things for different reasons and react to different emotions. Aesthetics is important and the biological aspects are likewise important. However, again, I am stressing that we should also look at the economic aspect more and more because I think, in terms of real estate and land use dynamics, this will become the key measurement for land-use decisions being made in our favor.

LOUIS ALDERSON [Ft. Worth, Texas]: As a point of communication, I would like to remind some of us that the Legislative Committee of the National Association of Real Estate Boards is meeting here now, so you can take it from there.

MR. NOONAN: Yes, I saw them downstairs and I am reminded of the motto of many real estate brokers, which is, "Under all is the land and upon its wise and profitable use depends the future of mankind." I hope we can begin to redefine profitable use by looking again at the ecology and economics of leaving natural areas alone. Thank you very much.

CO-CHAIRMAN ALLEN: I believe our time is up. I declare this first session adjourned.

Strategies and Plans for Improving Management of Resources

Chairman:
EUGENE P. ODUM
Director, Institute of Ecology
University of Georgia, Athens

Cochairman:
EDWARD T. LaROE
Senior Scientist, Office of Coastal Zone Management
National Oceanic and Atmospheric Administration
Rockville, Maryland

Opening Remarks

Eugene P. Odum

This morning what we are doing is looking into the very near future of America's Third Century. A lot of people enjoy looking ahead to the end of the century and wondering where we will be in this country in a hundred years. We are not all sure whether we will make it that far ahead but we do think we will make it at least into the next century and so what is of immediate concern to all of us is what are some of the prospects for revolutionary changes?

You might say, also, that we all know that revolutionary changes in attitudes and in management strategies are well on the way. Therefore, the participants today are looking forward to discussing with you what, to them, seems to be really new breakthroughs.

Obviously, we are going to have revolutionary changes in our food system and in how we manage it. We manage that separately from the natural ecosystem and our urban system and, obviously, we now have to think about linking all of these together.

The first real, you might say, experiment in land-use planning for such linkage is the coastal zone management situation. The coastal zone of this country is going to be the first place where we really and genuinely try to manage large areas as integrated systems, and that is so new that nobody really knows how we are going to do it or even if we are going to do it at all.

Therefore, we have three speakers to give different viewpoints on the progress we hope to see in this area within the next 15 years. How, for example, can we successfully manage our coast in such a way as to couple the natural environment, fisheries, wildlife, urban development, industry, etc., and, further, whether conflicting demands can be made anywhere near compatible.

In this, of course, ecology and economics have to be merged. Instead of being constantly contradictory, we have to put them together, so we will be proposing the possibility of an economic approach that is symbiotic with the environment.

Finally, the final papers of this program will show the fact we are going to have to rebuild a lot of nature—we are going to have to rebuild habitat—we are going to have to do a lot of restocking of things. It is very important we consider the genetic materials that we use for these rebuilding processes.

We are already rebuilding swamps and marshes and already talking about wilderness areas and this means, of course, we need to have the necessary components. The biochemists, believe it or not, are contributing some new technology which will be of interest to this kind of management. This, as a matter of fact, is the kind of technology that probably has not even been recognized by most fish and wildlife students of today.

The first two papers will deal with the revolutionary changes in our attitude towards food production and, of course, one of these involves the use of pesticides.

We are fortunate to have with us today one of the outstanding proponents of alternative and evolving new strategies to the practice of pest control—in other words, he will discuss what is known about the third generation pesticides. He is Dr. Robert van den Bosch, Chairman, Division of Biological Controls, University of California at Berkeley.

Three Generations of Pesticides: Time for a New Approach

Robert van den Bosch
Division of Biological Control,
Department of Entomological Sciences
University of California, Berkeley

A more appropriate title for this talk might have been, *Three generations of pesticide chaos: time for a new approach*, since much of what has transpired in pest control over the past 30 years has been chaotic. And, in many respects matters are currently about as bad as they can get, which really isn't surprising since this reflects our unique capacity to foul the earthly nest.

Pesticides are chemicals used to control organisms that compete with us for valued resources and possessions, transmit diseases, or annoy us. Overwhelmingly, pesticides are designed to kill, and therein lies a major problem, for many of them are biocides which kill indiscriminantly. To make matters worse, many, if not most, are used carelessly and excessively. It is thus not surprising that under the prevailing heavy biocide load, there are unfortunate episodes among non-target populations, including wildlife.

In this discussion, I will largely limit my comments to insecticides, first because I am an entomologist and therefore most familiar with these materials, but also because they are our most heavily used pest killers (about 50 percent of the annual pesticide load) and thus most commonly involved in wildlife injury episodes. There is a simple reason for this: modern insecticides are mostly nerve poisons or choline esterase inhibitors, which means that they kill higher animals in the same way that they do insects. There are other kinds of insecticide lesion, such as organochlorine disruption of avian reproductive physiology, carcinogenesis, teratogenesis, etc., but nerve poisoning and nerve message inhibition are the main killing mechanisms of the modern materials.

I will not dwell on specific incidents of insecticide injury to wildlife, for I am quite certain that most in the audience are aware of such episodes. Instead, I will discuss our current pest control strategy, its very serious faults, the reasons for its persistence, and possible ways to phase it out.

Chemical Control: The American Way of Killing Bugs.

In America today, we are committed to chemical control as our pest management strategy. This is a very foolish, harmful and costly course, which we should abandon as quickly as possible, but probably won't, since powerful persons and agencies who benefit from the status quo don't want change.

I shall presently describe what is wrong with the chemical control strategy, but first I should outline how DDT boosted us into the chemical saddle. Prior to the arrival of DDT we had maintained a sort of running truce with the insects. We managed their populations as best we could with a hodge-podge of cultural, chemical, physical, biological, genetic and legislative measures, but we never had any illusions about stomping them into total submission. On the other hand, we really weren't very happy with this arrangement since the insects did rob and harrass us, but perhaps most importantly because they were the only group of lower animals that we had never been able to dominate.

So we were ready for an agent like DDT, with its apparent capacity to put down the insects once and for all. Thus, when DDT surfaced in the 1940's as the conqueror of typhus and other insect borne diseases, and the dazzling killer of age-old crop pests, we tumbled to its lure like a flock of sheep to a slaughterhouse goat.

We could hardly wait to grab the miracle powder and throw it about the environment like road dust, a habit we still haven't kicked after 30 years. Only now with hundreds of chemicals in thousands of formulations the dust cloud has become a torrent of spray. One must concede that DDT has worked considerable benefit, but even its great redeeming attribute, malaria suppression, is being lost as the wily mosquitoes become increasingly resistant to it. So today, the "miracle" bug killer is largely noted for its bad traits: broad toxicity, persistence, mobility, lipid affinity and the associated magnification in food chains, and possible carcinogenesis. But in many ways, its most unfortunate characteristic is its low cost. This is what really led us into the chemical control trap, and the subsequent evolution of the array of cheap biocides which overwhelmed pest control technology. Oh, I know the argument about low cost DDT enabling us to make great gains against malaria. But in relying too heavily on cheap DDT we neglected other aspects of malaria control and now that the anopheline mosquitoes are beginning to crack DDT, and the other insecticides, the poor Third World finds itself without a miracle killer and bereft of a broadly based technology to combat the resurgent malaria transmitters.

"Cheap" DDT has also engendered a bitter legacy in agriculture. How well I remember the rationale of the San Joaquin Valley cotton farmer of the 1940's and early 1950's which went as follows: "Yeh, I know there ain't many bugs out in them fields, but why should I worry about 'em? Shucks, for a couple of bucks an acre I can lay on that DDT and *know* them bugs is gonna be dead. And you know what? I can go to bed at night and sleep like a baby not worrying about Lygus bugs and bollworms and all them other critters."

My colleague Vernon Stern, now of the University of California, Riverside, used to call DDT the growers' sleeping pill. There was a broader implication in Stern's remark than we realized at the time. DDT was indeed a sleeping pill, but those it put to sleep included the research entomologist and the pest control program administrators as well as the grower. DDT lulled these technologists into an ecological siesta, and while they were dozing chemical control became our insect control strategy. And, regardless of whether we were asleep or awake during this evolution, we are now hooked with this strategy and its associated ecological, sociological and economic nightmare. What's wrong with the chemical control strategy? Why can't we beat the bugs head on, by biociding them back to the Carboniferous Age? There is an obvious answer to this question: the strategy is too simple. To some, perhaps most of us, this is difficult to understand. We ask: why is poisoning too simple an approach to the control of such lowly creatures as the insects? What we forget in asking this question and what we overlooked when we first employed DDT, is that the Insecta is an extremely complex group. In their incredible variety (an estimated 1.5 million species), tremendous adaptability, and immense numbers, insects are simply too complex a group to be defeated by a strategy having but a single string in its bow. And what we must realize, and rapidly so, is that the insects have already defeated the chemical control strategy; that the time has come for us to abandon it and adopt a better strategy before we flounder into deeper chaos.

The symptoms of failure are everywhere. I won't detail these because a full chronicling of episodes would fill a book. Instead, I will cite the following broad examples which I believe support my contention.

(1) In California, where insecticide usage is more intense than anywhere else on earth, virtually all of the twenty-five most serious insect and spider mite pests of agriculture are either resistant to a spectrum of insecticides or are insecticide induced or aggravated pest species (Luck et al. in prp.). As a result, California is on a gigantic pesticide treadmill.

(2) Worldwide, spider mites, formerly relatively minor pests of agriculture, have been propelled to the top of the pest heap, largely as secondary outbreak species which develop in the wake of insecticide usage (Huffaker 1971).

(3) In Asia, and to some extent other areas, the powerful resurgence of malaria is in considerable measure attributable to the development of vector mosquito resistance to DDT and other insecticides. In some of the most severely affected areas, agricultural use of insecticides has been implicated in the development of resistance (Georghiou 1972).[1]

(4) In vast forest areas of eastern Canada and the northeast United States, nature's silviculturist, the spruce budworm, which was once epidemic at approximately twenty-seven year intervals, is now perennially epidemic because chemical control practices, designed to save every tree, have thrown the forests into a constantly vulnerable condition. Though annual spraying is considered economically justifiable under prevailing conditions, there is deep concern among entomologists and foresters that the huge numbers of moths generated by the sustained outbreak populations will fan out over millions of additional acres, and eventually engender a perennial outbreak of immense proportions (*Forestry Chronicle*, 51(4), Aug. 1975).

We appear, then, to be rapidly approaching a state of widespread and perhaps overwhelming chaos as we hold to chemical control as our pest insect management strategy. Indeed, it is not inconceivable that unless we change our strategy, the insects may eventually manage us.

But what can we do about it? Is there an alternative, and if so is it available and can it be rapidly implemented? As for the first part of the question, the answer is yes, there is an alternative; the strategy of integrated control. But that is as far as I can go in answering the question for I have strong reservations as to whether we have the wisdom and willpower to implement a better strategy in the face of a powerful political, financial and propaganda campaign in support of the status quo.

[1]My colleague, Richard Garcia, informed me that Dr. M.A. Farid, a consultant to WHO, reported extensive mosquito resistance to DDT and the implication of agricultural spraying in this development to the UNEP/WHO meeting on bio-environmental methods of control of malaria, in Lima, Peru in December, 1975.

The Alternative: Integrated Control.

No single tactic will subdue the insects, they are simply too diverse, adaptable and prolific to be so easily overwhelmed. Yet we keep on seeking the elusive one-shot panacea, and in doing so, we waste enormous amounts of money, energy, resources, brain power, manpower and time. This is reflected in the huge amounts of energy, time and money invested over the past quarter century in researching autosterilization, pheromones, third generation insecticides, microbial control, antifeedants, etc. with only minimum return. And an even greater waste has occurred in the so-called eradication and area control programs. Among these, the fire ant eradication program alone has consumed more than $150 million, and the boll weevil program additional millions. Screwworm fly "eradication," the showcase of autosterilization, annually costs society about $10 million (to the benefit of Texas stockmen), and now that it has broken down, its proponents are seeking additional millions to "eradicate" the beast from Mexico. Finally, if we add to all this the $1-$2 billion our society spends on conventional chemical control we come up with a whopping bug control bill with very little to show in the way of problem solution.

All of the tactics and/or materials just described are of potential or real value to an overall pest control strategy, but none in itself can fill the total need for pest insect management. Yet we keep tumbling to the beguiling illusion that one or another of these will provide the whole ball of wax.

It is vitally important that we abandon this futile chase and accept the truth, that the only way to effectively contend with the insects is through a strategy of integrated control, or if you will, integrated pest management. Integrated control is, in the broadest sense, a philosophy. That is to say, it is a way of looking at insects and their environment and concluding how best to work out an advantageous accommodation with them.

And so, under integrated control things start with the gathering of all significant information about the pest, the resource(s) that it attacks and the encompassing ecosystem. Once this data based is in hand, it provides the framework for an on-going information gathering and decision making process which enables us to effectively manage the pest (or pest complex) by efficiently integrating materials, agents, tactics and methods with those factors in the environment which naturally constrain the pest populations.

The development of an integrated control program entails the accumulation of background data for use in system design, and then once the program is set in train it involves continuous information gathering, the utilization of decision making criteria (i.e., economic and/or aesthetic injury thresholds), and the employment of tactics, methods, materials and agents as the system demands. Typically, the methods and materials that are employed become mutually augmentative or at least compatible, and the same holds true for their relationship with the naturally-occurring pest regulating mechanisms in the ecosystem. The integrated control system also maximizes the benefits of long term adjustments, such as crop plant resistance to pest species, and natural enemy introduction.

What has just been described for integrated control, contrasts sharply with the typical chemical control program in which we characteristically plug in the insecticides on a prophylactic basis, and essentially leave it up to them to run the system. This contrast can perhaps be best visualized if a comparison is made of the two systems in corn rootworm control. Here under prevailing practice, insecticides are used as a form of crop insurance in which about 50 percent of the nation's 66 million acres (26.73 million ha) of corn land are treated with insecticides to protect the seedling plants from possible insect attack. In other owrds, in the USA each year, about 33 million acres (13.36 million ha) of corn land are prophylactically treated with insecticides to protect the crop against soil infesting insects. But this represents an enormous waste and expense, not to mention environmental hazard, because annually only about 3 percent of the corn land soils are actually infested by economically threatening insect populations.[2]

There is high irony in this because corn belt entomologists know how to identify insect threatened acreages, have devised rapid pest assessment techniques, and have developed an integrated control plan which, if implemented, would restrict insecticide usage to the absolute necessary minimum. Furthermore, this scheme would be less costly to the corn grower than the prevailing chemical control program. In other words, if fully implemented, integrated corn of corn rootworms would probably entail insecticide usage on only a fraction of the currently treated 33 million acres, save the corn industry tens of millions of dollars in annual pest control costs, slow the development of insecticide resistance in the target pest species, eliminate a massive waste of petroleum based chemicals, drastically reduce an environmental pollution problem, and guarantee full corn yields and product quality.

This latter point is extremely important. All integrated control programs of which I am aware have maintained optimum product yields and quality (or health and comfort standards), and they have done this under reduced insecticide inputs, and at lower costs than have conventional programs in the same situations (van den Bosch 1975) (Huffaker and Croft in press). It is important that hard headed farmers, foresters, mosquito abaters, other pest controllers and just plain folks understand this, becuase there are those who would have us believe that integrated control involves a sacrifice in pest control efficiency in exchange for enhanced environmental quality. I reiterate, that, if anything, the opposite is true.

Now what does this mean to people interested in wildlife or for that matter simply life itself? This can perhaps best be answered by assessing the human health impact of pesticides under existing conditions in California. In doing this it should be understood that under the status quo there is enormous pesticide overuse in that state, probably in the order of 50 percent or more. At any rate, under prevailing conditions, the California Department of Health reported 1,150 official cases of pesticide poisoning for 1974. Now, if this statistic concerned an infectious disease, it would reflect an epidemic condition and trigger drastic abatement measures. But with the pesticide injury epidemic, we just shrug our shoulders and do nothing. Apparently this is the price we pay for "abundant food and fibre." The atrocity goes on year after year, and if it involves an inflated level of human injury, it must be presumed to have the same effect on wildlife.

[2]This information was given to me by my colleague, Dr. A.P. Gutierrez, formerly of Purdue University. Dr. Gutierrez and colleagues at Purdue once proposed an insurance program utilizing their knowledge of the corn rootworm problem as its basis.

But it doesn't have to be this way. Integrated control could guarantee us abundant food and fibre and freedom from insect borne disease and insect torment, and a relatively pesticide free environment as well. For example, in California widespread adoption of integrated control programs would very rapidly reduce the amount of pesticide injury to man and wildlife, simply by reducing the environmental pesticide load.

It all seems so simple: just switch over to integrated control, and sit back and watch the ugly pesticide impacts fade away. But, of course, this isn't going to happen, primarily because powerful persons and groups want insecticide usage to remain just as it is, and they have things pretty well rigged to assure that status quo. There are other obstacles, too, such as the enormous job of acquainting the farmer, forester, mosquito abater, home gardener, housewife, farm advisor, aggie college researcher, and just about everyone else who hates, fears or resents bugs with a new pest control philosophy. Finally, the development of integrated control programs requires time, funds, brains and dedication and ultimately a cadre of professionals to run the delivery system. Because of this, even under optimum circumstances, the transition would not occur overnight.

Faced with these realities, society will not be handed a better way to battle the bugs, the day after tomorrow. But what society can and must do if it wishes change, is to start screaming and raising all kinds of hell about the virtues of integrated control.

Now, what I have said here today may seem to many to be just the kind of wooly headed scheme that one can expect to emanate from a place like Berkeley: a grandoise idea with no real relevance to bug control down on the farm. But integrated control isn't considered a frivilous concept in China, where 800 million mouths have to be fed, and the same number of bodies protected from insect borne disease and insect harrassment. In fact, China has a full-fledged national integrated pest management scheme underway, and it appears to be working superbly. I heard all about it from a group of America's leading entomologists who had visited China last summer and reported their impressions of pest control in that country to a plenary session of the Entomological Society of American at its 1975 meeting in New Orleans.[3]

The Chinese system is in the classic mould of integrated control, involving continuous monitoring of pest populations, use of action thresholds, and employment of a variety of control tactics, materials, and agents (including insecticides). But in using insecticides, the Chinese carefully choose the materials and apply them in ways to maximize their action on the target organisms and to minimize their effects on non-target species including man and other higher animals. The materials in greatest use are seven organo-phosphates of moderate to low hazard to warm blooded animals. Thichlorfon (Dipterex ®) is the most heavily utilized insecticide in China, principally because of its safety, lack of persistence, environmental degradability and low cost. On the other hand, DDT is being rapidly phased out of use because of its incompatibility with integrated control programs, its persistence, and because of increasing pest resistance to it.

[3]This presentation was made on December 1, 1975, under the title, "A report to ESA on the status of entomology in the People's Republic of China." The discussion leader was Dr. Robert L. Metcalf whose observations form the bulk of my comments in this paper.

In their spraying activities the Chinese generally employ spot treatment of heavily infested areas with very little use of aerial applications.

An interesting aspect of China's agriculture in light of its dependence on integrated control, is that she produces enough rice to feed her 800 million citizens and yet ahs sufficient surplus to make her the world's third largest rice exporter.

In closing, I can't help but allude to the performance of Assistant Agriculture Secretary, Robert F. Long, at the same Entomological Society meeting before which the China panel gave its report. Long was brought to the entomology meetings by a group of chemical companies, to deliver a tirade against EPA, a prime target of the pro-pesticide consortium. The thrust of Long's statement was that America and the world are on the brink of a terrible disaster because EPA with its "stifling" pesticide registration and re-registration requirements is about to choke off our 1,400 pesticide species and their 30,000 formulations. Long was, of course, simply blowing smoke because he well knows that political gamesmanship and legal maneuverings will keep the pesticides going indefinitely, no matter what encumbrances EPA invents. What he was really telling us is that he and his agri-business friends are going to exert all the power they can to weaken EPA's existing pesticide controls, so that these biocides can be released into the environment just like they were in the good old days.

America's answer to three generations of pesticides—business as usual!

Good luck, America!

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Discussion

MR. KELSO: I am unattached. In the forests of Italy, Germany and many other countries, the strategy of taking out and transporting anthills and putting them where anthills can be of service is of paramount importance. This can regulate a forest better, you might say, than humans or pesticides can. I understand this method is widely used over there, but it has never been experimentally tried by the Forest Service of the United States or Canada. I wonder if you have had any experience in relation to that.

MR. ROBERT van den BOSCH: I am familiar with that program in Europe and it has been very successful. You know, we have a problem in importing exotic insects. However, I think there has been an effort to import some of these species of ants. I believe this was started in Canada and as to the present state of progress, I am not sure. It is not the ant that they use in Europe and I don't know how they get away with it because usually the quarantine people are on your neck all the time in relation to this particular type of thing. However, the state of the art from the standpoint of committing beneficial insects is a varying development.

We have, I think, been quite successful in California, but the ant situation that you mentioned really has not been definitely explored in North America.

Obtaining Protein From the Oceans: Opportunities and Constraints

Norman J. Wilimovsky
Professor
Institute of Resource Ecology
The University of British Columbia
Vancouver, Canada

My purpose in this assessment of the status and future of resource management, commemorating the U.S. Bicentenary, is to review the present and potential contribution of the ocean to the world protein supply and to suggest some opportunities for, as well as constraints on, the utilization of aquatic resources.

The central long-range problem facing the world today is balancing the human population with the finite resources of the planet. Any continuously growing population can eventually outstrip its resource base. The data on the growth of human populations are voluminous and opinions range from one extreme that the present population growth will tax the resource base beyond its capability to respond, to the view that technology will solve the resource problem. In the long-range, it is obvious that birth rates or other population parameters must adjust themselves to available resources. The level of the population asymptote (steady state size) in relation to the food resource size is critical but eventually it is likely to be achieved at six or seven billion people, i.e., a world population twice the present size. Without planning and some change, the food problem could remain one largely of distribution of available resources, as it appears to be today.

The contribution from the world ocean to food resources has been of only modest significance though most calculations usually fail to consider the replacement cost of fish as food. Because of the nature of the distribution and the microscopic sizes of plant life in the ocean, most food energy (carbohydrates) will continue to come from plants grown on land. However, nitrogen fixation in the sea is at least four times as great as that of the terrestrial environment and this fixation rate controls the amount of protein produced. Therefore the ocean's primary importance lies in protein production and this role cannot be diminished. Most importantly, the nature of the food-distribution-population problem suggests that the issue is critical, that there is no single solution and that the expanded use of all food resources must be considered.

The object of this paper is to assess the potential of aquatic living resources on the basis of: their present contribution to the world supply of protein; the factors influencing this input, positive and negative; the trends in the harvest; their processing; and their future in terms of the opportunities and constraints on the development of existing and new fisheries.

Fish and fishery are here considered in the broad sense to include the harvest of all living products from the aquatic environment.

Present Yields

In the last quarter century fisheries have experienced their greatest recorded growth, expanding from less than 25 million metric tons to their present more or less stable level of about 70 million metric tons. The origin of the catches and of the harvests show different and uneven distributions. Study of the most recent data (FAO 1974) shows significant and dynamic changes over the past several years. However any analysis must consider that a single species (the Peruvian anchoveta [*Engraulis ringens* Jenyns]) has been responsible for as much as 18 percent of the total catch and the fluctuations in its abundance will be reflected in the stability of world totals. Even with the apparent temporary decline in the anchoveta stocks, the new single species leader Alaskan pollock (*Theragra chalogrammus* [Pallas]), contributes 7 percent to total landings. Nevertheless real regional differences and trends remain. Formerly, catches from the North Atlantic dominated the world landings. Today, catches from the North Pacific exceed those of the North Atlantic. The landings from the Indian Ocean are still comparatively small. The contribution from the tropics and southern waters was of a minor significance in the past, whereas today, while the northern temperate waters contribute over 60 percent of the total, landings from the tropical regions have risen to about 30 percent and are increasing. Primarily because of weather and distance to markets, the cold southern waters contribute less than 8 percent of the world's total landings but are also increasing.

The magnitude of these total landings is placed into perspective when it is recalled that the entire catch from Baja California to Alaska, including the rich harvest of salmon (*Oncorhynchus*), halibut (*Hippolglossus stenolepis* Shmidt) and inshore ground fish contributes less than 5 percent to the total. The catches made by several nations off eastern North America do not surpass 9 percent. It is not surprising that with her present fishery the United States occupies sixth position among nations in world fisheries.

Factors Controlling the Harvest

Several factors contribute to the uneven distribution of fisheries and landings in the world. At the harvest level there is the fundamental distribution of the resource as well as the nature of the environment itself. There are great differences in the numbers and types (e.g., ground fish, pelagic, inshore forms) of harvestable species on a latitudinal basis. Fewer kinds of fish live in cooler waters than in the warm tropical seas, though their individual abundance may follow a reverse pattern. Overlaying this pattern is the fact that there are relatively few kinds of large aquatic animals; as adults most fishes average only about 10 - 20 centimeters (ca. 4-8 in) in length.

The vast proportion of presently harvested fishery resources are confined to productive areas over the continental shelf and adjacent slope. The shelf area of the ocean's surface includes only about 7.6 percent of the total and greatly varies in its productivity by region. The shelf varies in width from a few kilometers in such areas as the Canadian west coast to hundreds of kilometers as in the East China and Yellow Seas. In depth, the shelf is generally considered to extend down to about 200 meters (ca. 600 ft) but a precise definition is operationally difficult. Fish production does take place in deeper waters but at lower rates. Since many fish and invertebrates occur in coastal shelf waters of estuarine character, their life cycles are intimately related and sensitive to the adjacent terrestrial environmental systems.

Basically, the biological factor controlling production involves the nutrient base of the food web. The distribution of these nutrients is fundamentally related to planetary circulation patterns. Conversion through photosynthesis of this nutrient base to phytoplankton serves in turn as the basis for zooplankton production. The other herbivores and carnivores form a complex interacting web with man at its apex, giving rise to concentrations of life which biologically range from marine deserts to lush tropical gardens. In contrast to the terrestrial environment, because of the size distribution of aquatic forms, man must wait for the production to be accumulated into organisms of sufficient size and concentration to warrant harvest.

Non-biological factors limiting man's catch and landings involve the proximity of the fishing areas to market as well as marine weather. The areas and potential time available for small boats to carry out fishing varies greatly in different parts of the world and at different times of the year.

There are a number of economic and social factors affecting catch. The object of the fishery itself is important in that subsistence and non-export operations have different requirements from those fisheries whose objective is to obtain foreign capital. Distribution systems are intimately involved, particularly with the former type of fisheries. The degree to which a nation's transportation system is developed often dictates the extent to which processing and marketing are successful. Perhaps the most important non-biological factor is man's inability to effectively respond to reduction in stock size. Economic and social pressures to continue over-exploitation have left many stocks in a depleted state.

Product demand is related to traditional social and religious beliefs of people, which change only slowly with time. Food habits vary widely and fish consumption ranges from about 40 percent of the total animal protein consumed per day in the Far Eastern regions to less than 4 percent in North America (Finn 1960).

Technology, which once was a dominant factor in determining a nation's fishing success, is less important today because of the exchange of technology, monetary or technical aid programs and the implementation of joint ventures in fisheries.

Trends in World Harvest

The overall growth rate in world aquatic harvest has been in the order of 4 to 5 percent per annum over the last quarter century. Although temporarily stabilized because of the decline in the anchoveta fishery, it is the marine catch which has grown the most dramatically. The growth in freshwater landings has been slightly over 3 percent per annum as that for other products, such as shell-fish and crustaceans. It is interesting to note, however, that in the United States it is this last category (primarily shrimp) which has contributed to the greatest dollar value to the landings.

If the growth in landings is examined by country, it is apparent that the leaders in world fishing have exhibited striking shifts in position since World War II and comparisons with the distant past are even more dramatic. Early historical data are difficult to obtain but in 1880 the leading fishing countries were the United States, the United Kingdom, Japan, Russia, France and Canada (including Newfoundland) in that order. The United Kingdom has since dropped to 13th place and France no longer appears among the top contenders. In

1880, as world leader, the United States had a catch of 75 thousand tons with a value of $45 million. In sixth position today, the United States' catch is about 2.7 million metric tons with a value of over $900 million. These rankings form a very different pattern in terms of value of landed catch or as a proportion of the GNP. The positions of Mainland China and the Soviet Union are not definite as neither nation reports the value of their catch.

The growth in fishery landings has not been an even progression and, even among the leaders, fluctuations are apparent. The few declines in country totals are due to a variety of causes, some of which extend beyond the realm of fisheries per se and have affected even such traditional fishing nations as Japan. Several patterns usually attributed to biological causes could have been the direct consequence of economic factors (Quirk and Smith 1970).

The contribution of freshwater and other inland fisheries has remained steady over the last decade at about 14 percent of the world total. Almost 80 percent of the world's harvest from inland waters is made in Asia (including the USSR) and about 14 percent in Africa—the only two regions where it is significantly increasing—and which in part could be a statistical artifact. In South America, Europe and North America, inland landings consist of only 2.6, 2.4 and 1.5 percent of the total respectively. These lesser contributions to total protein in North American and European countries where adequate food is available are outweighed by the value of the freshwater fisheries as a recreational resource.

Processing of the Harvest

Changes are also taking place in the use of products from the sea. In terms of processing method, approximately 35 percent of total landings are reduced to meal, 30 percent used as fresh fish, 14 percent frozen, 12 percent cured, less than 10 percent canned and a small fraction is used in miscellaneous specialty products. Recent advances in production methods for fish sticks and fish pastes are increasing the proportion of the landings which are being converted to direct food products. Although the current decline in the Peruvian anchoveta fishery has been reflected in a temporary drop in production, the most significant change in use has been in the large increase in the proportion of landings reduced to meal. It should be emphasized that fish reduced for meal are not to be considered 'fish fertilizer'. The product is extremely valuable with numerous industrial uses, including one as an intermediate step in feeding other animals. The only difference between reduced and other fish products in terms of total protein contribution lies in the conversion efficiency before reaching human food; the energy conversion subsidy being presently acceptable.

Comparison with Agriculture

The latest available figures for world agriculture are in the 1972 Production Year Book of FAO (1973). During that year about 109 million metric tons of meat was produced. Substantial amounts of protein came from other sources. The land also produced over 1.2 billion metric tons of cereal, 500 million metric tons of root crops and pulses, 300 million metric tons of vegetables and 200 million metric tons of fruit, not to mention numerous other smaller harvests or byproducts of living animals (as 400 million metric tons of milk) used as direct food.

During the same year, production from the sea was something over 65 million metric tons. To put this in perspective, let us make some simplifying assumptions. First, that fish have the same density as water; thus a ton of fish would occupy the same space as a metric ton of water (one cubic meter). Let us also assume that because of discarded harvest and other losses, the amount of fish actually caught is in the neighborhood of 100 million metric tons. This amount of fish would form a volume of one kilometer by one kilometer and reach a height of 100 meters. Indeed because of our simplifying assumptions, the pile is too large, fish are more dense than water and only 65 MMT was landed.

One could argue that using the same simplifying assessments the volume of terrestrially produced meat would be about the same magnitude. However, the total terrestrial yield must be the basis for comparison as the catch of 100 million metric tons represents the total living resource extracted from the sea - plants, invertebrates, fishes, whales, etc. It is difficult to accept the fact that the waters overlaying three quarters of the surface of the globe yield so much less than one quarter of the earth that is above sea level.

It has been argued that much of the sea occupies depths of limited production; in fact the thickness of the productive layer is greater in the ocean than on the land. Even making adjustments for the great regional differences, it is clear that we are extracting only a small proportion of the potential products of the sea.

Potential for Harvest from the Sea

Estimates of the optimum potential of the sea to contribute to the solution of the world protein problem require examination from at least three positions: biological, technological and the institutional (social-economic-legal) aspect. These are interrelated and any significant increase in production from the sea assumes that the solution would be approached in a unified fashion. Improvement or correction of only one will substantially limit achievement of the objective.

Biological Opportunities and Constraints

The productivity of the sea varies by orders of magnitude from area to area and with season of the year. These differences have led to widely different estimates of potential yield. Rounsefell's (1971) review of the topic should be considered in light of Hempel's (1973) technical anayslsis of the basis of productivity. Together these documents place into perspective arguments which pertain to specific locations and specific issues (e.g., Moiseev 1969, Ryther 1969 and Alverson, et al. 1970). Gulland's (1971) compilation of potential harvest summarizes the best 'guesstimates' available from field studies.

Even on a conservative basis, expansion of existing fisheries and current means of utilization could increase annual yield by 20-50 million metric tons. With a reduction in waste and improvement in management which would allow recovery of presently depleted stocks (to be considered later) this amount could be doubled. With modest expansion of existing technology and fishing strategy, a number of presently unharvested or under harvested species as saury (*Cololabis saira* (Brevoort)), sandlance (*Ammodytes spp.*) blue whiting (*Micromesistius poutassou* [Risso]), and pelagic red crab (*Pleuroncodes planipes* Stimpson), might be exploited

(Gulland 1971). Some other promising forms are krill (*Euphausia* spp.), grenadier (Family Macrouridae), lanternfish (Family Myctophidae), and squid.

Krill

It is estimated that the potential annual harvest of Antarcic krill could exceed 100 to 200 million metric tons. The Soviets (in the Antarctic) and Japanese (in both the Antarctic and North Pacific) are actively fishing krill as well as developing methods of capture and processing. In Japan there is a good demand for the product and it is apparently being well received in the U.S.S.R. West Germany, Poland and Chile all have exploratory efforts for krill underway. The stock size of the Antarctic krill is so vast that krill harvest appears unlikely to adversely effect other species.

Grenadier

Extensive stocks of this distant relation to cod have been located in many areas of the world. Grenadier live near the bottom, usually beyond the edge of the continental shelves. Estimates based on catches and underwater photographs suggest the harvestable stock may be in the order of 8-10 million metric tons. Grenadier are soft bodies fish rich in oil, making them excellent candidates for reduction.

Lanternfish

Sonic surveys indicate substantial quantities of lanternfish and other inhabitants of mid-water layers throughout most ocean regions of the world. A pilot fishery utilizing conventional gear is taking 20,000 tons annually off Africa. There are new techniques for harvesting such stocks more efficiently though none have reached commercial use. It is this group of fishes, which hold the most promise for proponents of "moving down the food chain." While these fishes average only a few centimeters in length, they exist in vast quantities and many of the forms are rich in oil and vitamin A.

Squid

Voss (1973) estimates potential yields of 8-10 million metric tons of the larger squid and cuttle fish in the world oceans. At present only limited fisheries are involved in their harvest. Properly prepared, they make an excellent food.

Aquaculture

The question of the potential of aquaculture presents an enigma. Fish culture represents one of man's oldest efforts at ecological manipulation. However, after centuries of effort, there are only three major species groups, all from brackish or freshwater, which are domesticated. These are the carps (Family Cyprinidae), salmon and trout (Family Salmonidae), and more recently a few kinds of catfish (Family Ictaluridae). In the ocean, aquaculture (=mariculture) has been less widely practiced except for oysters, a specialty produced which has achieved a high degree of success. Extensive pond culture in some parts of the tropics, particularly Southeast Asia, show yields approaching 2 tons per hectare (0.8 ton per acre) and four times that amount in some individual Indonesian reservoirs. There are unpublished reports from India of yields of up to 12 tons per hectare using polyculture. These levels of production rely primarily upon herbivorous fishes. This exceeds anything achieved to date in terrestrial agriculture. Unfortunately in temperate latitudes, the enthusiasm for aquaculture exceeds our technology, particularly where multispecies are involved (=polyculture). Schaefer (1969) states "Mariculture is a fine way of making money, through the growing of high priced edible marine organisms and other marine products, but is a poor way of obtaining large quantities of animal protein at low prices . . . ." In one sense, the problem is that aquaculture means different things to different people. There are several kinds of fish culture and the success and potential of each of these methods depends on region and species. Most efforts have been empirical and a systematic approach would likely identify many suitable, presently unharvested forms, particularly among tropical freshwater herbivores. At this time, it would appear that the cost of labor will be the limiting control but it could also be that the total energy cost for some kinds of aquaculture will reach uneconomic levels.

In the future, with fundamental changes in our approach to aquatic harvest, major advances in the field of aquaculture are feasible. Possibilities include controlled harvest using sound, light and chemicals (Alverson and Wilimovsky 1964), or stocks of fish maintained on ocean ranches to be harvested as required. A logical extension of the use of satellites in management (to be treated later) would be their employment for the near surface searching and tracking of migrating pelagic stocks. While effective genetic studies pose very difficult questions because of the long life of the animals involved, knowledge of the genetic nature of fish should permit selective breeding of fast growing, disease resistant forms. With selection, year round breeding and growth of fishes might be as commonplace in aquaculture as it is with poultry and swine. Even in the short range it is mandatory that we improve our ability in fish genetics in order to cope with the problems brought about through the use of artificial propagation techniques. For example, it appears that some of the fish stocks raised under controlled conditions before release are eliminating their natural siblings from the environment; the long term effects of which are unknown.

Other modifications affecting biological production more directly dependent upon man's management ability will be discussed under social-economic-legal opportunities.

Technological Opportunities and Constraints

A wide variety of general technical advances has or can materially improve harvest from the sea. These range from new communication and navigation aids, such as miniaturized radar to improvements in ship design, propulsion and construction materials. These will not be discussed here as their adoption by any consequences to the fishing community is largely a problem of socio-economics.

Reducing Waste

Without any major change in our way of fishing, simple reduction of waste by not discarding presently unused fish and otherwise using more of multi-species catches could increase world harvest in the order of 20 to 30 percent.

A distinction should be made between catch and landings. The 70 million metric tons which comprise the world's annual *landings* are only a proportion of the total world *catch*. With the exception of Southeast Asian countries, most fisheries discard a substantial proportion of their catch. This is wasteful and constitutes the second greatest loss in contemporary fisheries (at least 5-10 million metric tons annually). In temperate climates, where fisheries are dominated by single species operations, only the commercially important form is retained and the other fishes cast overboard. The majority of fish returned to the water are already dead and few of the injured survive. In multiple species fisheries, the argument is often that the labor involved in handling the less valuable catch does not warrant their landing. (Contrast this situation with most Asian fisheries where everything caught is landed for market and sold. The term 'bringing to market' does not convey the artistic and attractive form in which they are displayed at both the wholesale and retail markets).

A better utilization would result from the introduction of the rotary de-boning machine to fisheries which now discard the smaller and less dominant forms. The machine extracts the bones by forcing the tissue through a perforated plate in a form which allows the protein to be reconstituted. Tests in some tropical countries indicate an increase in yield of 40 percent in multispecies fisheries through use of presently otherwise discarded harvest.

In shrimp catches, the fish by-product often represents 85 to 90 percent of the catch by weight (forming about seven times the bulk of the shrimp) but having only one third of their value. Since the storage hold size of ships is limited, a common practice is to jettison the fish. As Allsopp (1975) points out, as an example, off the Guianas where some 500 shrimp trawlers annually land 23,000 tons of shrimp, approximately 200,000 tons of fish are lost. The use of a deboning machine would result in substantial protein savings. The resulting minced product can be prepared at competitive costs and at least on a trial basis is achieving market acceptability wherever tried.

Gear Improvement

On a longer range basis, significant improvement can be made in our ability to detect and identify fish stocks and in the gear to harvest them. While sophisticated electronic and sonic approaches to the detection and identification problem are underway, much of the gear development is still progressing by trial and error. Gear research laboratories are few and there is need for combining our knowledge of materials and machines with information on fish behavior and hydraulics in a productive and practical way. The analysis of the stress and strain in nets remains in its infancy and our present harvest ability is for the most part limited to relatively shallow depths.

Cooperation in Fishing

In moving towards the goal of optimal sustained harvest, many improvements are possible and practical. One likely to show early effectiveness is co-operative effort in fish finding. Assuming the provisions of monopoly and combines legislation can be overcome, there is no reason why companies could not participate in major joint ventures. Thus most boats could be devoted to harvest tasks and only a few equipped with the expensive and sophisticated electronic gear necessary for fish finding. Much of the fleet could be devoted to the harvesting process while still increasing the efficiency of the search process. From the resource management viewpoint, more effective control would be possible. Since this could be done at a substantial saving in cost, there should be much incentive to implement such schemes both by industry and by the agency responsible for resource management. The individualistic nature of fishermen need not be destroyed in the process.

Social-Economic-Legal Opportunities and Constraints

There can be no question that the ultimate size of potential harvest is fundamentally controlled by biological factors and further that our technological ability will determine the proportion of that potential which might be harvested. However, the actual harvest will depend upon mankind's ability to plan, manage and manipulate resource use within the complex interacting and often conflicting social, economic and legal regimes.

Solutions of almost all of the issues are within our present ability. Their relative priorities remain to be developed.

Eating habits

The demand for fish as food will in part control the rate of expansion of the harvest. The feeding of man is an illogical process only slightly dictated by physical need and substantially influenced by psychological and sociological experience. This makes the feeding of under-nourished peoples as difficult as that of the more fortunate, as most people are unwilling to accept any food falling outside their customs or cultural norms. The failure of the FPC (fish protein concentrate) program was largely due to consumer unfamiliarity with the product though the far reaching effect of absurd impediments (as the necessity to package in 2 pound lots) placed on the U.S. effort by its Food and Drug Administration should not be minimized. The value of fish as a direct food and the regional differences in their use have already been considered. Unfortunately, in spite of a greater protein content per unit cost than for other foods, fish, even where abundant all too commonly are not sought after as food. Comparisons of food preferences show a substantial degree of indifference by the North American population to fish and the problem is not limited to North America. Part of the problem is that there are often cheaper (even if less nutritive) alternatives available. But the simple fact is that very few people know how to properly prepare fish.

There is a vast potential for increasing interest in and utilization of fish products by the innovative processor with an active sales program, including attractive, effective packaging and suitable advertisements (the only TV ads one usually sees are how to combat the fish smell in the refrigerator). As eating habits become more sophisticated, the many Oriental ways of preparing fish could become less of a novelty in the kitchen. One wonders however, whether everyone is working toward the same goal. In a recent newspaper, an article on the food page was describing the preparation of sashimi while the health column was cautioning the public against the danger of eating raw fish.

Perhaps one should take comfort in the fact that while per capita fish *consumption* is generally low, per capita fish *use* is growing and reflective of the wide use of fish as an intermediate stage in other food production. In this sense, it is immaterial whether fish are used directly or indirectly in feeding people. Nevertheless, in the long range the energy cost of conversion will require consideration.

Control of the Resource

Until recently, the resources of the sea have been considered to belong to everyone and anyone. One of the many implications of this common property aspect of fisheries is that there is no limit on the number of participants. In any given fishery the development pattern tends to be similar to that of any other fishery. In the virgin state the population is in equilibrium with the environment. Man disrupts this balance and at the onset his catch per unit of effort is large. Profits accrue and other new participants enter the fishery. As their numbers increase, the total catch rises and the catch per unit of effort declines. Almost invariably, progressively greater biological depletion occurs as technology attempts to improve the catch per unit effort. Invariably the fishery is harvested to the point of no profit. The total cost of production equals the total return from the fishery and the economic 'rent' is dissipated among the units of labor and capital that are in substantial excess of that required to harvest the stock.

Since the resource was considered to be common property, there was no effective mechanism to limit entry (or to reduce participation once begun). For the same reason, the individual harvester could not justify an effort for resource conservation. Any such effort must be cummunal by definition. Since fisheries tend to be unlimited in scope and the interests of individuals not similar, agreement became difficult and multi-national conservation measures tended to be ineffective in competitive situations. The regulatory measures imposed on the fishery tended to be directed towards limiting the efficiency rather than the numbers of participants. No other primary industry promulgates new regulations designed to increase inefficiency. The consequence has been 'overfishing' or serious depletion of a number of stocks. Efforts at limiting entry in order to reduce the effort (and consequently the cost) have been applied only in isolated instances to specific fisheries, e.g., British Columbia salmon.

This principle of common property, which provided no incentive for conservation, is about to be discarded at the international scale. The impact of the Law of the Sea deliberations is clear in the desire of most maritime nations to establish a 200 mile economic zone for control of resources. Whether initiated unilaterally or through a Law of the Sea treaty, it is only a matter of time before such zones are established. Under these provisions, each coastal nation would have control over harvest from its shores seaward to distances of 200 miles and could limit entry of its citizens to the zone. There is nothing magic about the distance (it does not even represent average shelf width) but will define the area for which each nation theoretically is to carry on meaningful conservation efforts and be responsible to the world community for such conservation. The impact on resource control can be appreciated from the fact that 37 percent of the oceans, about equal the area of the continents, will come under national jurisdiction and will include over 90 percent of the major marine landings.

In spite of the years devoted to the Law of the Sea negotiations, few maritime nations are prepared to implement control and conservation over their shelf resources. The questions of resource allocation, the accommodation of traditional but foreign harvesters of the resources, as well as the scientific and enforcement problems imposed by extended jurisdiction, constitute a formidable challenge. Proposed restrictions on research carried on by the international scientific community in the economic zone may prove to be a deterrent to developing nations rather than giving them the protection and control against exploitation for which they hope (Wooster 1973). The result of the "accessability for scientific research" debate may be the most critical limitation to the short term increase of ocean harvest and could result in less rather than more international cooperation.

The Resource Management Syndrome

Even with controls over the continental shelf, it appears that we are determined to continue the time honored habit of working on yesterday's problems. Public opinion to the contrary, many scientists hold the view that management of aquatic resources is not being conducted on a scientific basis (Larkin 1972). The resource manager, the industry, the policy maker and the public sector seem forever engaged in a macabre minuet.

A central and crucial point is that each element of the system has been at partial fault. The fisherman, including the fishing industry and the unions, fail to respond to the early warnings of the biologists. Economic and institutional pressure to continue exploitation often are such that warnings are never heeded until it is too late and then miracles in resource rehabilitation are expected overnight. The political units fail to provide support until pressured by the public sector by which time the situation is usually critical and the 'blame game' begins. Then because of the interaction of many associated problems, the solution becomes difficult, costly and time consuming, if not totally impossible. It is the resource that suffers most in this circular approach to the problem.

The individual fishery scientist is frequently tardy in his warnings because of his reluctance to make projections on the basis of incomplete data. If the necessary data were available, there would be no need for the prediction (or perhaps the scientist). The fundamental difference between the scientific method and current concepts of management seems to have been missed by both groups. To paraphrase Gulland (1970), management is the matter of making decisions and it is at least as important to make a decision in time as it is to make the best decision. Science has to provide evidence on the likely result of possible management actions in order to enable more rational decisions to be made. It is worthwhile emphasizing that management is not only timely decision making but systematic, informed risk taking. Many resource managers have relinquished (or never assumed) their responsibility in risk taking and must come to recognize that their role is an essentially and legitimately risk-oriented one. Much of the solution appears to be in having the right kinds of up to date data and the methods to cope with uncertainty.

Data Requirements

It is apparent that most aquatic living resources are either non-managed or mis-managed. Because of this a substantial fraction of the available harvest is wasted. Even if this loss in terms of harvest and greatly excessive inputs of energy as capital or manpower only averages 10 percent of the total value of the landed catch, the total waste amounts to over a billion dollars annually. It is conservatively estimated that the waste in many stocks is much in excess of this 10 percent assessment. The reasons for non-management or mis-management usually lie in not having the right kinds of data for management of the stock as well as the associated problem of effectively communicating the information (its acceptability) as has been the case with the blue whale (*Balaenoptera musculus* Linneaus). In many instances, the data are not collected. In others, the data are collected but not distributed in timely fashion and in still other instances, the wrong kind of data have been or still are being collected.

The nature of management information today is that often it is of limited accuracy, little precision, of questionable credibility (sometimes even falsified) and often communicated through means which effectively reduce its acceptability. It is a wonder that resource management performs as well as it does.

The data problem, including ways of managing data, represents the greatest single barrier to increased harvest. Rational management of the world's oceans will not be possible without correcting this situation. The cost of such information will be expensive but far less than the revenue lost without it. The procedure to convince fishing nations of their responsibilities for the collection and timely distribution of pertinent resource information remains to be developed.

Monitoring Resource Use on a Real-Time Basis

Associated with and part of the data problem is the matter of obtaining credible current information on the distribution and effort employed in resource harvest. Collection of information at ports of landing and from log books maintained on the ships has its merits as well as its severe limitations. Where such information is used for taxation purposes, there is a reluctance to cooperate and in any case the data are always after the fact. The amount and distribution of harvest effort is critical to management. Radio reporting of vessel location is only partially effective in that some fleets employ 'slave' or repeater stations to transmit combined position information to the shore station. This procedure makes triangulation and similar verification techniques impossible. Such 'active' procedures are always likely to fail. Passive use of a transponder in connection with existing and proposed satellites seems to be the only practical solution to real-time acquisition of fleet distribution data. It has been suggested that a small transponder could be affixed to a vessel for up to a year without requiring maintenance and could be fabricated in quantities at low costs. I know of no estimates comparing the costs of the total satellite data acquisition system with that of contemporary methods.

Choice of Management Objective

Given the opportunity for credible but limited data for real time management, it would be difficult for the investigator to specify what information is required, since most operational situations lack a clear statement of management objectives. Without articulation there can be no direction and a desirable management objective for one interest may be totally inappropriate to another. The recognition that maximum sustained yield, while a possibly desirable biological objective, might better be supplanted by optimum yield to meet economic objectives only reached fruition in the past few years (Roedel 1974). Other interests suggest that management should be based on a total ecosystem approach but it appears that we are a long way from having the requisite understanding to carry out such management on a general basis. The use of simulation techniques to describe and to test the implications of complex models does show promise for the future.

Management Models

Prediction of population behavior and permissible yield has for the most part been based on surplus production models and/or the so called dynamic pool models. The first requires only information on catch and effort to be applied while the latter utilizes information based on the growth and other parameters of the individual. Both models were designed to accommodate single species harvest under equilibrium conditions. While many of the major fisheries in temperate regions approach these concepts, the situation is not true in the tropics where almost all fisheries involve multiple species and there is no adequate existing model available to cope with their interactions. Essentially we still are unable to predict the effect of selective harvest of one species on the composition and relative abundance of other members of the community. Some management models have data-limited input parameters. Unlike forms living in colder waters, no satisfactory means of determining the age of tropical marine fishes has been found. The lack of the time parameter has severely limited our predictive capability in managing tropical fisheries. Another example is in stock-replacement relationships. In spite of major efforts, our inability to predict the size of incoming year classes on which the future of every fishery is based, severely limits the efficient short range use of the resource. Cushing (1975) details the complex nature of the problems involved.

The means by which populations transmit information by the state of their own condition is another area in which heretofore theoretical questions assume fundamental importance in the optimal use of living resources.

Stability and Resilience in Resource Management

A variety of earlier observations and experience are reflected in Regier's (1974) comment that the ease of manipulation of a resource depends not only on its size but on the degree of variability characteristic of the population. Our success in the management of stable populations of large size has been relatively good. We have been less successful with modest populations showing significant variability and have a poor record with small populations of high variability. In one respect, the problem may be viewed as our inability to determine when a population moving to a new equilibrium state is approaching a critical size or alternatively, the populations' resilience to perturbation. An attempt to explain the mechanism of some stock declines has been sought in catastrophe theory (Clark 1974). Catastrophe theory has been developed only for static situations and the natural environment is dynamic in character. Nevertheless, as interpreted by this theory, it appears that when a population falls below some critical level it loses its ability to recover even under conditions of no harvest. In such a situation, the population drops to levels from which it may not recover without some unpredictable environmental perturbation. This concept exhibits real biological analogs in the flip-flops of species which ecologically alternate and replace one another, such as happened with the California sardine (*Sardinops sagax* [Jenyns]) and anchovy (*Engraulis mordax* [Girard]) over at least the last two centuries (Soutar and Isaacs 1974) . . . long before man could be blamed for the result.

The responsibility for resource decisions should lie within the management agency. Because it frequently does not (as was discussed in the section on the management syndrome) the onus of failure responsibility is not defined. Consequently contemporary management planning has not made sufficient use of contingency planning in coping with resource problems and continues to rely on the ad hoc approach. The fact that it may be an international or government organization with a staff of "experts" is no longer (if it ever was) sufficient assurance of success. Public concern over the state of some resources has resulted in calls for separate and independent assessment of management decisions. Any resource plan must assume a finite possibility of failure. The management strategy must be designed so that if a failure does occur, it would fall within the range of human and biological limits to permit recovery of the stock within a reasonable time frame. Until we understand more about the nature of critical limits in populations, it will be necessary to err on the conservative side. This so called safe-fail concept (rather than fail-safe, c.f. Holling and Clark 1975) should be coupled with an "early warning system" based on timely monitoring of environmental and stock data.

Natural Experimentation

Our limited understanding of populations has resulted in one enigma of scientific resource management; our inability to test predictions through experiment. The manager as well as the public is reluctant to initiate the necessary risk taking action to manipulate stocks at such levels that the consequences of the manipulation can be differentiated from environmental noise, particularly when a reduction in yield may result. Instead the manager waits for natural perturbations and attempts to separate man-made factors from the natural effects on the system. This reaction is a response to our management success (or rather lack of) to date.

In spite of such concerns, it must be emphasized that the principles of the scientific method are not different when applied to the aquatic environment and our understanding is severely curtailed by the reluctance to experimentally manipulate stocks. Walters and Hilborn (1976) have suggested techniques which could provide information on the stocks while taking account of risk to yields.

Food Web Manipulation

There is some evidence that any given region of the sea can support a more or less fixed biomass. It behooves us to take advantage of natural as well as man-induced population shifts in the numbers and kinds of organisms inhabitating the region. The replacement of the California sardine by the anchovy is well documented but political apprehension and misunderstanding have prevented the latter species from being harvested at a reasonable level. Through application of excessive effort, the abundance of bottom fish in the Gulf of Thailand has declined but total biomass appears to have remained constant; the fish apparently being replaced by squid and cuttle fish which fortunately are an acceptable market substitute in the area. There is some evidence that a similar shift, which has not been exploited, has taken place off the coast of Brazil.

Perhaps the most exciting possibility for future resource manipulation will be to fish off the predators forming the apex of the food web and make use of the smaller fish which presumably would have increased in their abundance under reduced predation. Theoretical work by Andersen et al. (1973) suggests that the intensive fishing effort on larger fishes may account for the substantial increases in the abundance of sandlance and other heretofore little utilized fish in the North Sea. In most instances the limitations of our knowledge of stocks and management skill have prevented us from taking advantage of such situations. In spite of the foregoing, not all stock manipulations are beneficial. Great caution must be exercised in the transplanting or introduction of organisms as well as in the development of new fisheries, to avoid breaking critical ecological links.

Special Considerations

While the foregoing generalized problems apply to the major aquatic management problems facing mankind today, there are a host of special situations warranting urgent attention. Superficially each represents only a small concern but in total could have serious ramifications on the resource. Two such examples follow. Unattended fishing gear should be fabricated in such a fashion that it ceases to fish after being lost or untended for some specified time. There has been reason to believe that without such a 'break-link', stainless steel crab pots continue to fish for months or even years and possibly may have affected population size. Reef fisheries and other specialized habitats hold special problems. Current reef harvest procedures, while utilizing large fish, destroy many young, greatly curtailing re-establishment of harvestable levels of these stocks.

Contaminants

In the coastal zone, the multiple purpose needs of water as an environment, as a source of minerals, for transportation, real estate, industrial use and recreation, as well as an outlet to dispense waste products, increase the likelihood that we will ultimately degrade the general biological productivity of some coastal areas. While this might be avoided with planning and monitoring, the real concerns in terms of living resource use are the pollutants of terrestrial origin. Most of the pollutants found in the sea originate far inland and it is there that control must begin. In this respect, it should be noted that the criterion of sub-lethal level of tolerance for any pollutant is irrelevant if the accretion of the pollutant continues. Time in this respect does not possess the infinite quality usually ascribed to it.

Conversely, the unrealistic restriction and categorization of selected foods as unsafe to human health because they cause damage to test animals when fed to them in excess must be brought within rational limits. Carried to the extreme, there is little doubt that almost every product will be found to be cancer producing or otherwise lethal if consumed in great excess. The means of determining permissible safe limits for human use of foods must consider realistically the biological and physical half-life of the alleged critical chemical. This is not to suggest approval of sub-lethal additions of contaminants to the sea. Certainly some areas and products which have concentrated toxic substances must be barred from use. As a counter example, the swordfish (*Xiphias gladius* Linneaus) fishery was closed in one large region because of mercury loadings in these fish, but even with increased use of fish as food, most of our lives are too short to consume enough swordfish to do bodily damage.

Management for Mankind

Resources should be managed for mankind and a distinction must be made between those elements of the public wishing to preserve and protect the resource for its own sake from those who believe conservation and wise use must place human needs foremost. The approaches are not mutually exclusive and society should be able to afford both positions. For example, the ornamental fish trade which has reached $4 billion per year (Conroy 1975), poses a threat to the preservation of some species of fish life. In addition to harvest for food, many reefs are subject to exploitation from collectors of shells and corals as well as exotic fishes. Establishment of "reserves" to protect endemic species from the inroads of man and his machines or from the effect of indiscriminant transplanting of other species is necessary. In neither case is the contribution to total human food an issue, but rather the preservation of an irreplaceable heritage.

Unfortunately, the preservation philosophy, through well-meaning but misguided efforts, has resulted in some near impossible management situations. The Marine Mammal Protection Act of 1972, as it applies to the tuna-porpoise question, is a good example. The fishery makes use of the ecological association between some yellowfin tuna (*Thunnus albacares* [Bonnaterre]) and porpoise with the consequence that a number of the latter are killed in the harvest process. No one questions the desirability of avoiding excessive destruction of porpoise. Yet the law seems to imply total preservation, i.e., zero fishing mortality for the porpoise. Through legislation, decades of non-research on these animals was to be overcome in a two year period and understanding of the population dynamics of these animals acquired instantly. While much has been accomplished, the side effects of the legislation (including effects on scientific research) and its ramification for one of the few healthy fishing industries in North America are bound to have far reaching effects. Forcing the tuna fleet to register under another flag or barring tuna from the U.S. market will not help the porpoise.

Recreational Use Conflicts

To most North Americans, fishing traditionally conveys sport fishing and this same image is held by a significant number of fishery biologists. While the principles of management are the same, there are fundamental differences in the application of management practices to commercial fisheries from those used to meet the sport fish demand. In addition to emotional considerations, conflicts often arise not only when both interests compete for the same resource but even when seeking different fishes in the same area. Until there are objective ways of quantifying the true value of these sport fisheries and separating them from associated recreational (non-consumptive use) and commercial values, these problems will be difficult to equitably resolve. Where such conflicts exist, the fundamental protein production question is often lost.

Energy Conversion

Serious consideration is being given to the use of "wave farms," ocean temperature differences and the use of kelp for methanol production as partial solutions to the energy problem. It is gratifying to note that current research on these subjects is being carried out with concern for the environment. The by-products of such energy production, as well as those from thermal effluents and waste disposal plants, might be considered in aquacultural applications. While the potential total protein contribution from these activities is likely to be slight, the possibility of their use for this purpose should not be dismissed.

Human Resource Requirements

Implementation of an expanded approach of harvest from the sea will require a significant addition to the numbers of people with resource management capability. Some of this need can be accomplished through re-training and up-grading of existing personnel but a substantial quantity of new talent must be developed. Unfortunately most of the surveys for such requirements are based on objectives other than here proposed. The nearest statement of training needs and graduate education is that of Parsons (1975). In any event, the planning necessary to implement any expanded use of the sea must include the human resource factor.

Conclusions

The possibility of increasing protein yield from the oceans lies in improvements in three areas: knowledge of stocks, fishing technology, and modification or removal of social, economic and legal barriers.

It is apparent that with very little change, an additional 20–50 million metric tons could be obtained with today's harvesting techniques. With modest technological and management improvements, double this amount could be taken on an annual basis. If mankind is intelligent enough to cooperate, plan and skillfully apply the available management techniques, an annual optimum harvest from the sea could be maintained at least at 200 million metric tons and ultimately more.

These increases in annual yield will require the development of rational fishery plans and a major break from the piecemeal approach to resource management which exists today. This is not to deny pursuit of multiple objectives or a "diversity of management" concept but will require systematic consideration and definition at the policy level of the acceptable limits of compromise (the trade-offs). In spite of some signs of improvement in that the responsibility for stock assessment and harvest planning has shifted to the policy level within a number of governments, attempts at rational resource use are almost invariably carried on without consideration of other associated resources and needs of the overall system. The procedural tools and techniques for such planning are available.

The primary failure, in many instances, is the lack of clear policy guidance, agreement and implementation for management at the national and regional levels. This may be a reflection of the regard given to the importance of protein from the sea. With recognition of the new responsibilities dictated by the proposed provisions of the Law of the Sea, these attitudes will undergo some change. The urgent need is for the initial thrust and for guidelines of such policy consideration from the highest national levels. While it is likely that any initiative will first be implemented on a national basis, hopefully the national policies will have been tested for international compatibility. Such planning at the international level would require minimum bi- or multi-lateral commitment and planning could proceed in stages. Data exchange, cooperation in management of mutually harvested stocks and mutual trust would be a natural consequence of the effort. Certainly the protocols, framework and agencies exist to facilitate such an international cooperative effort for obtaining protein from the sea.

Fortunately, in this important matter the distance between our hopes and our belief of the possible is a short one. In particular, the U.S. role in fisheries needs to be strengthened. It is time to reawaken the American character of organization and aggressive leadership which has been so notably lacking in fisheries. Perhaps the challenge to bring this about at the state and national, as well as the international level, could be placed high on the list of objectives for early accomplishment in the third century of this country's existence.

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Discussion

CO-CHAIRMAN LaROE: As we can see, this paper is a wide-ranging discussion and sometimes controversial. There are many issues and concerns in relation to ocean protein. I think it followed appropriately the comments yesterday of Dr. Borgstrom's paper. Are there comments?

DR. DURWARD ALLEN: [Purdue University] This was certainly a constructive paper in every way because the more we can learn about producing food of every kind, the better our technology will be able to improve the quality of life for generations of the future.

In the next century, man on earth has many choices to make and one of these is that, if he wishes to maintain reasonable numbers, he can feed on animal protein—he can eat meat and, likewise, he can feed from the bottom of the food chain.

With a population now, we are told, of about 4 billion people, we can look back at 1975 and if our statistics are good, the earthly population increased by about 75 million this year. As a matter of fact, it will be nearer 76 million.

With that sort of thing in prospect for the next few decades, it suggests that things may get a lot worse on this earth before they get any better and it might even be that the sooner that happens, the more we will have left for generations of the future to work with.

It suggests also that distribution, even if it were ideal, would not solve any long-term problems and it suggests to me that if we can furnish unlimited food supplies to all the people of the earth who need it, that would be the greatest catastrophe that ever overtook mankind.

CO-CHAIRMAN LaROE: Thank you for your comment.

MR. RICHARD WARNER [University of Florida]: I felt that many of the comments given by the speaker were well taken and I have no quarrel with most of them. However, I am very deeply troubled by one of his basic premises, which he took as a point of departure for his discussion. That is the evidence, which I consider to be a very large body of evidence, of the topping out of the world production of fisheries in around 1980. In fact, according to regional fisheries statistics, the fisheries right off of the speaker's own shoreline are one of the classic cases in point. Virtually every commercial marine fisheries resource there is exhibiting declines of one kind or another. In other words, even in British Columbia there is no stability in the fisheries harvesting program.

The tendency to treat as yet unexploited fisheries as gold mines, in the absence of any kind of conjunctive or associative management plan, is traditional in the world fisheries and I think it can be demonstrated to be one of the things that has destroyed, one by one, the individual world fisheries.

DR. WILIMOVSKY: The paper does go into detail on this point. The manuscript consists of some 50 pages and I was only able to hit the high spots in the time available.

My statement in response to your point about British Columbia, Washington and other West Coast Fisheries as a whole, is that with proper management, rehabilitation is possible. I really believe that if we take the optimum approach to management rather than the maximum-sustained-yield concept, with the tools available today, the fisheries can be brought back. The big thing is not the tools or know how—it is the social ramifications of limiting entry.

No, I don't think unknown stocks should be considered as gold mines but I am a believer that we can manage properly if we only have the strength to sit down and do it. It is going to take real political intestinal fortitude to bring this about because if we are going to be managing properly, some people are going to be hurt in the process. This point was not stressed in the presentation.

This is one of the ways, I believe, aquaculture can help, because the limitation in aquaculture is in the labor area and costs. As a labor-intensive task, this very well may be a mechanism for putting fishermen who have been displaced to work. However, unless we have the ability to limit entry and manage optimally, your fears will be verified. I think when the paper is published you will find the other points you raised are in it.

MRS. COTRELL FREE: I am a newspaper and magazine writer and I am also involved in the Albert Schweitzer Fellowship.

I was very much disturbed, sir, that you wrote off so easily something which many people consider an integral part of the quality of life and that is the Marine Mammal Act in connection with tuna and porpoises. You seem to feel that in relation to getting more tuna to eat, the end justifies the means. You also said that the Japanese propensity for whale meat was something that we might as well live with, but is that necessarily so?

DR. WILIMOVSKY: I believe you misunderstood me and perhaps in trying to go through the paper quickly, I may not have made myself clear.

I did not say that we should take more tuna at the cost of destroying the porpoise. What I was complaining about was the nature of the Act which attempted to adjudicate the outcome and resolve all the other questions overnight. The questions with regard to rational, balanced resource management are just as important to me as to you. I believe that in balancing total resource use, one must have information from all aspects of the environment. My complaint is in relation to the restrictive nature and the time demands of the Marine Mammal Protection Act and its implications to balanced management. I certainly am not calling for destruction of the porpoise and no one can change my words to suggest that I have.

As to the whale, I would like to point out that while some whales are on the Endangered Species List and should be carefully protected, there are a great many other whales of species which are under-utilized. With the food problem as serious as it is purported to be, since some people like to eat whale, then as long as they are in abundance and are harvested in a rational fashion, I don't see such use as wrong. Nor do I agree with some of my colleagues and some of the people in this audience who say that we should bar foreign fleets because they are taking our stocks. If they are over-exploiting stocks then, certainly, bar them but if we are not using the resource and somebody else can harvest it, why not use it as long as it is done within an overall program so that we know what is happening and are monitoring the resource. Finally, it should be recalled, with a 200 mile limit, the control and responsibility for wise use is ours.

CHAIRMAN ODUM: We have asked almost the impossible of these speakers but then they spoke brilliantly on the global problems.

We are all, of course, concerned with the global vista that we just heard about in relation to pesticides and fisheries.

We also know that we have a revolution going on on a somewhat smaller scale. There was a parallel sort of thing done some 30 years ago in relation to the Soil Conservation Service, which developed as a result of cooperation between local, state and federal agencies. The SCS is an excellent example, as you know, of a multi-level governmental effort to improve the environment, although bureaucracy sometimes creeps in, and as political power increased there has been a tendency to overdo alterations such as stream channelization.

As with SCS, the coastal zone management effort should attempt to involve in as humble and harmonious a way as possible, the Federal Government, State and local governments, in trying to plan for coastal development with the elimination of abuses and preservation of natural values.

Governments' Role in Managing Coastal and Marine Resources

David H. Wallace
Associate Administrator for Marine Resources
National Oceanic and Atmospheric Administration
Rockville, Maryland

Fejos (1956), in *Man's Role in Changing the Face of the Earth,* stated:

> The story of mankind may be considered as man's own exploration of the various physical and biological conditions on the earth's surface as a result of the elaboration of human needs, capacities, aspirations, and values. Three interrelated factors are involved: (1) the earth's resources; (2) the numerical pressure of population upon, and sustained by, the resources; and (3) man's differing cultures, or ways of life. Understanding these relationships involves knowledge of values, equipment or artifacts, and of the social organizations by which people group themselves, function, and interpret resources and their use. Cultural development may be viewed as man's growing knowledge of, and control over, forces external to himself. By increasing his range of action, man has intervened more and more in the rest of the organic world. Man's evolutionary dominance seems assured—only he himself can threaten it. Man has supplemented organic evolution with a new method of change—the development of culture, the transmission of organized experience, retained, discarded, or altered by further experience.

When the Pilgrims landed in the New World they found abundant natural resources, and I suspect they believed these resources, particularly fisheries, were so vast that they would never be depleted. It was not until the beginning of the second half of the nineteenth century that a few scientifically minded individuals began to feel that the resources of the New World were not inexhaustible. And it was only very recently that we have come to realize that we need to manage these resources, along with the environment, if we are to supply the needs of a complex civilization.

Historically, conservation and management of domestic fisheries have been the responsibility of individual states, and in some cases the counties and even the towns. Beginning in 1865, the Commonwealth of Massachusetts was the first to establish a state fisheries commission. By 1871, ten states had established such commissions. In 1870, as a result of concern about the depletion of our natural resources, a small group of scientists and fish culturists banned together to form The American Fish Culturists' Association, which later became the American Fisheries Society. The Society, one of the cosponsors of the Forty-first North American Wildlife and Natural Resources Conference, was the first biological society in North America organized to foster research and management of a particular natural resource. In 1871, the need for fisheries conservation was first officially recognized by the Federal Government with the creation of the United States Commission of Fish and Fisheries under Spencer Fullerton Baird. At about the same time, because of widespread devastation of timber by logging and fire and the consequential destruction of wildlife, a growing number of thinking citizens began sounding alarms about the destruction of our natural resources.

Over the past 100 years, many of these valuable natural resources have been sustained as a result of efforts by outstanding conservation leaders, like Spencer Baird, Thomas Gill, Aldo Leopold, John Muir, Gifford Pinchot, Theodore Roosevelt, and others; by efforts of conservation and scientific organizations, like those sponsoring this conference; and by efforts of local, state and federal government agencies.

Since that time we have had major developments in our ability to carry out conservation of natural resources. As a result of greatly increased demands on our natural resources, it is obvious that we must develop new strategies and plans for improving management. In this connection, I will comment on governments' role in managing (1) living coastal and marine resources, (2) oil and gas resources of the continental shelf, and (3) hard mineral resources, such as ferromanganese nodules, in the deep sea bed.

Living Coastal and Marine Resources

Fisheries Management

The United States is in the process of asserting jurisdiction over the coastal fisheries resources out to 200 nautical miles from its shores. Congress has already passed legislation and it will be sent to the President for his signature in the very near future.

With the imminent imposition of extended jurisdiction, the United States must reexamine its national fisheries policy because, for the first time, we will have the authority for managing the fisheries beyond the contiguous fisheries zone of 12 miles (19.30 km) out to the 200-mile (321.8 km) zone and in certain cases even beyond. There are both challenge and opportunity here. With this action, living resources are recognized as important components of our national trust, contributing food and recreation to past, present and future generations. Such a commitment will have a strong positive impact on conservation of living coastal and marine resources of this Nation.

The common property aspect of marine fisheries resources, coupled with the lack of effective management regimes, has resulted in overfishing of a large number of valuable fish stocks. The International Commission for the Northwest Atlantic Fisheries (ICNAF) is our most sophisticated international fisheries regime. Yet, despite major and determined conservation efforts on the part of the United States and Canada, serious overfishing has occurred in the northwestern Atlantic Ocean, primarily because of the intensive efforts of large foreign fleets. I have been the United States Commissioner to ICNAF for several years. In spite of our aggressive efforts, until very recently it was impossible to have imposed the kinds of controls on fishing needed to restore the biomass within a reasonable time. The fact that the stocks had been badly damaged was unchallenged, but the distant water fishing nations were unwilling to accept the imposition of the severe restrictions necessary for rehabilitation. Last fall, and at a subsequent meeting early this year, major progress was achieved in conserving stocks, meeting United States fishing quotas, and international enforcement objectives. This recent success is almost certainly the result of recognition by the distant water fishing nations that extended jurisdiction is about to become a reality in the United States and that they must adjust to such a new regime. Now that it is clear that the United States will have control over its coastal stocks of fish, those involved in the management and stewardship of the living coastal and marine resources must meet the challenge facing them. We must take major steps to deal comprehensively with the problem of managing these fisheries stocks.

The proposed federal legislation grants the authority to allocate rights to harvest the resource and to limit such rights in accordance with carefully devised biological, economic and social principles. Congress has agreed that the basic management principle in the new legislation is optimum yield (OY). At a recent symposium, OY was defined as "a deliberate melding of biological, economic, social and political values designed to produce the maximum benefits to society from a given stock of fish." This means that the interests of all the users of a resource will be considered in determining the allowable catch. This is different from the maximum sustainable yield (MSY) concept in fisheries management, in which maximum protein production is the primary consideration.This does not mean that a stock cannot be harvested at MSY, or that MSY will be ignored in determining OY. MSY still is and will be in the future an essential tool for resource managers. An important asset of OY, however, is that the recreational potential of a resource can be incorporated into yield determinations regarding allocation of the harvest. Another consideration is the possible provision for an ecological reserve to protect against unpredictable natural disasters or the lack of precision of the data system used in management.

What will be the respective roles of the federal, state and local governments and the public and private sectors in the management and development of fisheries and other living resources? The Federal Government will have the responsibility for management of fisheries in the 3-to 200-mile zone. However, this will be undertaken with the fullest cooperation with state and local governments, recreational and commercial interests, other special interest groups, and the general public. In this regard, management programs will be developed by regional councils composed of state and federal officials, recreation and commercial interests, environmentalists, and others, and reviewed by advisory committees. After a management plan has been developed by a regional council, and approved by the Secretary of Commerce, it will be implemented by the Federal Government and the involved states as appropriate.

Regional councils will be established in geographic areas and will have authority to develop management plans for resources within their area. For those resources which are restricted to the waters of one state, that state will continue to have responsibility for management. While recreational and commercial fishing does take place within a state's territorial waters, most of the fish stocks supporting these fisheries are distributed between two or more states, or beyond state waters. As a result, regional councils will be concerned with management of these stocks throughout their ranges. The regional councils will be composed of people recommended by the governors of the states involved and appointed by the Secretary of Commerce and other members appointed directly by the Secretary. Representation will include state government officials, recreational, commercial and environmental representatives. The exact way that a management plan will be implemented will depend largely on the resource in question. Both state and federal governments will provide support for the management teams which will develop the plans. Enforcement and information systems necessary for management will be cooperative, with the respective roles depending upon the way the resource is distributed and the nature of exploitation by domestic and foreign users. This will be a cooperative state/federal management system, the success of which will depend on how well the cooperation is carried out.

The councils, with advice from the recreational and commercial fishing industries and public, and others will have authority to recommend the allowable harvest based on the OY concept. Some fisheries may have allocation systems that will establish quotas among user groups. Everyone, I believe, is now aware that the ocean living resources are finite and that they can only support a certain amount of fishing effort. We must maintain the proper balance between the capacity of the stock to produce and the demand on it by the users.

A major issue facing us under extended jurisdiction is "on what basis and under what conditions will access to the resource be granted to domestic and foreign fishermen?" The Federal Government will allocate fish stocks among domestic and foreign users for the benefit of the United States under the concept of OY of the total biomass in each ocean region. Preferential access would be given to the domestic commercial and recreational fishermen within the 200-mile zone. Foreign fleets would be given access to excess fisheries resources after the domestic fishermen's needs have been accommodated. As the United States fishing industry improves its capability to harvest the stock, foreign fishing will be phased down until in some instances the entire harvestable stock will be taken by American fishermen.

Coastal Zone Management

Under the Coastal Zone Management Act of 1972 management plans are being prepared by coastal and Great Lakes States, with federal technical and financial support. The Act provides for local, state, and federal involvement in the development and implementation of these plans. We in the National Oceanic and Atmospheric Administration (NOAA) regard the coastal zone planning process as a most significant opportunity to strengthen existing mechanisms to conserve our estuarine and coastal habitat. We are placing high priority upon developing sound federal policies for formulation of these plans and for cooperating with other agencies and interests in their development and implementation. NOAA's Office of Coastal Zone Management and the National Marine Fisheries Service are working with the Fish and Wildlife Service of the Department of the Interior to provide federal coastal zone guidelines concerning the protection of fish and wildlife habitat. Our regional staffs are available to assist the state offices in this important undertaking.

While the Act places the lead role for preparing Coastal Zone Management (CAM) Programs with the coastal states, it also puts particular emphasis upon the participation of local, state and federal interests in program development. To achieve the full potential of the CZM Act for protection, preservation, and restoration of our coastal resources will require active participation by spokesmen for marine resources, be they federal, state, or local government, or the public or private sectors.

With regard to participation in the CZM process, we have received reports that some state fish and wildlife agencies are not actively participating in development of their state CZM programs. These agencies may not be fully aware of the ramifications of the CZM Act or of the rare opportunity that exists to provide representation of living resources in coastal zone planning processes. It is our strong belief that some fish and wildlife managers have not recognized their own unique opportunity to assist their states in achieving balanced coastal zone management programs. They should avail themselves of every opportunity to provide information and advice to the state agency charged with the responsibility for developing the state coastal zone management plan, since it will undoubtedly have resource management benefits for decades to come.

Oil and Gas Resources

Agency Roles in Management

As this nation seeks to develop more fully its energy resources, it is clear that the oil and gas reserves of the outer continental shelf (OCS) must be exploited in an environmentally acceptable manner. The lead responsibility for implementing the leasing objectives of the OCS Lands Act of 1953 has been assigned to the Bureau of Land Management (BLM) within the Department of the Interior. These responsibilities include planning and preparing for leasing, conducting lease sales, collecting bonus revenues, directing OCS environmental studies in support of leasing decisions, and administering the leases. Emphasis is on property management relative to national, environmental, and socio-economic conditions and needs.

Although the principal responsibility for OCS development rests with BLM, several other federal agencies have both distinct and complementary roles in the program. The United States Geological Survey (USGS) and NOAA are both involved, but in different ways and to different degrees.

USGS has the responsibility for appraising geologic conditions and for classifying the energy and mineral resource potential of federal OCS lands. It works closely with its sister agency, BLM, in developing a provisional OCS leasing schedule, tract selection, and input into the environmental assessments. The USGS and BLM cooperate in developing both pre-sale evaluations and post-sale analysis. The USGS is responsible for supervising oil, gas and mineral operations on OCS lease tracts. Activities include basic geologic investigations, mapping, and both general and detailed assessments of oil, gas, and mineral resource potentials. The USGS is also responsible for the supervision of exploration, development, and exploitation activities, as well as the collection of rentals, royalties, and related revenues. The focus of the USGS involvement is on the geologic environment and conservation of associated resources in support of the leasing program and to assure safe and efficient operations.

On the other hand, NOAA contributes to the development of oil and gas resources of the OCS by conducting marine environmental assessments with field investigations of proposed lease areas. In developing the environmental assessments of selected lease areas, NOAA is engaged as a contractor to BLM through interagency agreements although substantial NOAA funds and facilities are also being contributed. NOAA is presently involved in the OCS environmental assessment program being conducted by BLM in Alaska, South Texas, and the Mississippi-Alabama, Florida (MAFLA) region.

Under an interagency agreement, NOAA has management responsibility for the environmental assessment studies for Alaskan OCS regions. This responsibility includes: developing the technical plan, selecting the principal participants, coordinating operations, integrating the results of the field and laboratory work, and preparing the final report. Participation by other federal agencies such as the USGS, and the Fish and Wildlife Service in the Alaskan OCS environmental studies program is secured by interagency agreements with NOAA.

In the other OCS areas NOAA, along with other research agencies, is assisting the BLM by conducting specific research tasks or surveys to develop the information required for a scientifically adequate environmental assessment of a given OCS region.

Coastal Impact

As I have stated previously, NOAA is administering a program designed to provide guidance and assistance to coastal states to develop and administer comprehensive CZM plans. In 1973, Congress provided funds to initiate the program and in 1974, many coastal states had developed a planning strategy and were submitting proposals to NOAA for first-year program development grants. These state programs must, among other things, identify coastal areas of particular concern, and provide guidelines as to priority of uses within specific geographic areas of the coastal zone.

At the same time NOAA was initiating the federal CZM program to encourage states to develop a CZM plan, another federal program, the BLM OCS program, was embarking on an expansion of the OCS leasing program.

The development of OCS lease tracts on an environmentally sound basis is clearly in the national interest. Although state government has been encouraged to participate in the planning of lease sales, many coastal states up to now have not been able to fully analyze or prepare for the anticipated impact of oil and gas development in terms of resultant onshore environmental, social and economic trends. Through the NOAA-administered CZM amended program, coastal states are now being provided resources with which to start integrating OCS impact studies into their developing state coastal zone management plans. Such planning should substantially improve the capability of the coastal states to deal with the potential impacts.

Hard Mineral Resources

The United States and other countries have been looking to the oceans for additional sources of hydrocarbon as available supplies on land decline. In the case of hard minerals, a similar situation may be developing in the near future for a number of minerals essential to our Nation's needs. Near shore marine minerals available to the United States include construction aggregates such as sand and gravel, placer deposits containing platinum and other rare metals, and other phosphorite deposits. On the floor of the deep ocean beyond limits of national jurisdiction lie immense deposits of manganese nodules which contain manganese, copper, nickel and cobalt. Although the United States produced approximately 80 percent of its copper requirements from domestic resources, we are dependent on foreign sources for nearly 100 percent of our manganese and cobalt requirements and produce only about 5 percent of our nickel requirements.

Present Situation

With the exception of some dredging for sand and gravel in rivers, lakes, and estuaries, near shore shell dredging, and a relatively small barite operation in Alaskan inland waters, there is no commercial mining taking place for marine minerals in near shore or offshore waters of the United States. In fact, a virtual moratorium exists within state waters on marine mineral mining except for shell dredging. The Department of the Interior two years ago published proposed rules and regulations and a draft programmatic environmental impact statement for mining hard minerals on the OCS, but no further action has been undertaken by the Interior Department.

Deep ocean commercial mining for manganese nodules is not expected to take place for several years. United States companies at present appear to hold a substantial technological lead over companies from other countries. However, progress may be impeded due to the lack of a favorable investment climate which has resulted from the uncertainties surrounding the ultimate outcome of the Third United Nations Conference on the Law of the Sea. In an effort to improve the investment climate, essential for raising very large sums of money (hundreds of millions of dollars per company), necessary for construction of vessels and nodule refineries, United States industry has pressed Congress for the enactment of interim domestic legislation for the orderly development of deep ocean mining by United States nationals which would guarantee their original investment. Several bills to accomplish this purpose have been introduced in both the Senate and the House. Committee hearings have been held, but so far no action has been taken.

Government's Role

Exploration and exploitation of marine hard minerals in state and federal waters imposes responsibilities on government which must be recognized. These responsibilities require regulations whose purpose may be summarized as follows:

(1) Avoid or minimize damage to the marine environment.
(2) Be compatible with other uses of state and federal waters such as recreation, navigation, fishing, and other commercial activities already taking place.
(3) Return an economic rent or some part of the resource value to the public.
(4) Minimize wastage of the resource.
(5) Minimize damage and risk to human health and safety.
(6) Provide favorable investment climate to industry.

Existing statutory authority to a large extent already exists for the Federal Government to carry out and enforce its responsibilities in the areas listed. Key agencies involved include the Department of the Interior, Department of Commerce, the Environmental Protection Agency, the Army Corps of Engineers and the Coast Guard, although still other have somewhat lesser responsibilities.

With respect to state governments, for the most part, they possess statutory authority to carry out their responsibilities in overseeing the development of marine hard mineral resources. However, in a few states a need exists for additional legislation.

Conclusions

We are on the threshold of an exciting new era in managing our living coastal and marine resources. In considering new strategies and plans for managing these resources, in my opinion, the following components are necessary for an optimum management regime.

First, the regime must have a policy-determining and regulating component. This component must consider local, state, national and international issues; it must be decisive and equitable in the decisions it makes because such decisions will affect people and how they live.

Second, the regime must have a system for adequate data collection and analysis. Resource surveys and a continuous program of research will be the basis for assessing the condition of the resources and the effect of man's utilization of these resources.

Third, the regime must have means to enforce the regulations and adjudicate violations at state, national and international levels.

Fourth, local, state and federal governments, and the public and private sectors, must participate if optimum management programs are to be developed.

Finally, optimum management needs to be an evolving process that concerns itself with the assessment, protection, allocation and utilization of our coastal and marine resources in a manner that provides the greatest benefit to society.

Literature Cited

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Discussion

CHAIRMAN ODUM: Ladies and gentlemen, I am going to exercise my prerogative as Chairman to postpone the discussion on this paper until we finish the other two papers.

One of the exciting new approaches which comes out of the impact statement technology is that of looking at alternative plans in some kind of logical manner. In other words, planner, developer and the Federal Government and State Government propose certain kinds of plans for a coastal or other regions. This then sets the stage for the public to raise questions and take part in deciding on alternative choices.

This requires an approach we have never used before and that is to make a model, so to speak, of the whole.

The next paper gives an example of this kind of approach and our speaker is Dr. Suzanne Bayley, who, along with the growing school of modelers is working very hard to translate natural and theoretical cost-benefit factors into practical economic and social terms of the real world. Her paper summarizes a comprehensive study on alternate proposals for the East Coast of Florida, a study not yet published in the open literature but so important I wish we had many hours for her to describe it because it would really take much more time than she is allowed to do it justice.

Energy Evaluation and Management Alternatives for Florida's East Coast

Suzanne E. Bayley, Howard T. Odum and W. Michael Kemp

Department of Environmental Engineering Sciences and Center for Wetlands University of Florida, Gainesville

Florida has been one of the fastest growing states in the U.S. Paralleling this accelerated economic growth and development, there has been a growing public awareness of environmental values and the long-term ecological and social costs of unplanned development. Conflict between development and conservation interests has developed numerous critical resource management problems.

The public agencies and officials responsible for managing Florida's resources are continually faced with decisions as to what are acceptable or unacceptable development projects. Traditionally, government agencies and political decision-makers have been faced with the difficult task of trading-off between economic, environmental, and social factors intuitively. This paper presents a methodology using quantitative energy criteria to evaluate proposed development projects which affect both natural and man-dominated systems.

Prior to the passage of the National Environmental Policy Act (NEPA) in 1970, most decisions for proposed developments or projects were made on an economic or technical basis, and did not include environmental considerations. The most common methodology used then and still used is the economic benefit-cost analysis (BCA) which compares the benefits incurred by a project to all the costs and negative effects of the project (James and Lee 1971; Water Resources Council Principles and Standards 1973). In general, this procedure attempts to choose among alternatives to determine the alternative that brings the highest economic welfare, but it includes only the money flows associated with the natural environment (fisheries, recreation, etc.). The so-called intagible unquantifiable aspects of natural systems are not considered in BC analysis.

Recently a new theory has been advanced by Odum (1971, 1976) which uses energy as the basis for value. Energy flows in both natural systems and in man-dominated systems, and so can be used to assess the work of all systems. Energy analysis of the systems provide understanding into the interdependency and linkages between man's fuel-powered systems and the natural ecosystems. The systems of man and of nature are coupled with man benefitting from the life support system of nature and in turn enriching, reducing and changing the natural system. This dynamic interaction can be viewed as a balance of man and nature with the energies of both systems contributing to the larger coupled system. Energy analysis has evolved into an energy evaluation procedure which can be used to assess resource management alternatives (Odum 1971; Bayley and Odum 1973; Kemp et al. 1976; Odum, Brown et al. 1975). In this paper, energy evaluation techniques were used to assess the impact of a water resource project of the Corps of Engineers on the wetlands, agricultures, and towns located on the east coast of Florida.

Concepts for Energetic Analysis and Decision-Making

Some of the princples and concepts used in energy analysis and energy cost-benefit are presented in the following section. A more complete discussion is given in Odum and Odum (1976); Odum, Brown, et al. (1975); and Odum (1976).

Energy as a Common Denominator

Since all work processes and all interactions require energy, the flow of energy is a useful measure to quantitatively evaluate all systems. Natural system processes include the work of the rain, wind, tide, waves, and sunlight. In human societies, the economic system is normally used for the trade of energy, goods, and services which flow in the opposite direction to money. That is, we pay money for fuels, goods, and services. By using the ratio of total energies used in the United States to the Gross National Product, we obtain a general number for kilocalories (kcal) expended per dollar used in the U.S. on a yearly basis. In 1970 this ratio was approximately 25,000 kcal per dollar in the U.S. This energy to dollar ratio represents a mixture of many types of work processes, from forest and agricultural production to automobile manufacture. Since most of the sectors of our economy involve integration of many types of work processes, this average ratio may serve reasonably well to estimate energy flows associated with monetary flows. As supplies of money and fuels change in the economy, so does the ratio, and Kylstra (1974) has shown that it (the ratio) has been declining since 1947.

Energy Quality

Within the coupled systems of man and nature there are myriad work processes which involve many different types of energy, ranging from sunlight and winds in natural systems to electricity and computers in man's systems. Although energy is defined as the ability to do work where energy of one type is concerned, it has long been recognized that different types of energy flow do not possess equal ability to do work (Evans 1969; Tribus and McIrvine 1971). For example, one kilocalorie of sunlight cannot do the same work as one kilocalorie of electricity, even though they have the same heat value. This means that there is a quality difference in those kilocalories.

Energy from the sun enters the earth's atmosphere in a very dilute form, heating the waters, driving primary productivity, and driving the winds, waves, and water cycle. As the flows of energy perform work, they are transformed from one form to another; part is upgraded into a higher quality form, and the rest is lost as heat. In this way the heat content of each component declines along the chain, but the quality increases. The higher quality energy components feed back control and management functions to interact with lower quality energies maintaining an effective functioning of the total system. To compare one kind of energy to another in terms of ability to do work, a scale of "energy quality ratios" must be developed, relating the various energy types to a common level. Odum (1974, 1976) and Zucchetto (1975) have reported such scales with coal energy as the basic unit of comparison, and all energies are given in terms of coal equivalents (ce).

Very general conversions for natural system processes have been calculated. The conversion from sunlight to sugar dispersed in green plants is approximately 100 to 1. That is, 99 percent of the energy was used in the process of making organic matter. To convert from dispersed sugar to coal there is approximately a 20 to 1 upgrading of the energy. Each ecosystem will have a different quality factor dependent upon conditions of sun, water, nutrients, etc. that are available for that ecosystem. These were not known for each ecosystem, so a generalized value was used to convert primary production to coal.

Maximum Power Principle

In 1922, A. J. Lotka suggested a general principle for evaluation and survival of systems based on energy flow. By this principle the system which can develop more power inflow and use it best is the one most likely to survive natural selection over a long time period. This implies that the system of man and nature that will be most competitive in Florida is the one that maximizes its use of available energies (both natural and purchased) through patterns which promote symbiosis, diversity and feedbacks, and avoids the unnecessary waste of energy.

Investment Ratio to Evaluate the Contribution of Natural Systems

The natural ecosystems of a region contribute energy in their work processes which can be measured in energy analyses. Although most of the solar-based energies are of lower quality than fossil fuels, the abundance of these energies makes their total work contribution large. When a region is developed, the natural systems are changed and coupled with man's system. Nature provides man with a well buffered life-support system and any region that has abundant free energy attracts outside investment and is more competitive than a region without the natural subsidy. The subsidy allows human industry to generate more work with less expense. For example, a town which is not densely developed can use septic tanks for sewage disposal while a more developed town must have central sewage systems with at least secondary, and possibly tertiary, treatment. The denser town would have higher costs since it must use a fossil fuel-based system rather than the free subsidy of nature. Thus the more rural town will be more competitive. It will have lower taxes, and can sell its goods at a lower price. Industry from this town, with its lower prices, would capture the competitive markets, have more work, and so attract more energy. (The principle is believed to apply after rapid growth is over. During rapid growth, power is maximized by growth of those already ahead in growth.)

To make this concept workable in planning and decision-making, we define the "investment ratio" as the ratio of the total amount of purchased energy invested from outside the system to the free natural energy input to the system, with both expressed in calories of the same quality. Odum (1976) has calculated the investment ratio for the U.S. in 1970 by using the total fossil fuel energy as the invested energy and the total sunlight as the free energy, both in coal equivalents.

$$\frac{\text{Invested Energy}}{\text{Free Energy}} = \frac{\text{Fossil Fuel}}{\text{Solar Energy}} = \frac{17.6 \times 10^{15}\ \text{fifi/yr}}{7.15 \times 10^{15}\ \text{fifi/yr}} = 2.5$$

This ratio is useful as an index of the competitive balance of natural and purchased energies to compare with that of regions that are proposing further economic development.

Modeling

In order to understand the complex interactions of man and nature, diagrams of the system components and their interactions should be drawn to include all the important details. As the details are more fully understood and the data gaps identified, the model can be aggregated with the similar components grouped together. The models ranging from the most detailed ecosystem scale to the regional scale interactions permit the effect of a project to be analyzed at several levels, and the critical factors identified at each level without losing the overall view. A systems analysis must evaluate on a scale larger than the proposed project in order to determine the impact of that project in the larger system of which it is a part. Computer simulations of system models can be used to predict the effects of a proposed project on the system components and functions. This information can then be used in an overall energy evaluation of the project.

Calculation of Energy Flows for a Project of the Corps of Engineers in the Upper St. Johns River Basin, Florida

The economic growth in Florida over the last 20 years has created water and land use problems in the Upper St. Johns River Basin which are common throughout the state. The expansion of agriculture into areas previously covered with standing water has diverted this water to the sea, reduced the flood plain marshes, and increased the need for irrigation water. Water flow has diminished in the rivers and marshes particularly during the dry season when urban and agriculture demands are greatest. In the wet season the reduced flood plain and increased runoff resulting from channelization have caused the water to flow faster downstream, thus flooding lower basin areas. Construction of drainage canals and runoff from agricultural lands have caused eutrophication, with the proliferation of water hyacinths and organic sedimentation in some of the lakes.

The drinking water supply in parts of the coastal area cannot be obtained from the aquifer due to salinity intrusions. Therefore, the towns have become dependent on the fresh water lakes in the upper St. Johns. Since these lakes are greatly reduced in size and the river flows have decreased over the last 20 years, they are less able to provide the water needs for the region in a time of rapid urban expansion.

In an attempt to provide for both agricultural and urban water requirements, the U.S. Army Corps of Engineers has proposed to manage the water in a series of upland impoundments and floodplain reservoirs. The basic question considered in this paper is twofold: Would such a project have significant impact on the remaining natural floodplain, and is it the management alternative most valuable to the overall public interest?

Description of the Study Area

The St. Johns River emerges from dense marshes in east central Florida and flows 260 miles (418.3 km) north to the sea. The northern two-thirds of the river is saline, while the southern third of the river is primarily fresh water. The land in this region is very flat with the average gradient of the river for the entire distance only 0.15 feet per mile. (4.57 cm per 1.61 km) This flat topography makes the region and the river drain slowly so that extensive marshes and swamps form a broad floodplain on both sides of the river. The rate of development of urban areas along the river has been slow compared to urban growth along the beaches and estuaries elsewhere in Florida.

The upper St. Johns River Basin was a land of meandering river channels, shallow fresh water lakes and extensive marshes (Fig. 1). Part of this pattern still exists. Tributaries, flowing through cypress swamps, bring upland runoff down to the marshes and the river. The river emerges from the dense sawgrass and passes through a number of shallow lakes. The dense vegetation covers a deep peat layer similar to the Everglades of South Florida.

In this century much of the natural floodplain has been channelized and diked so that in many places it has been reduced from 13 miles (20.92 km) in width to 1 mile (1.61 km) (Fig. 1). In the most southern reaches entire drainage districts have been created with the water diverted east to the sea, and so lost to the river. The drainage has been for agricultural production of sugar cane, citrus, and cattle which require extensive irrigation during the dry season.

The plan proposed by the U.S. Army Corps of Engineers includes three upland impoundments stretching along the western bank of the floodplain parallel to the river. Principal areas directly affected by the proposed project are shown in Figure 1. Four valley reservoirs were proposed including one which would provide drinking water for the municipalities. The primary purpose of the reservoir system was to provide irrigation water for agriculture. The land use changes associated with this project would reduce marshland and increase the area of open water, as well as the pasture and citrus acreage.

Energy Analysis of the Marsh Ecosystem

Under the Corps plan, marshland would be replaced with agriculture or drained. In order to compare this to the existing marsh, field studies were made to measure the magnitude of major ecosystem work functions under the existing situation. The productivity, nutrient levels, and water levels of the marsh were measured. Gross primary production is a measure of the work processes in natural systems and an index of the overall health of the ecosystem. Other natural energies such as winds, the river flow, and tides and waves in coastal areas do various kinds of work, but many of these functions are integrated into the ecosystem in productivity. Gross primary production in the marsh ecosystem in the St. Johns averaged 244 kilocalories/m^2/day (sugar). This represents the work of the entire marsh community. The productivity of the river system was 13 kcal/m^2/day (sugar). Native pasture grasses, at 112 kcal/m^2/day (sugar), had a much higher productivity than the river, but this was considerably less than for the marsh. The detailed interactions of the marsh system have been aggregated in the model in Figure 2. All data were measured in order to obtain baseline values so that changes due to the project could be assessed.

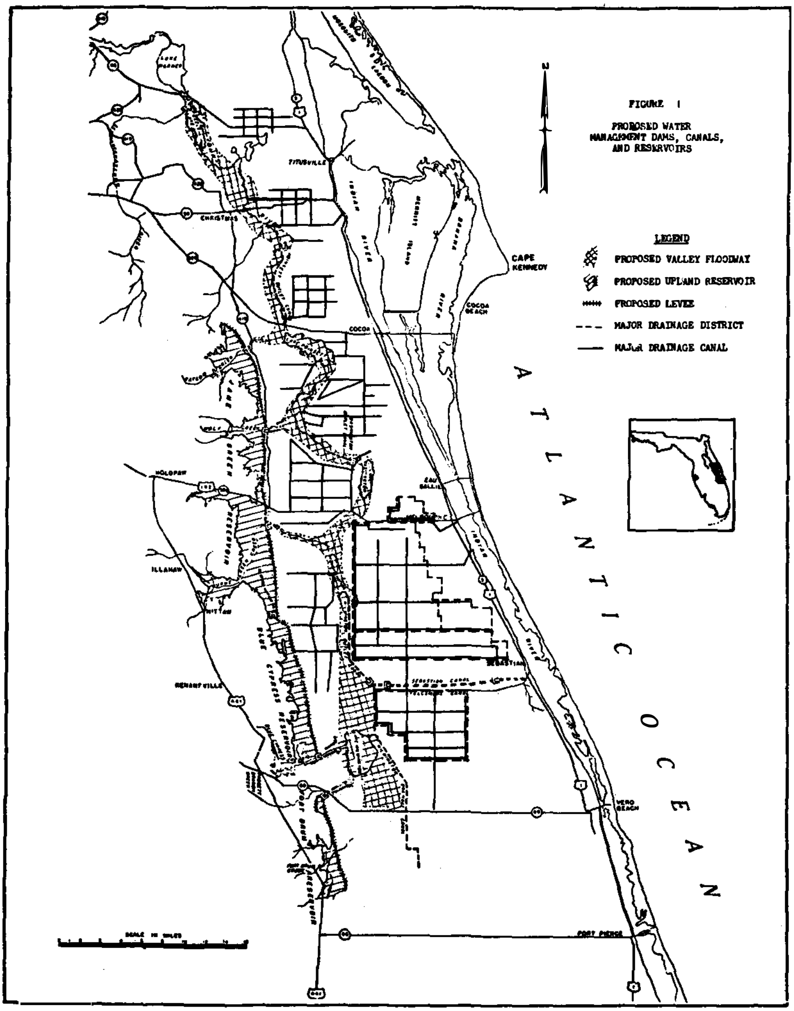

Figure 1. The upper St. Johns River Basin with the proposed Corps of Engineers project and other drainage works.

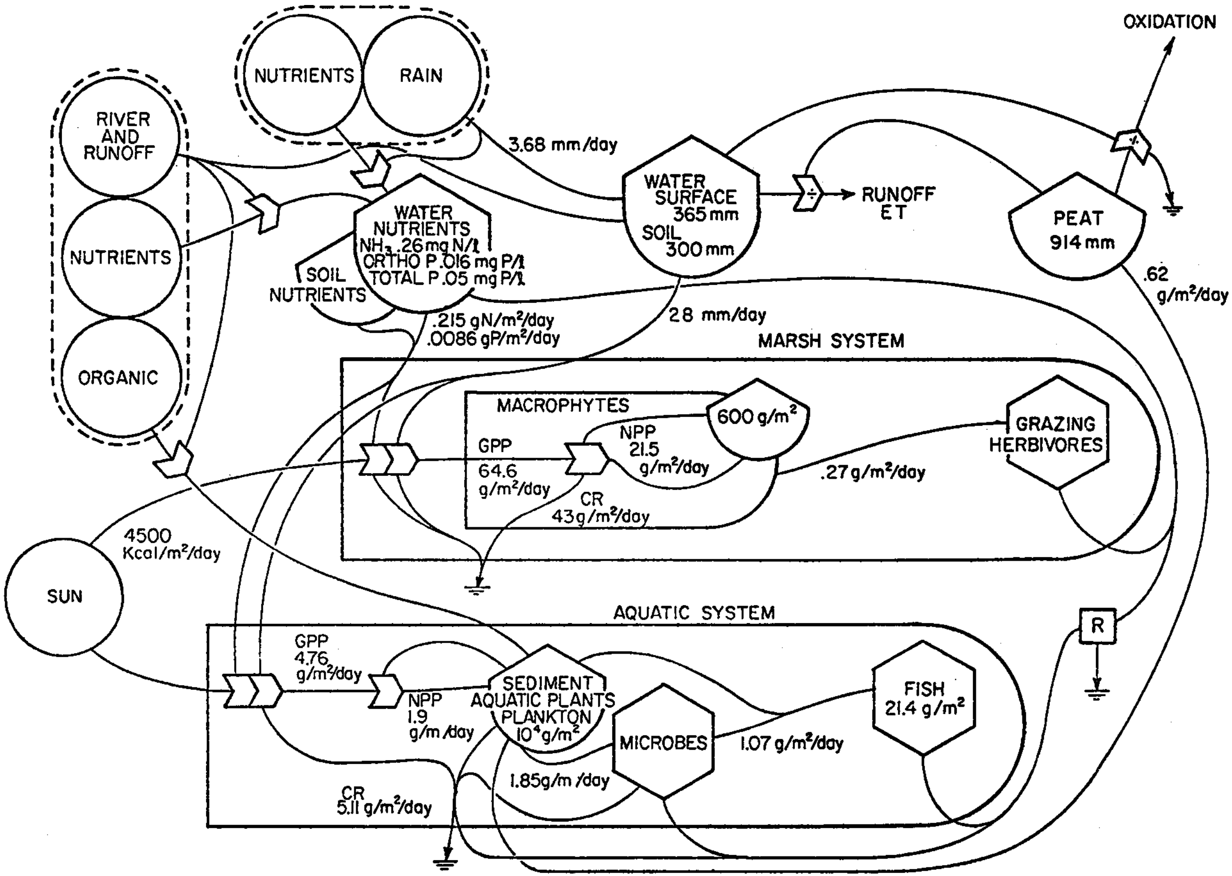

Figure 2. **Model of the marsh ecosystem.**

Modeling of Interactions Between Ecosystems and Man

Detailed models of the interaction of the reservoir and dam on the marsh ecosystem were made (Fig. 3). The dominant marsh communities were characterized by specific regions of fluctuating water levels (Fig. 4). When these water levels or seasonal fluctuations are changed, the species composition changes (Rodgers, Hagenback, and Thompson 1973), which in turn changes the overall marsh productivity. The precise hydrologic changes which would be induced by this project are not known, but the community structure would respond to such changes through alterations in species composition. The model in Figure 4 indicates some of the possibilities. The nutrient levels would probably have increased due to increased agricultural runoff. Computer simulation of the aquatic portion of the model represented in Figure 4 indicated that the productivity of the aquatic (slough-marsh) system increased with the increased agricultural runoff (Bayley 1975).

While the marsh system might be altered due to the project, a more critical question would be what is the effect of the project on the regional energy flow. In order to address this question, it was necessary to expand the analysis to a large scale in which detailed data from the marsh system would serve as important input.

Regional Analysis Using Energy Evaluation and the Investment Ratio

A general model was developed for the study area (Fig. 5) to evaluate interactions between the proposed project and the natural and human systems in the region. The model includes all major economic and energy flows into the regional system, Brevard County, and an energy budget corresponding to the regional model was developed by evaluating these energy flows. This energy budget is given in Table 1 for 1970. The budget includes energy flows for each of the major ecological communities, as well as flows of the fuels and goods and services into the urban sector.

Land areas for the major ecosystems shown in Figure 5 were calculated from analysis of aerial photography. Productivity and respiration of each major ecosystem were measured in the field research program. The productivity of each ecosystem times the number of acres of that ecosystem gives the regional work performed in kilocalories per year. Predicted alterations of land-use patterns attributable to the project indicated changes in the acreages of each subsystem. Effects of hydrologic changes on the productivities of some ecosystems were estimated from Carter et al. (1973), who found that a 20 cm (7.87 in) drop in the water table resulted in a 40 percent drop in productivity. Details of these calculations are presented in Bayley and Odum (1973).

Natural energy flows make up 18 percent of the total work of the region when their flows are considered in coal equivalents. The photosynthetic energy flows are measured in heat calories and converted to coal equivalents described in the section on energy quality.

Comparison of the current energy budget of the county with energy flows for the reservoir plan indicates that the natural energies would be even further reduced (Table 2). An alternative water conservation plan is also calculated. In this plan a non-structural approach to water conservation is used with flood-

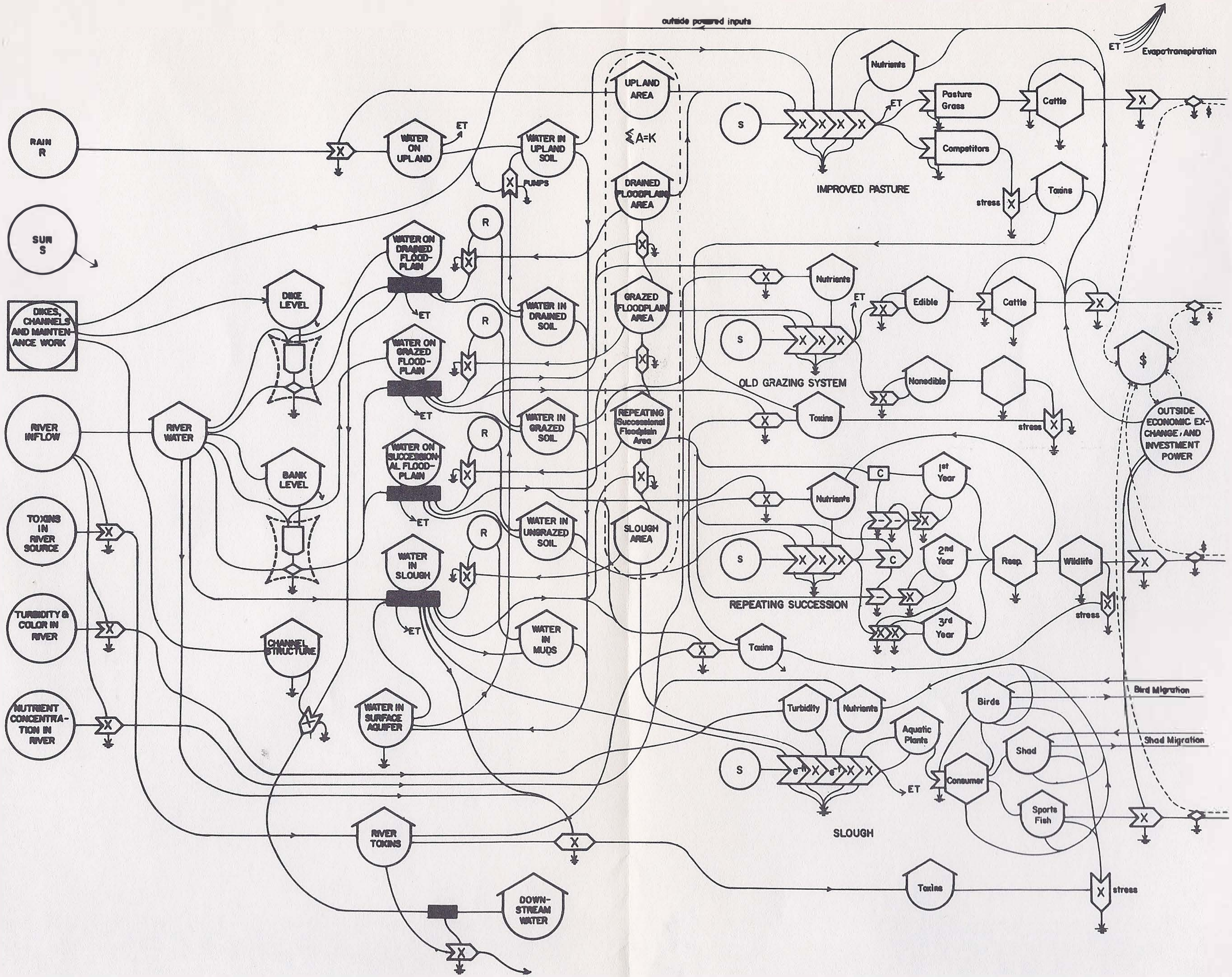

Figure 3. Model of the interactions of marsh floodplain ecosystems with the Corps of Engineers Project.

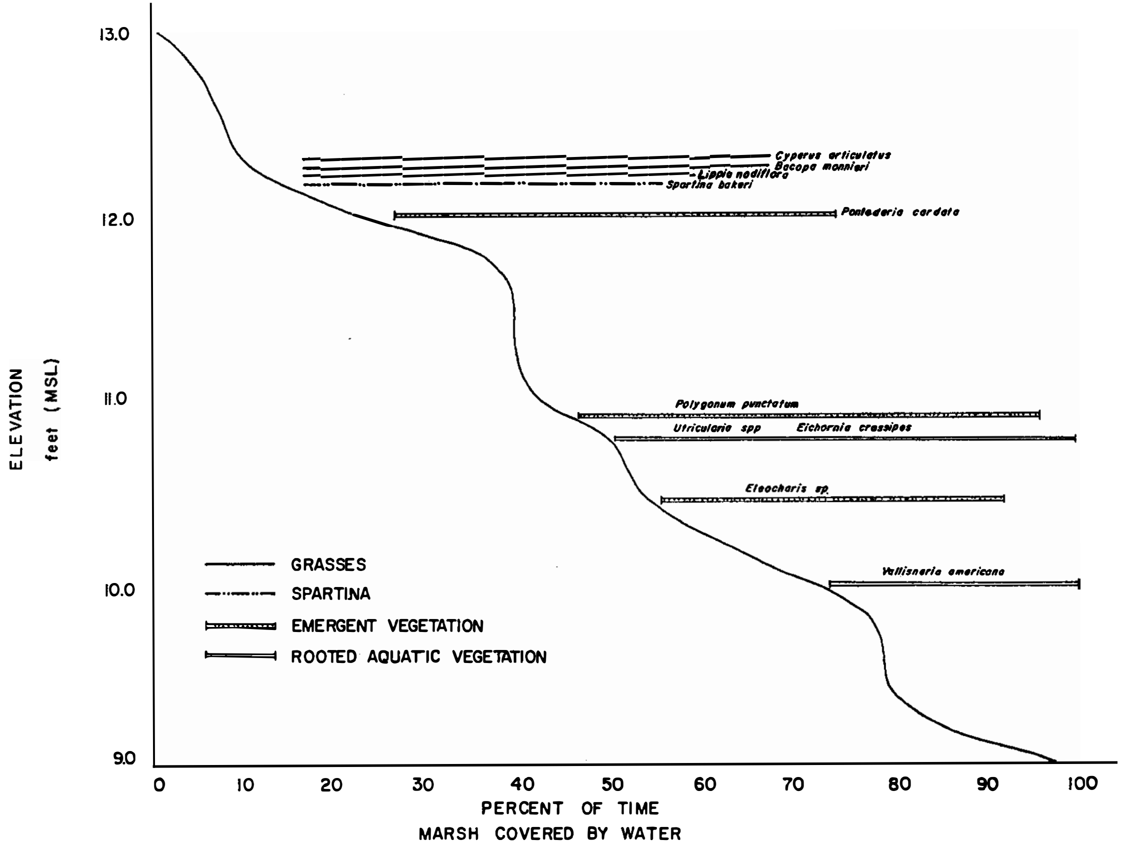

Figure 4. Stage hydrograph with a comparison of the water regime of the major plant communities in the floodplain.

Table 1. Energy budget of Brevard County in 1970.

Name of Energy Flow	Area of system (×1000 acres)	Annual work in that × 10^6 kcal/acre/yr of that type	Energy Quality Factor	Annual work in coal Equivalents ×10^6 ce/acre/yr	Region's Annual Work 10^{11} ce/yr
1 Metabolic Energy Flows in Natural Systems					
A Natural Ecosystems					
Marsh	88	361	.05	18.05	15.88
Pine Flatwoods	188.6	110.3	.05	5.5	10.4
River	3.	19.0	.05	.9	.06
Lakes	15.	13.6	.05	.68	.20
Cypress Hardwoods	17.4	156.	.05	7.8	1.79
NASA area	104.	47.6	.05	2.4	2.5
Estuaries	130.085	36.9	.05	1.8	2.4
Marine	227.840	5.9	.05	.295	.67
B Man Dominated Ecosystems					
Improved Pasture	171.7	80.	.05	4.5	7.7
Intensive Agriculture	40.1	51.	.05	2.5	1.0
Urban Area	47.0	21.5	.05	1.08	.5
2 Contributing Natural Energy Flows					
Tide	357.9	2.58	1.66	4.30	15.4
Waves on Shoreline	—	7.4	.2	1.48	1.7

Table 1. (cont.) Energy budget of Brevard County in 1970.

Name of Energy Flow	Area of system (×1000 acres)	Annual work in that × 10^6kca/acre/yr of that type	Energy Quality Factor	Annual work in coal Equivalents ×10^6ce/acre/yr	Region's Annual Work 10^{11}FFE/yr
2 Contributing Natural Energy Flows (cont.)					
Hydrostatic	Head of Rain	—	—	3.125	.099
2.089					
3 Total Natural Energy (1 = 2)					62.289
4 Urban Energies:					
Bunker C fuel	3.5 × 10^4kcal/gal[s]	2.24 × 10^8gal/yr[r]	1.0		78.4
Gasoline	3.2 × 10^4kcal/gal[t]	1.02 × 10^8gal/yr[r]	1.0		32.6
Diesel fuel	3.5 × 10^4kcal/gal[s]	2.23 × 10^7gal/yr[r]	1.0		8.0
Natural gas	278 kcal/cu ft[w]	8.7 × 10^9cu ft/yr[r]	1.0		24.2
Food	9.12 × 10^5kcal/cap/yr[u]	230,000 people[x]	1.0		2.1
5 Total Fuels					145.3
6 Purchased Goods and Services (Non Fuels)					
A Goods and Services excluding NASA					66.75
B NASA Goods and Services					67.0
7 Total Urban Work					
A Fuels and Non NASA Goods and Services					212.05
B Fuels and All Goods and Services					279.05
8 Total Regional Work					
A Natural Work, Fuels and Goods and Services excluding NASA					274.34
B Natural Work, Fuels and All Goods and Services					341.34

This ratio is useful as an index of the competitive balance of natural and purchased energies to compare with that of regions that are proposing further economic development.

Table 2. Comparison of the annual energy values for the Reservoir Plan and the Floodplain Conservation Plan in the Upper St. Johns Basin

Alternative	Natural $\times 10^{12}$kcal ce/yr	Investment Ratio (IR)	Urban Energy Flow[d] attracted if IR is 2.5 and Natural Energy remains as projected $\times 10^{12}$kcal ce/yr	\$/year attracted[e] ($\times 10^6$)
Present (1970)	6.229	2.33[b]	15.57	622.9
Present (if goods & services & space program included)	6.229	4.48[c]		
Reservoir Plan[a]	3.996	2.5	9.99	399.6
Conservation Plan[a]	6.96	2.5	17.4	696.0

[a]This assumes that the high growth rate continues and that the region can pay for as much fuel and goods and services as it wants and that all water goes for human consumption.
[b]Observed - ratio of total fuel to total natural. Can be compared to U.S. average and Miami.
[c]Observed - ratio of total fuels, goods and services to natural. Since input of goods and services are part of the input energies they should be included, however comparisons must be made in a consistent manner and boundaries defined in the same way.
[d]Urban Energy Flow Attracted if the IR were 2.5 and the Natural Energy remains as presented for each alternative.
[e]Dollar Flows Attracted if the IR were 2.5 and the Natural Energy remains as presented in each alternative.

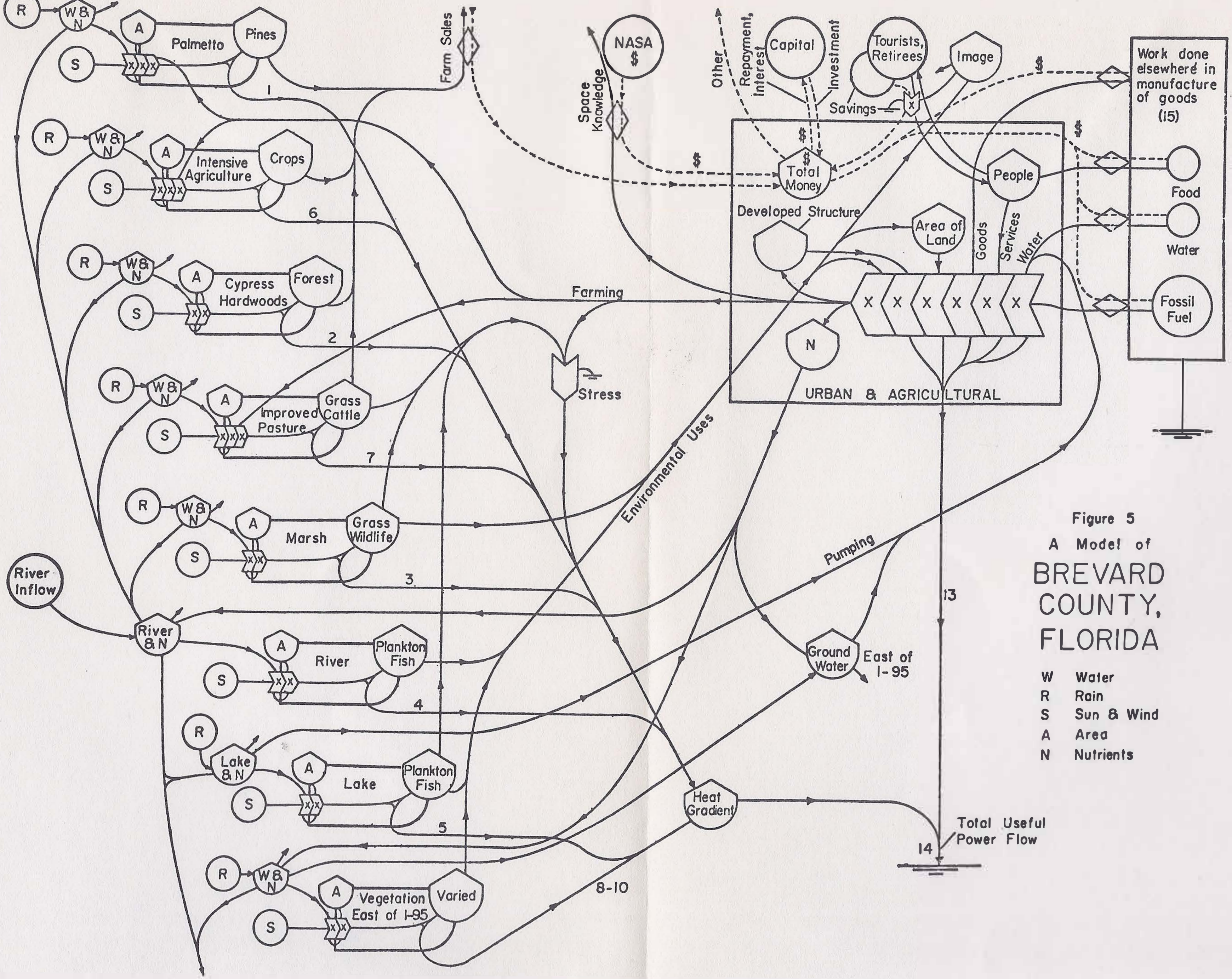

Figure 5. Model of interactions between the natural ecosystems and society in Brevard County, Florida.

plains maintained for water control. Under this plan the natural energies increased. For both the reservoir plan and the conservation plan, a high growth rate in the region was assumed, with all of available water used for municipal consumption. It was further assumed that the region would have the monies available to buy the fuels and goods required by the projected four-fold increase in population.

It is useful to compare the energy balance of this region with that of the U.S. as a whole to understand the relative level of development in Brevard County. As previously discussed, an investment ratio is used as an index of a competitive balance between purchased energies and the free resource base. The investment ratio for the average U.S. economy is 2.5, while in Florida ratios have been calculated at 1.7 for the rural north-central part of the state (Kemp et al. 1976), and at 4.0 for the Miami region (Zucchetto 1975). The investment ratio for Brevard County in 1970 was 2.33. This is slightly less than that of the U.S. It implies that the county is nearly as developed as the U.S. average and less than that of an urban area such as Miami. The adoption of either the reservoir plan or conservation plan would further intensify development.

The United States, with its large undeveloped areas coupled with metropolitan areas of intense fuel consumption, has maintained a pattern that thus far is competitive based on currently available fuel resources. With increasing cost of fuels, this pattern may change favoring a lower investment ratio. The reservoir plan with an energy budget 3.6 times more developed than Miami would appear to be less competitive than a plan which is not as dependent on purchased energies. The conservation plan, while protecting the floodplain marsh, uses the available water for municipal growth, with the attendant high fuel requirements. A plan that protects and enhances the natural productivity and does not use technological means to replace what can be performed by nature free would enable the region to attract its proportionate share of the nation's fuels and goods, even in a time of uncertain energy resources.

It may be that the public does intuitively value the free services of nature and will reject those plans which will further reduce these values as we enter a time of increasingly expensive fuels. In any case, the State of Florida did not adopt the Corps of Engineers' plan in 1974. We are currently studying several other water management alternatives to compare the energy evaluation techniques with traditional economic analysis. This should enable us to further demonstrate the utility of these energy analysis methods to evaluate the free subsidies of nature, and to judiciously allocate our increasingly expensive fossil fuels, in order to maximize the value of our interdependent system of man and nature.

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Discussion

CHAIRMAN ODUM: Did I interpret that last column to mean that the conservation plan would have been the choice over the water development plans if you chose the weight factors as you did, is that right?

DR. BAYLEY: Yes, but I would like to say that also, in our situation, the Conservation Plan was not the most desirable plan because it also assumed more growth than the region could sustain in the future. In fact, I think the Corps Plan, sensing this balance of nature's energy and of man's energy, was rejected by the State of Florida and so was their estimate of projected growth in the Region. Now we are into another plan.

CHAIRMAN ODUM: We have one more short paper on the model approach. This is a different approach from the previous paper. One of the keys to all of these assessments involves basing values on all types of environment in some kind of common denominator. Energy, of course, is one possibility and there may be others that will be developed.

A Modeling Approach to Evaluate Tidal Wetlands

Douglas Hill
Grumman Ecosystems Corporation, Bethpage, New York

During the past few decades there has been a period of coastal development in which large quantities of tidal marshes were destroyed. To those aware of the importance of these marshes to natural systems and those who value marshes for their own sake, it became clear that the normal functioning of the marketplace ignored such considerations. To protect marshes in the face of this failure of the marketplace, political action was taken, sometimes in the form of a moratorium or complete prohibition of any commercial development that intruded on wetlands.

Political choices tend to be of an all-or-nothing nature, as the initial steps were in this case. The continuing management of wetlands requires a finer discrimination of the importance of a given wetland in the light of its alternative uses. The steps taken toward "fine tuning," as it has been put, have therefore led to society's other way of making choices, i.e., judging by their price.

A number of attempts have been made to establish in dollars the "true value" of tidal marshes, taking into consideration environmental and social functions that may otherwise go unrecognized in decisions affecting the continued existence of marshlands. The historical practice of ignoring extra-market natural and social values of preserved wetlands—as nesting areas and open space, for example—in effect imputes a value of zero to these values. On the other hand, an absolute prohibition on the destruction of wetlands implies that these natural and social values must approach infinity, or at least be higher than any conceivable economic value of filling them. Those who must decide the fate of wetlands deserve a better choice than that the external effects are approximately zero or approximately infinity. Unless all marshes are equal, moreover, the true value may vary from one place and situation to another.

Setting a dollar value on wetlands is useful because it provides a graduated decision tool calibrated in a measure with which the decisonmakers, a group that increasingly includes the lay public, are familiar. Moreover, the destruction of wetlands like many other environmental problems can be understood as a failure or imperfection of the marketplace which may therefore be subject to economic remedies. The ultimate argument for an economic view of the problem is that any wetland allocation has economic implications: resources are exchanged, and somebody somewhere pays. Whether the evaluation of salt marshes is adequately viewed as an economic problem, or whether a dollar value simply provides an economic rationale for what is ultimately a political decision, the usefulness of a dollar value as a measure of importance seems evident.

Since economics are part of the problem, however, attempts to set a dollar value on wetlands are likely to be viewed with some skepticism. The economic concept of value is fundamentally the ratio in which two things are exchanged; when one of the things exchanged is money, the ratio of exchange is the price.

This concept of value depends upon the scarcity as well as utility or desirability of the things in question.

The vital role that tidal wetlands play in the way the world functions may seem to go totally unrecognized in this value in exchange. The paradox has its precedents. The question of why water, which is so very useful that life itself is impossible without it, has such a low price while diamonds, which may be quite unnecessary, have such a high price puzzled Adam Smith himself. A modern economic explanation is that price is determined by the supply and demand for the marginal unit, not by the total utility of all diamonds, water, or wetland. With water plentiful and diamonds scarce, water is cheap and diamonds expensive (Samuelson 1973, page 435). One may argue that people and the market processes do not necessarily perceive an existing or inevitable scarcity of the services provided by wetlands, of course. Even if there were complete knowledge of consequences, moreover, there is no marketplace to determine the value of public goods such as the environmental benefits of wetlands.

Other functions of the marsh that are difficult or impossible to quantify include their serving as a buffer against storms or as a sediment trap, their role in global cycles of nitrogen and sulfur, and perhaps in providing other vital links that maintain the integrity of the system of living organisms, their possible contribution to scientific understanding (perhaps to answer questions that we do not yet know how to ask), their importance as habitat for wildlife, and the aesthetic appreciation and other psychic value to be derived from them by this and future generations. These benefits may be intangible. They may be incommensurable, i.e., capable of being quantified but not monetized. They are nonetheless real.

If these incommensurables and intangibles cannot be estimated before the fact, a boundary is nevertheless imputed to their dollar value when a choice is made among alternatives that differ in these respects. If a marshland is filled for commercial development because its market value is higher than the value of the monetized benefits of leaving it in its natural state, by implication the dollar value of the incommensurables and intangibles of the natural state is taken to be less than the difference in the two dollar figures. Willy-nilly, a value is set. What analysis can do is to make explicit before the fact the implications of the choice.

Purpose of Modeling

The purpose of formulating a model to assist in the evaluation of wetlands is to provide a conceptual framework in which technical information, economics, and political decisions are all given their place. The evaluation is framed in economic terms. Scientific information is used to describe the consequences of alternative courses of action. The decision is ultimately political in the sense that a final judgment of the value of wetlands, taking into consideration the incommensurables and intangibles, is left to be made from a range of choices appropriate to a time and place.

The device for providing this conceptual framework is a resource allocation model of the linear programming type. It is in effect an extension of the "component" approach used by Gosselink, Odum and Pope, (1974) as it may be applied to a particular geographical area. Since it makes use of numbers, it provides for gradation which is not to be confused with precision. Exercise of the model shows the values that are imputed to wetlands by alternative resource management decisions.

Description of the Model

The model consists of the set of equations shown in Table 1 which define the biological, physical, chemical, and economic boundaries on the possible uses of Hypothetical Bay (Rows 1 through 13), as documented in Hill (1976). The several uses of the estuarine area that may affect the value of wetlands are shown by the column headings: preserve *Spartina alterniflora,* build and operate a marina, produce and harvest clams, mussels or sea worms, produce cod and flounder, culture oysters, fill the *Spartina* acreage, and discharge waste water into the Bay possibly after secondary or tertiary treatment.

Each row in Table 1 represents an equation. Row 1, for example, states that the 120 acres of tall, fringing *S. alterniflora* may be preserved or filled; if a marina is constructed, three acres are filled in the process.

The geography of Hypothetical Bay is based on the Plymouth-Kingston-Duxbury Bays of Massachusetts on which data have been compiled by Isard (1972). Following Nixon and Oviatt (1973b), a distinction is made between the tall *S. alterniflora* that fringes areas of open water and is the principal source of detritus in the estuary, and the remaining salt marsh which is assumed to contribute no detritus. Other sources of the data in Table 1 are Harrison and Hobbie (1974), Nixon and Oviatt (1973a), Nixon, Oviatt, and Northby (1973), Odum and de la Cruz (1967), and Thomann (1972).

Detritus provides the linkage between *Spartina* and the natural products of the estuary, as shown in Row 6. In addition to the tall *S. alterniflora* that is preserved, discharged waste water contains organic suspended solids that contribute to the supply. The natural fouling communities that form on the floats and pilings of a marina also produce a small amount. Tidal flushing removes some detritus, but 60 percent is estimated to remain in the bay until it is consumed by clams, mussels, sea worms, oysters, and by herbivores in the first level of the food chains that eventually produce cod and flounder. It is assumed that there is a reduction in the amount of organic product formed at each successive trophic level to one-tenth the previous amount. The amount of detritus consumed by clams, mussels, seaworms, and oysters is therefore 10 times the amount of organic product formed. To produce one pound of flounder and cod, which are two and three trophic levels away from detritus, respectively, therefore requires 100 (45.36 kg) and 1,000 pounds (453.6 kg) of detritus. The constraint shown in Row 6 states that the amount of detritus consumed as food cannot exceed the amount produced and retained in the estuary.

To account for the possible role of salt marsh in nutrient removal, the nitrogen balance is maintained in Row 9. The principal source of nitrogen is untreated waste water with the amount of nitrogen progressively reduced with secondary and tertiary treatment. A total of 19 mgd is assumed to enter the estuary (Row 7) primarily through the sewage treatment plant as either untreated waste or treated waste (Columns 12, 13, and 14) but including a small quantity from the marina if one is in operation (Column 3). It is assumed that the waste water can be filtered through the preserved *Spartina*, each acre of which can remove 13.1 pounds (5.94 kg) of nitrogen per day. The flushing action of

Table 1. Data for resource allocation in an estuary.

+ Produces – Consumes Activities	1. Preserve tall *S. alt.* (000 Acres) (a) No filter (b) Filter wastes	2. Preserve other *S.* (000 Acres) (a) No filter (b) Filter wastes	3. Build & operate marina (#)	4. Produce and harvest clams (acres)	5. Produce & harvest mussels (acres)
Constraints					
1. Tall Fringing *S. alt.* (000 Acres)	–1	0	–0.003	0	0
2. Other *Spartina* (000 Acres)	0	–1	–0.007	0	0
3. Clam Beds (Acres)	0	0	–0.001	–1	0
4. Mussel Beds (Acres)	0	0	–0.002	0	–1
5. Sea Worm Bottom (Acres)	0	0	0	0	0
6. Detritus in Bay (000 lb per year)	+4050 +4600	0	+3.6	–300	–240
7. Waste Water (MGD)	0	0	+0.005	0	0
8. D.O. Level (mg/l)	–.0146 –.0165	0	–2	0	0
9. Nitrogen Load (000 lb per day)	0 –13.1	0 –13.1	+.002	0	0
10. Flounders (000 lb)	0	0	–116	0	0
11. Cod (000 lb)	0	0	–498	0	0
12. Fish Ratio	0	0	0	0	0
13. Marinas (#)	0	0	–1	0	0
Objective Functions					
A. Annual Net Income ($000)	+35	+35	133	+6	+1.7
B. Environmental Value	+	+	±	+	+
C. Social Value	+	+	+	+	+

the estuary is assumed to remove nitrogen at a rate of either 115 pounds (52.16 kg) per day in winter or 3,975 pounds (1803.06 kg) per day in summer. In these calculations the winter figure is used. Varying the nitrogen constraint (N) shows how the value of salt marsh varies according to the nitrogen load.

Within these constraints, the model determines mathematically the combination of uses that maximizes the value of the objective function, the components of which are shown in Rows A, B, and C. The annual net income of each activity shown in Row A represents its commercial value to an entrepreneur; for sewage treatment facilities the annual cost of operations and maintenance together with an amortized construction cost is shown. Finding the maximum dollar value (or, equivalently, the minimum cost) of this complex of uses of Hypothetical Bay identifies those that give the salt marsh its greatest monetary value. The annual

6. Produce & harvest sea worms (acres)	7. Produce cod (000 lb)	8. Produce flounder (000 lb)	9. Raise oysters (acres of rafts)	10. Fill *S. alterniflora* (000 Acres)	11. Fill *S. Patens* (000 Acres)	12. Discharge untreated waste water (MGD)	13. Provide 2^{ary} treatment (MGD)	14. Provide 3^{ary} treatment (MGD)	15. Exogenous supply	
0	0	0	0	−1	0	0	0	0	+0.12	=0
0	0	0	0	0	−1	0	0	0	+1.68	=0
0	0	0	0	0	0	0	0	0	+50	⩾0
0	0	0	0	0	0	0	0	0	+650	⩾0
−1	0	0	0	0	0	0	0	0	+140	⩾0
−2	−1000	−100	−18	0	0	+275	+27.5	+13.8	+0	⩾0
0	0	0	0	0	0	+1	+1	+1	+0	=19
0	0	0	−2.11	0	0	−.052	−.0052	−.0026	+15	⩾ {6.5 / 0}
0	0	0	0	0	0	+.5	+.35	+.05	{− .115 (W) / −3.975 (S)}	⩽N
0	0	+1	0	0	0	0	0	0	+0	⩾0
0	+1	0	0	0	0	0	0	0	+0	⩾0
0	+3.67	−1	0	0	0	0	0	0	+0	=0
0	0	0	0	0	0	0	0	0	+0	⩾−1
+0.24	+0.207	+0.214	+.35	+225	+225	0	−66	−87.1		
+	+	+	+	−	−	−	+	+		
+	+	+	+	±	±	−	+	+		

dollar value of an acre of salt marsh is determined by the extent to which it contributes to net income or reduces the need for costly alternatives.

Three kinds of use of wetlands may be distinguished.

(1) It may be permanently altered, as for example by being filled for development.

(2) It may provide a renewable resource, for example, in producing detritus year after year.

(3) It may be used productively without "consuming" it in the sense that the use precludes others; for example, duck hunting requires that the marsh be left in its natural state, but this does not interfere with the marsh's natural function of producing detritus.

The first two types of use are shown as mutually exclusive alternatives. If the marsh is filled, it produces the annual revenues of its commercial development. This is taken to be $225 per acre (.40 ha) per year, based on a typical price for such land. Where the marsh is used without in any sense consuming it, the value of this compatible use is contained in its market price. For example, the market value of preserved salt marsh is based on a typical annual rental of hunting rights: $35 per acre. The additional dollar value of the detritus crop from preserved salt marsh remains to be determined by the model.

No distinction is made in this model between income that results from using the wetland and that which results from destroying it; the typical year considered is assumed to extend into the indefinite future. The option value inherent in preserving an irreplaceable asset and systematic changes in benefits and alternative technology over time are discussed by Krutilla et al. (1972).

There are two additional lines in Table 1: the objective function for environmental value (Row B) and social value (Row C). In these two rows, only the sign of the value is given; no estimate is made of a quantitative amount. For example, a plus sign for both environmental and social values is shown in the columns for preserving *Spartina* to indicate that the true value of this preservation in both respects exceeds the $35 per acre per year assigned to this preservation on the basis of its market value. On the other hand, the environmental effect of filling salt marsh is definitely negative as indicated by the minus signs for environmental value in Columns 10 and 11. The social effect of filling marsh land is more ambiguous because there are both beneficial and detrimental social consequences possible as indicated by the sign ±. Social values such as aesthetic appreciation and protection from storm damage are lost. On the other hand, filling the land may have positive social values in providing acreage for residences or industries producing jobs. The way in which these environmental and social values enter the evaluation is discussed below.

The model is solved initially to determine the mix of uses of the estuary that leads to maximum value (or least cost) to the community. The dollar value of salt marsh in supporting the most valuable activities or replacing the most costly should be maximum under these circumstances. In all these examples, at least secondary treatment of waste water is assumed to be required.

Model Results

Under the postulated conditions with 115 pounds (52.16 kg) of nitrogen flushed out of the bay daily, all 120 acres (48.6 ha) of tall *Spartina* should be preserved and 380 (153.9 ha) of the 1,680 (679.9 ha) acres of other *Spartina*. This allocation provides the necessary level of nitrogen removal and sufficient detritus to support the product of 2.65 acres (1.07 ha) of clams and 140 (56.7 ha) acres of sea worms. Harvesting these clams and sea worms is a more profitable use of the detritus than harvesting the other natural products: mussels, cod and flounder. Oyster aquaculture would have to add value beyond the cost of production of more than $350 per acre of oyster raft; in the absence of definitive cost data, this possibility was omitted from these results. All 19 mgd of waste water received only secondary treatment before being filtered through the salt marsh.

The most lucrative use of the area occupied by salt marsh in this example is the construction and operation of a marina. This use is precluded in this example by the demand that sport fishermen would place on the supply of cod and flounder, 498,000 (225,892.8 kg) and 116,000 pounds (52,617.6 kg) per year respectively, which cannot be supported by the available detritus. The alternative to preserving salt marsh is therefore in all cases to fill it at an assumed commercial value of $225 per acre (.40 ha) per year.

There are two kinds of results that are obtained regarding the value of salt marsh:

(1) The dollar value of the marsh determined by the extent to which it supports or replaces other activities in the model which have a market value or cost.

(2) The total value, including incommensurable and intangible values not reflected in the other activities of the model, that the salt marsh must be judged to be worth in order to alter the resource allocation.

The first is a partial estimate of the value of a salt marsh depending, for example, on changes in net income (e.g., the extent ot which it produces seafood of commercial value), or the cost of the alternative (e.g., the extent to which it reduces the need for the construction and operation of sewage treatment facilities). The second kind of result is the decisionmaker's judgment of a higher value representing the community's willingness to pay to preserve more salt marsh than that which leads to minimum dollar cost.

The value of an acre of salt marsh is given in the program by its "shadow price": the increase in the total value (or reduction in total cost) of the entire complex of activities that would result from the availability of one more acre. Notice that this is likely to be quite different from its simple market price. The value per acre together with the number of acres to be preserved is shown in Figure 1 as a function of the exogenous nitrogen load (N), i.e., the load that may enter the estuary from a polluted river or storm runoff, in addition to the normal sewage discharge. With the estuary flushing out 115 pounds (52.16 kg) per day as assumed and no other load, acreage of *Spartina* other than the tall fringing variety is divided between being preserved and being filled for development. If one additional acre were available, it would be filled; its value is thus the $225 per acre per year that would result. (All results are shown in dollars per year. The value per year may be converted to total value per acre by capitalizing at some interest rate. At 5 percent, the value per acre is 20 times the annual value; at 10 percent, 10 times.)

By contrast, the annual value of tall, fringing *Spartina* is $317 per acre. An additional acre (.40 ha) of the tall grass would release one acre of the other grass to be filled at a value of $225. In addition, the detritus output of the tall grass will support another 0.0153 acre (.0061 ha) of clam production (4.600/300) at $6,000 per acre of clams for an incremental increase of $92 per acre. As shown in Figure 1, the values of $317 per acre of tall *Spartina* and $225 per acre of other grass hold over a wide range of nitrogen loads, not only at the postulated flushing rate of 115 pounds (52.16 kg) per day. This ranges from a removal of 5,080 pounds (2,304.28 kg) per day, when none of the other grass need be preserved, to an additional load of 16,930 pounds (7,679.45 kg) per day when all of the *Spartina* needs to be preserved for its nitrogen removal ability. The latter is

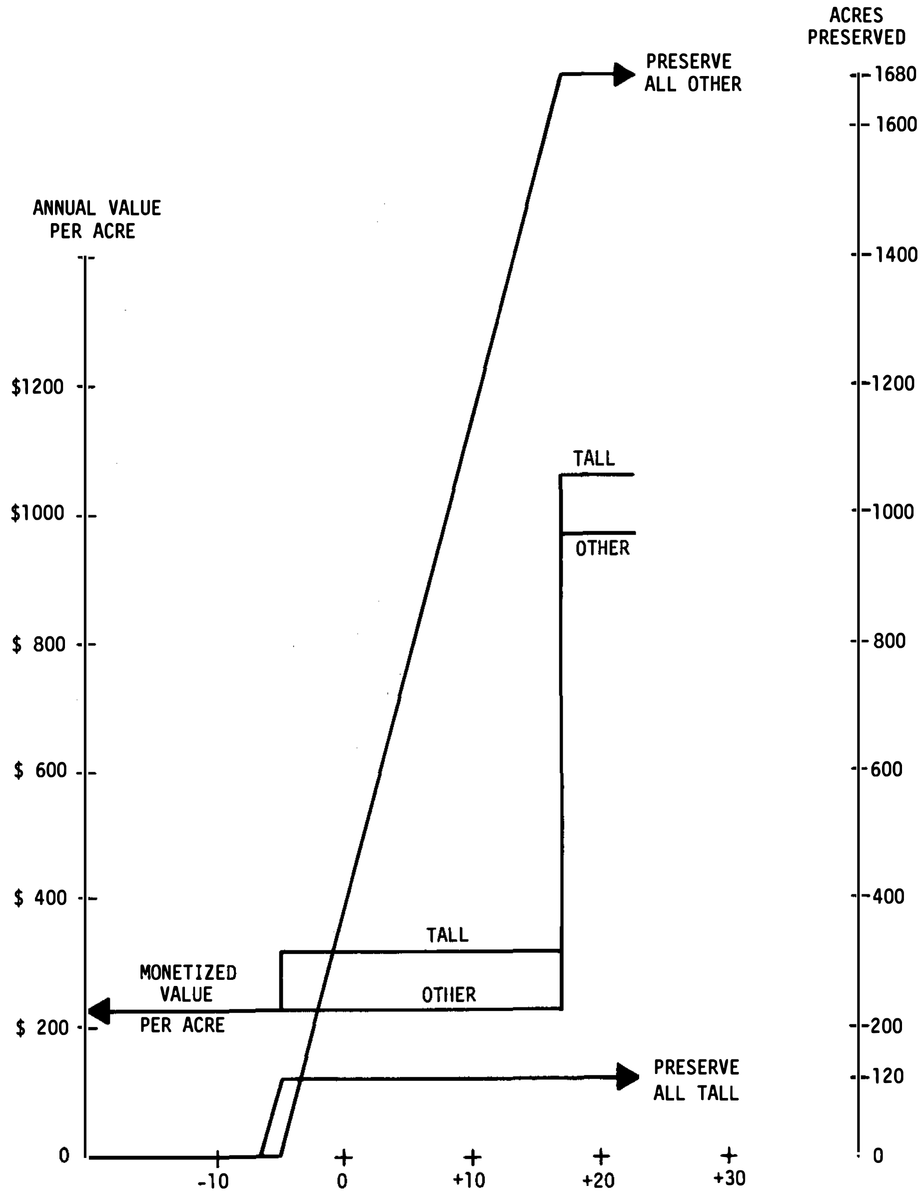

Figure 1. Wetland allocation vs. nitrogen load

equivalent to an additional input of about 40 mgd of raw sewage, not an inconceivable amount for a marsh located on a polluted river.

The nitrogen load in an estuary may be very uncertain, for example, if there is runoff from agricultural or paved urban areas. If the load is greater, the value of preserved salt marsh is increased. If the exogenous load of nitrogen were to exceed 16,930 pounds (7679.45 kg) per day, tertiary treatment by the sewage treatment plant would be required to maintain the nitrogen balance. Under these circumstances, the value per acre of tall *Spartina* would increase to $1,060 per acre and other *Spartina* to $968 per acre because they would reduce the need for this expensive equipment. One acre of *Spartina* reduces the need for tertiary treatment of 0.0437 mgd of waste water (13.1/[350 - 50]) at an annual savings of $31,100 per mgd ($87,100 - $66,000) or $912. There would also be an increase in the flow of detritus into the estuary of 600 lbs. (272.16 kg), (0.0437 × [27,500 - 13,800]) with 0.0437 mgd of waste water receiving only secondary instead of tertiary treatment. This would support 0.002 (.00081 ha) of an additional acre (.40 ha) of clam production at $6,000 per acre, an increase of $12. Together with the $35 market value of preserved salt marsh, this results in $968 per acre of *Spartina* (921 + 12 + 35). As noted above, tall *Spartina* is worth $92 more per acre because of its production of detritus. Above a nitrogen input of 22,630 pounds (10,264.97 kg) per day, the nitrogen balance could not be maintained.

On the other hand, if the flushing action of the estuary is much more effective in removing nitrates, fewer acres of *Spartina* will need to be preserved for the purpose of nitrogen removal, and the dollar value per acre is accordingly less. No *Spartina* is needed for nitrogen removal if more than 6,650 pounds (3,016.44 kg) per day are removed by flushing of the estuary; between removal rates of 5,078 (2,303.38 kg) and 6,650 pounds (3,016.44 kg) per day, some but not all of the tall *Spartina* would be needed. Under these circumstances, an additional acre of either type of grass would be worth only the $225 per acre resulting from its being filled.

If the *Spartina* does not provide nitrogen removal, the resource allocation leading to maximum dollar value (or minimum dollar cost) results in filling all salt marsh areas and preserving none. Under these circumstances, the preservation of any *Spartina* depends upon its unquantified environmental and social values.

The change in the allocation of wetland as increasing importance, expressed as incremental dollar value, is assigned to these unquantified environmental and social merits is shown in Figure 2. In this figure, however, the annual dollar value per acre is that which is implicit in the allocation. It is the total value—quantified plus unquantified—that must be placed on the wetland for it to be preserved.

Where the salt marsh does provide nitrogen removal, by comparison, we served unless the unquantified values reach the minimums shown by the broken lines in Figure 2, at which point they break even with the market value of filled wetland of $225. For the tall *Spartina* this occurs when the unquantified values reach $109 per acre. At this point, the value of the detritus resulting from the tall *Spartina* in increasing clam production is $81 ($6,000 per acre of clams times 4050/300,000 acres). Together with its market value of $35 per acre, the three components add to $225. For other *Spartina* that does not produce detritus, the unquantified environmental and social values must reach $190 to break even

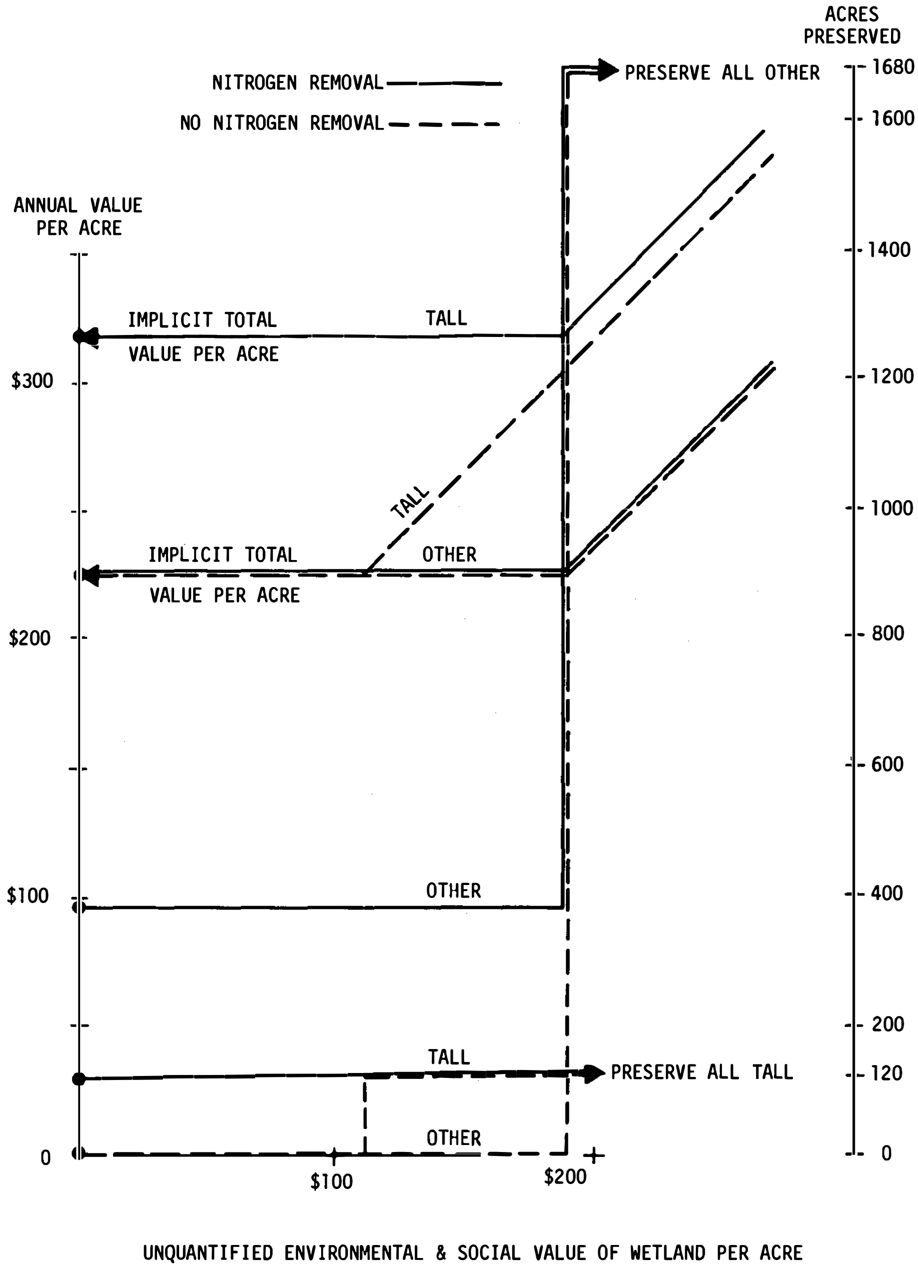

Figure 2. Wetland allocation vs. unquantified environmental and social value

(190 + 35 = $225). At $109 and $190 per acre, respectively, the amount of tall and other *Spartina* to be preserved therefore changes from none to all.

Where the salt marsh does provide nitrogen removal, by comparison, we again see in Figure 2 that all of the tall *Spartina* is to be preserved even if the unquantified environmental and social values were zero. Even without these, its marginal value of $317 per acre exceeds the $225 per acre value of filling. Since 500 acres of salt marsh are needed to provide the necessary nitrogen filtering, 380 acres of the other *Spartina* are also preserved. An additional acre of other *Spartina* would be filled, however, making its marginal value only $225 per acre. As in the case of no nitrogen removal, no change in the allocation of other *Spartina* would take place until its unquantified value reaches $190 per acre, at which point all of it would also be preserved.

Preserving this additional 1,300 acres (526.5 ha) of salt marsh because its non-market values are considered to be worth at least $190 per acre per year means that the community is willing to pay $247,000 per year to preserve all its salt marsh. Whether or not it is worth this amount is left to the judgment of the decisionmakers.

Although this kind of result does not give the decisionmakers the "answer" (and does not guarantee wisdom on their part), it narrows the range in which judgment must be exercised. As compared to making the judgment as to whether marshlands are worth approximately zero or approximately infinity, the decisionmakers must decide whether the community they represent is willing to pay a quarter of a million dollars per year to preserve 1,300 acres (526.1 ha) of salt marsh for their incommensurable and intangible values.

Merits of Modeling

On the basis of this example, the advantages and limitations of a modeling approach to evaluating tidal wetlands can be summarized. The caveats to this type of analysis have been documented elsewhere. Most fundamentally, a question can be raised as to the adequacy of the base of scientific knowledge for describing and predicting physical, chemical, and biological phenomena (Walker 1973). If the model is mostly fiction, may it not be misleading? Even given the necessary basic understanding, the absence of data specific to a given situation may cripple any attempt to draw quantitative conclusions: results expressed in numbers thus may provide an illusory sense of precision.

The essence of natural processes is their complex behavior as systems which may not be analytically decomposable, much less adequately represented by a linear model. Their measure may more appropriately be an index of diversity than their productivity. Continuous trade-offs in the preserved acreage of wetlands, such as we have shown, may mask an asymmetry between the environment getting better and getting worse (Bella 1974). Moreover, some discrepancy between economic reality and the requirements of the mathematical model formulation must be acknowledged. In mathematical terms the solution space must be convex for a linear program to behave properly. Economically, this precludes the possibility of diminishing average costs with increasing scale (such as decreasing unit cost of sewage treatment plants with increasing size), indivisibilities in discrete entities (such as the possibility of building a fractional marina), and other either/or type constraints. Any such model is therefore both simplified and incomplete.

In rebuttal, it can be argued that a model provides a structure, albeit simplified, to organize the knowledge that we do have. Where basic theory or data are deficient, a model reveals their absence and therefore the ways in which decisions are being made without full understanding of their consequences. In this respect, the model does nothing more than trace out rigorously the results of alternative decisions which may be overlooked in a less comprehensive treatment. Like the Monkey's Paw, the model inexorably leads to the consequences of choices however unwelcome they may be. Moreover, it is a thorough bookkeeper leading the results which if plausible are often not obvious. Since shadow prices represent a reallocation of the market values of the selected uses, there is no question that the dollars used as standards are the usual marketplace dollars.

Are dollars appropriate units in which to evaluate choices that are ultimately political? Political choices are normally couched in terms of "either/or" not "how much." For this kind of a choice, an ordinal comparison is sufficient. As Haefele (1973) has demonstrated, however, decisionmaking in a representative democracy depends upon the importance that voters attach to issues as well as their preferences on one issue or another, which makes vote-trading possible. Certainly one of the most common gages of importance is the price that one is willing to pay.

As long as there are incommensurable and intangible benefits attached to the decision to preserve wetlands, *a priori* estimates of their value will be incomplete. The price of saving wetlands instead of cashing in on the market value of filling them is ultimately set by the decision to forego this opportunity, i.e., the willingness of the community to pay the opportunity cost. Oscar Wilde defined a cynic as a man who knows the price of everything and the value of nothing. But if we can't fully know the value of wetlands, neither do we need to be naive about the price of trading them away.

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Discussion

CHAIRMAN ODUM: I think the papers we have listened to have a common theme, namely, that as you increase the man-made pressure on the natural environment, then by any kind of cost accounting you get an increase in value of the natural area because it has to bear more and more of the life-support cost. Therefore, we might say that sooner or later we must quantify the so-called environmental quality values.

This is one of the considerations for the immediate future. I wonder if anybody has a comment to make.

DR. FRED BUNNELL [University of British Columbia]: I think that over the last seven years, in the models that we have developed in association with the management agencies to assist them with management decision-making, our greatest problem has been in evaluation of the model. I am sure that either of these speakers could speak for many days on the problem of evaluating the present fisheries models.

We did make one assumption, at least based on some experience, and that is when an ecologist finds his model is not appropriate in the real world, he tries to change the model. When the economist finds that the model is not appropriate in the real world, he sometimes tries to change the real world. What we have in the two papers that have just been presented is an attempt to make economics and ecology link.

I would like to address this question to each of the last two speakers—how could you evaluate your model to find out whether it really will assist the decision-maker?

DR. HILL: Well, it is necessary to make a distinction between two kinds of models. Simulation models can be compared with what happens in the real world. You can make some estimate as to whether they behave in the proper way and predict what is going to happen.

The kind of thing I am talking about as a model is a set of calculations which is intended to find the highest point on a curve or the lowest point on a curve—that is, it is intended to take a given set of data and maximize, minimize or optimize it. What it is intending to do is to provide the implication of what is known in a sort of systematic way.

There are certain questions as to whether the data that might go into the model is entirely valid in terms of the biological phenomenon. Certainly what you can say, however, is that given that data, these are the logical consequences and I would think that knowing the logical consequences of your decision is an important thing to know.

CHAIRMAN ODUM: Well, there is much more that can be said there and we should point out what we have said at the beginning of this Session, mainly, that we are looking into the future, and attempting to assess procedures not yet completely operational.

What we are saying in all fairness, is that not many of the models that we are now working with are in their final stages—we still have to do a great deal of continuing research on the art of modeling. In the meantime, procedures for evaluating alternate choices are sufficiently good to act on now.

MR. DOUGLAS JESTER [Virginia Polytechnic Institute]: I would like to know what active constraints are in your linear programming model when the environmental value is above the critical value and how intensive that critical value is to those constraints?

MR. HILL: I don't have a chart here that gives all of the results. The active constraints, for those of you who are not familiar with modeling, are those which in fact are limiting the behavior of the model.

The natural result, the mix of activity that resulted in this program, was limited by the amount of nitrogen load, where it showed as a variable, and in terms of the national products by the amounts of Sea Worm, for one thing, that was available. The program was not limited by dissolved oxygen.

I refer you to the written paper, which has more of these things in it.

CHAIRMAN ODUM: I wish we had more time for discussion but we still have one more paper and we had better get to it to stay on schedule.

We have been talking about the large systems and modeling of large systems and so on. Also, I think we should recognize that resource managers may find some interesting tools and technology even going in the other direction, down to population level and even down to the biochemist's tools and techniques.

The next paper which deals with the species level is a joint effort by Michael H. Smith, H.O. Hillestead, M.N. Manlove and R.L. Marchinton, Research Scientists, Savannah River Ecology Laboratory, Aiken, South Carolina.

Use of Population Genetics Data for the Management of Fish and Wildlife Populations

Michael H. Smith,
*Savannah River Ecology Laboratory,
Aiken, SC*

Hilburn O. Hillestad,
*Institute of Natural Resources,
University of Georgia,
Athens*

Michael N. Manlove,
*Savannah River Ecology Laboratory,
Aiken, SC*

R. Larry Marchinton,
*School of Forest Resources,
University of Georgia,
Athens*

The role of genetics in determining attributes of fish and wildlife populations has traditionally received little attention in North American wildlife management programs. Environmental factors such as habitat and density or structure of populations have been the primary parameters available for manipulation by the manager in his efforts to enhance fish and wildlife populations as natural resources. In many cases, an examination of our harvest methods suggest that a tacit assumption of low heritability has been made for many important characteristics. Legal harvest regimes, when combined with sportsmen's mores, often emphasize cropping from the top. The ethical fisherman sometimes returns small fish to the water and prefers to remove only the largest, finest specimens.

In Europe, particularly Germany, genetics has traditionally been emphasized in the practice of wildlife management (Leopold 1936). According to Webb (1960), management is conducted on smaller units where the manager has detailed knowledge of the density, sex and age ratios, and quality (trophy value, body condition) of the population. There is wide belief among German hunters that genetic factors limit size of antlers and considerable effort is devoted to elimination of poor quality stock and to conservation of good individuals. The shooting plan is designed to put heavy pressure on males with poor antlers so animals with trophy antlers will breed. Even in forest where natural food is limited and supplementary feeding is essential, there seems little appreciation of the possibility that antler size may be governed by quantity and quality of food. Recently, genetic experiments in Germany have been designed to produce large-antlered red deer (*Cervus elaphus*) with small body sizes to reduce habitat stress while enhancing trophy antler development (Gottschalk 1972).

The nature-nuture issue has provided some of the most keenly contested debates among scientists during the past several years (Feldman and Lewontin 1975), but these differences in management strategies are probably rooted in political philosophies and cultural traditions as much as in science. It is evident upon the most casual reflection that *both* genetic and environmental factors are important determinants of population attributes. Obviously through modern wildlife management practices such as setting of harvest regimes, habitat improvement, stocking and predator control we are inadvertently manipulating the genetic structure of populations.

Fishery and wildlife managers have been unable to examine the genetics side of the biological management "coin" until recently. We have by necessity relegated genetics to an unknown catch-all category. Population phenomena we could not otherwise explain were assumed to result from genetic differences. Or, on the other hand, we ignored genetic solutions to problems and considered acceptable hypotheses to be those involving phenomena that could be tested (e.g., habitat and nutrition).

Demands for increased hunting and fishing opportunities and commercial production from wild stock has prompted a reassessment of management practices by state and federal agencies. The possibility of genetic explanations for some inter- and intrapopulation differences must now be considered prominently in the design of management strategies for many fish and wildlife species. Several investigators (Utter et al. 1973, Morgan et al. 1974) have described in general how starch gel electrophoretic techniques can be used to obtain information useful in wildlife management. These techniques have been widely documented in existing literature (Selander et al. 1971, Shaw and Prasad 1970). In this paper we have selected some prominent questions concerning the importance of genetic data that have been frequently asked by wildlife managers. Our objective is to answer these questions and to point out how this information can be used in a management context.

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Can Genetic Data be Useful in Helping to Define The Best Management Unit Boundaries?

Criteria for the establishment of management units normally involves political subdivisions, ownership patterns, habitat types, and the ecological characteristics of the species involved. The latter usually includes distribution and movement patterns. We believe that genetic criteria can sometimes be used to accurately define functional population units. This is clearly the case with some migratory species in which the relationship between the various breeding ground and wintering area populations has been difficult to establish (anadromous fish,

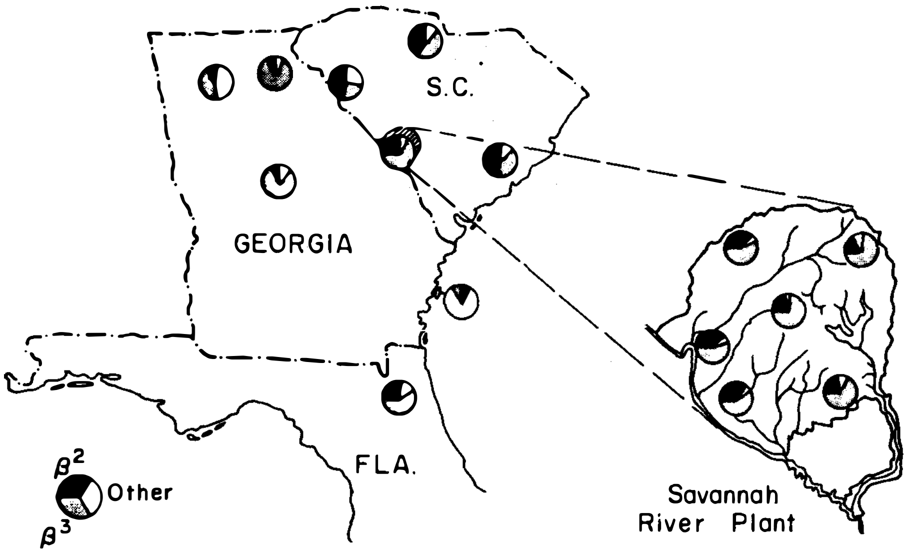

Figure 1. Allele frequencies for beta hemoglobin in populations of white-tailed deer over a three state area and on the Savannah River Plant. Frequencies of two major alleles and others combined are expressed in terms of the proportional area of the circle occupied. The data are summarized for 733 white-tailed deer.

Utter et al. 1974). The typical approach used in defining migratory populations has been through extensive tagging programs. This has been reasonably successful with some species but is extremely expensive in both time and effort. With other species it has been less than successful or has completely failed. The use of "genetic tags" may prove to be a much simpler and less expensive approach in certain cases.

For more sedentary species, genetic data may be a particularly sensitive indicator of population differences occurring within present management units (Fig. 1). Statistically significant differences in allele frequencies across relatively small geographic areas can be used to define functional populations which may or may not differ in other characteristics. Individuals can be collected at various locations and their tissues subjected to electrophoretic analysis for variation in proteins reflecting genetic polymorphisms (Selander et al. 1971). Theoretically population boundaries can be defined very precisely based on functional characteristics related to gene flow. This type of precise definition of populations may be useful for pooling populations into meaningful categories based on functional characteristics rather than more arbitrary criteria.

In many cases, a management unit may comprise a number of populations. On the Savannah River Plant near Aiken, South Carolina allele frequencies in white-tailed deer (*Odocoileus virginianus*) can show significant differences over relatively small distances. These genetic changes are associated with significant differences in other population characteristics (e.g., reproductive rate, Urbston 1967). A closer examination of similar situations may reveal many cases where smaller management units are indeed justified.

To What Extent are Qualitative Differences Within and Between Animal Populations Associated with Genetic Differences?

The past decade has seen a proliferation of techniques and studies designed to assess the genetic variability associated with other characteristics which we have classically used to define and describe populations. There are many problems which confound the analysis of genotype - environment interactions and they have led to a number of theoretical conflicts (e.g., neutralism vs. selectionism) in interpreting results of population studies. However, our purpose is to present evidence for genetic relationships with individual characteristics that might be useful in a management context.

Studies of protein variation have shown that there is spatial variability in gene frequency among populations of most species. Genetic subdivision has been demonstrated for fish taken from different rivers (striped bass, *Roccus saxatilis,* Morgan and Koo 1973; bluegill, *Lepomis machrochirus,* Avise and Smith 1974; orangebelly darter, *Etheostoma radiosum,* Echelle et al. 1975; Salmonids. Utter et al. 1973; walleye pollock, *Theragra chalcogramma,* Iwata 1975). Among mammals, white-tailed deer populations are genetically different in the southeast as well as within a more limited geographical area (Fig. 1, Harris et al. 1973) Similar results have been seen for house mice (*Mus musculus,* Selander 1970) and deer mice (*Peromyscus,* Selander et al. 1971, Smith et al. 1973, Avise et al. 1974a, b), Kangaroo rats (*Dipodomys,* Johnson and Selander 1971), and gophers (*Thomomys* Nevo et al. 1974, Selander et al. 1974). Other papers on vertebrates showing spatial subdivision include Ferguson (1971) on pigeons, (*Columba livia*), Baker (1975) on sparrows (*Zonotrichia leucophrys*); Redfield (1974) on blue grouse (*Dendragapus obscurus*), Webster and Burns (1973) on *Anolis* lizards, and Guttman and Wilson (1973) on American toads (*Bufo americanus*). A similar list could be given for invertebrates. Although there are some exceptions, such as *Drosophila willistoni* populations in South America (Ayala et al. 1971), genotypic heterogeneity over space appears to be the rule rather than the exception.

Relatively few studies deal with temporal variation in genetic composition of populations. There is evidence that gene frequencies and heterozygosity change in accordance with fluctuations in density of rodent populations (Semeonoff and Robertson 1968, Gaines and Krebs 1971, Krebs et al. 1973, Tamarin and Krebs 1969, Pickering et al. 1974, Smith et al. 1975). Redfield (1973) has followed gene frequency changes in blue grouse over time. Industrial melanism in Lepidoptera provides another classic example of gene frequency changes in a population over a relatively short time (Kettlewell 1956). Anderson et al. (1975) have found significant genotypic changes over a 30-year period in several *Drosophila* populations in the Western United States, and seasonal cyclic changes in genotype are described by Dobzhansky and Ayala (1973) for *Drosophila pseudoobscura.*

Many studies have demonstrated a direct association of phenotypic characteristics with certain genotypes. In domestic pigeons, females that are heterozygous at the transferrin locus hatch a larger percentage of their eggs than homozygous females (Frelinger 1972). Baldwin and Aleksuik (1973) have discussed the adaptive significance of the effects of temperature on reaction rates for certain enzymes in animals subjected to fluctuating body temperatures. From studies of salmonid and certain other fishes, Moon (1975) concludes that the maintenance of enzyme heterogeneity in organisms such as salmonids increases flexibility and adaptability in fluctuating thermal regimes. Powers and Powers (1975) formulated a predictive model for the degree of selection by environmental variability upon the LDH-B locus in the mummi chog (*Fundulus heteroclitus*) and Huzyk and Tsuyuki (1974) found an association of certain genotypes at this locus with superior swimming endurance in rainbow trout (*Salmo gairdneri*). Yardley et al. (1974) examined allele frequencies in three species of freshwater fish for evidence of genetic changes associated with their inhabiting different thermal regimes. While there were no apparent thermal effects on allele or genotype frequency, two species showed significant differences in allele frequencies between lake and river environments. Significant correlations between allele frequencies and environmental variables were found for a number of insect species by Schaffer and Johnson (1974).

Some studies have demonstrated phenotypic relationships with genetic heterozygosity. Certain behavioral characteristics, notably levels of aggression and exploratory behavior in mice, are correlated with genetic heterozygosity (Garten in press a, b). Selection for heterozygous genotypes occurs in young hybrid fish populations (Whitt et al. 1973, Fujino and Kang 1968), and Smith et al. (1975) concluded that, in general, survivorship is probably higher for heterozygous individuals due to their superior characteristics. Ayala (1968) suggested that the amount of genetic variability in a population is a factor in the population's ability to adapt to a changing environment. This view is supported by Bryant (1974) who has shown high correlations of genic heterozygosity with environmental variability. There is an increasing body of evidence indicating that genetic variability is maintained by selection and hence plays an important role in population processes (Johnson 1974).

Are Population Characteristics Related to the Genetic Composition of Populations?

There are four characteristics that affect the change in numbers of a population. These include (1) the original number of individuals in the population, (2) the natality, (3) the mortality, and (4) the net movement into or out of the population. There is evidence for relationships between these characteristics and the genetic structure of populations. With respect to reproduction, there is a positive correlation between reproductive rate and mean heterozygosity in old-field mice (*Peromyscus polionotus*, Smith et al. 1975) and between reproductive rates and genetic variability in *Drosophila* (Ayala 1968, Beardmore 1970). Genotypic influences upon mortality have been suggested by research on pigeons (Frelinger 1972), blue grouse (Redfield 1974) and a fresh water fish, *Notropis stramineus* (Koehn et al. 1971).

Population density is associated with changes in mean heterozygosity of old-field mice (Smith et al. 1975). Krebs et al. (1973) have demonstrated changes in gene frequency associated with fluctuating numbers in natural populations of microtines. In addition, Howard (1960) suggested there may be a genetic component associated with the dispersal of individuals and Krebs et al. (1973) and Pickering et al. (1974) have presented experimental evidence documenting this point.

Genetic composition may also vary as a function of age and/or body size. Koehn et al. (1973) found age specific genetic differences in mussels (*Modiolus* *demissus*) and Fujino and Kang (1968) demonstrated changes in levels of heterozygosity with increasing body size in skipjack tuna (*Katswvonus pelamis*). Garten (in press a) found that larger old-field mice were more heterozygous than smaller ones in the same population but heterozygosity was not related to age. The degree to which these relationships are causal may reflect the importance of hybrid vigor as a real phenomenon in natural populations. The evidence clearly suggests the need for further research of the genetic implications to population processes.

Are Inbreeding and Heterosis Significant Phenomena in Fish and Wildlife Populations?

The question concerning inbreeding is often asked and has resulted in much speculation. The public tends to view inbreeding as a problem especially for wildlife species. For example, deer that are small with poor racks are often thought to be inbred when in fact overpopulation or habitat quality may be the primary problem. Pressure has been brought on fish and game departments to correct this problem by bringing in new stock (Teer 1965). Much money has been expended with questionable results because there was no convenient method to assess the degree of genetic variability or calculate the inbreeding coefficient for these populations. Fortunately, with the advent of electrophoretic techniques, this is no longer the case.

Samples can be obtained from a population and subjected to electrophoretic analysis. The inbreeding coefficient can be calculated from data on the genotypic arrays for the variable loci. The deviation between the observed and expected number of heterozygotes is used to calculate an inbreeding coefficient (F, Wright 1969). Inbreeding should result in a decrease in the number of heterozygotes in the population compared to that expected in a randomly breeding population.

Past inbreeding may have reduced genetic variability even though the population is not currently inbreeding. With proper controls this reduction in genetic variability can be detected statistically by surveying a number of variable loci and calculating average individual heterozygosity ($\overline{H}$, Table 1). We know little about the effects of inbreeding in natural fish and wildlife populations, but there is abundant evidence of its deleterious affects in laboratory populations and livestock (Falconer 1960).

What are the Significant Genetic Considerations for Stocking of Species?

The historical development of this country's resources resulted in the widespread extirpation of many species of fish and wildlife from portions of their range. Many species have been reintroduced into their former ranges following the basic sequence outlined by Leopold (1933). To the credit of our resource management agencies, some of these introductions have been spectacularly successful. Species such as deer have become practically ubiquitous in recent years. Other species, such as the wild turkey (*Meleagris gallapavo*), have expanded even beyond their natural ranges as the result of restocking practices.

Many of these introductions were characterized by the release of a few individuals (often young animals) from different sources. For example, introduc-

Table 1. Estimates of mean proportion of loci heterozygous per individual ($\bar{H}$) and mean proportion of loci polymorphic per species of population (P) in several animal species.

Organism	$\bar{H}$	P	Number of controlling loci	References
Fish				
Minnows	0.049–0.068	0.25–0.50	12–24	Avise et al. (1975)
Cichlids	0.00–0.036	0.00–0.015	13	Kornfield and Koehn (1975)
Bluegill				
a. Savannah River (S.C.)	0.043	0.12	15	Avise and Smith (1974a)
b. Mississippi River (La.)	0.057	0.17	15	Avise and Smith (1974a)
c. Altamaha River (Ga.)	0.028	0.07	15	Avise and Smith (1974a)
Sunfish (9 species)	0.005–0.114	0.14–0.36	14	Avise and Smith (1974b)
Salmonids (6 species)	0.006–0.037	0.087–0.261	19–23	Utter et al. (1973)
Sparrow	0.035	0.33	15	Nottebohm and Selander (1972)
House mouse	0.110	0.30	40	Selander (1970)
Old-field mouse				
a. Florida peninsula	0.085	0.28	32	Selander et al. (1971)
b. Santa Rosa Island (Fla.)	0.019	0.06	32	Selander et al. (1971)
c. S. Carolina and Georgia	0.050	0.20	32	Selander et al. (1971)
White-tailed Deer	0.121	0.36	22	Manlove and Smith (in prep.)
Elephant Seal	0.00	0.00	24	Bonnell and Selander (1974)
Humans	0.067	0.28	71	Harris and Hopkinson (1972)

tions of deer in Georgia were composed of stock from many states including Texas, Maryland, Wisconsin, North Carolina, Kentucky and from the coastal islands of Georgia (Blackard 1971). Raccoons (*Procyon lotor*) have been released in the Piedmont and mountainous regions of many southern states from coastal plain sources (e.g., Frampton and Webb 1973). Stocking of fish has been even more common than for wildlife species (e.g., Robbins and MacCrimmon 1974).

Most reintroductions have been made on the availability of animals from a convenience standpoint. Little selection for particular animals has been involved in restocking efforts. With deer, for instance, biologists shipped the first animals captured and terminated capture operations upon obtaining the quota. However, with some species such as turkeys, selection for young birds (especially gobblers) is often practiced by the biologist who wishes to keep the superior animals in his resident flock. At any rate most of the stocking has been conducted without reference to relevant genetic information, although the use of diverse sources may have been important in establishing high genetic variability in the new populations.

A number of factors can be important in considering the genetic aspects of a stocking program. In populations restocked with few animals, genetic drift occurs. Since the number of animals in the population will remain small for several generations, genetic drift is further enhanced in populations with low rates of increase (Cavalli-Sforza and Bodmer 1971).

Genetic drift leads to the fixation of alleles, reducing heterozygosity and genetic variability. The Founder Principle states that the genotypes of the original stock determines to a great extent, the nature of the gene pool for future generations. Mutation is the only way new genetic material may be developed from within the population, but this is an insignificant source of variation during time intervals that are meaningful in a management context. Selection and emigration will alter the gene frequencies but do not contribute new material. New genetic information must come from additional introductions or immigrations. Therefore, the resource manager should introduce the maximum number possible to found new populations. With the advent of electrophoresis for detecting genetic differences between individuals and populations, the manager now has a tool to assist him in selecting animals for restocking purposes. For example, evidence now available suggests that it is appropriate to select stock with high genetic variability. Ideally these animals should be selected from several populations with differing gene frequencies. Our choice should be restricted to animals from relatively similar habitats. The resource manager can employ genetic data to maximize the chances for success and quality of the resulting population.

Can Population Genetics Data be Used in the Management of Endangered Species?

We are entering a time of deteriorating environmental conditions caused by the large human population and the industrialization of our society. Endangered species are one of the symptoms of this condition. Because of their small numbers, many of these species are especially prone to drift with its immediate consequence of reduced genetic variability (Wright 1969). As in many other environmental areas, our charge in resource management should be to maintain diversity at a high level. A species' account in the "gene bank" must be kept at a high level to resist extinction in the face of changing environmental conditions.

Low levels of genetic variability are found in certain populations which are isolated on islands or found in refuges (Selander et al. 1971, 1974). Frequently these forms are highly dependent upon proper habitat management and continued isolation from more vigorous competitors. Other species such as the northern elephant seal (*Mirounga angustirostris*) probably lost most of their genetic variability due to a bottleneck caused by their interaction with man (Bonnell and Selander 1974). The probability of extinction for such species should be higher than for those with higher levels of variability in the face of a changing environment.

We need survey data to assess levels of variability and spatial heterogeneity in endangered species. These data can be gathered using electrophoresis without killing the animals (Manlove et al. in press). Such survey data are needed before specific recommendations can be made for particular species. For example, if a species shows spatial heterogeneity in gene frequency, cross stocking between areas might be successful in reestablishing higher levels of genetic variability in local populations. Information on movement patterns and breeding structure (effective population size) should be useful in defining the minimum sizes for reserve areas for these species.

Electrophoretic data can also help identify the source of the animals and thus aid in law enforcement efforts to protect species that may be endangered in only part of their range (e. g., alligators, *Alligator mississippiensis*). In other instances, genetic data might be useful in distinguishing between closely related species (e. g., black ducks (*Anas rubripes*) and mallards (*A. platyrhynchos*), eastern and New England cottontails (*Sylvilagus floridanus* and *S. transitionalis*), Morgan et al. 1974). Monitoring levels of genetic variability through time would provide a sensitive indicator that could be used to help evaluate the effectiveness of management programs. Electrophoretic techniques represent the only reasonable approach to providing these data at this time. We must assess the "gene bank" of populations of endangered species and continue to monitor them. This will allow us to recognize a deteriorating situation before it results in certain species becoming candidates for extinction because of a loss of genetic variability.

What Course of Research is Needed to Provide the Necessary Genetic Information for Better Management of Fish and Wildlife Populations?

Emphasis should be placed on the development of techniques that can be used to rapidly survey large numbers of organisms for genetic differences. Whenever possible these techniques should be designed as part of nondestructive sampling of populations. Methods of drawing blood and/or taking muscle plugs without killing the animal are needed. The techniques need to be standardized for the different wildlife and fish species so that procedure manuals can be constructed and standards be made available for the interpretation of results (e. g., Selander et al. 1971, Manlove et al. in press). It would be best if the standards were drawn from natural populations, but this may not always be possible. Techniques and standards may have to be species specific but this is probably not the case for most situations as illustrated by the widespread use of electrophoretic techniques involving the same buffers and stains for fish and mammals (Selander et al. 1971, Utter et al. 1973).

There is a need to survey a variety of fish and wildlife species to assess spatial and temporal genetic variation and determine its significance to management. Data should also be collected to examine possible genetic relationships with desirable phenotypic traits. Should correlations exist, hypotheses could be constructed for experimental testing. For example, if the relationship between reproductive rate and genetic variability in white-tailed deer were similar to that found in mice (Smith et al. 1975), management alternatives that might affect the genetic structure of populations could be used as experimental treatments to search for cause and effect relationships. For example, heavy hunting pressure on deer in limited areas may disrupt spatial subdivision due to social behavior and result in an increase in genetic variability. Concurrent studies of the species' reproductive performance would be essential to evaluate the success of the various management strategies. Of course, other characteristics could be used for this evaluation in place of or in addition to reproductive rate (e. g., body size or condition). Large coordinated field experiments will be needed to determine the extent to which management policies affect genetics which in turn affects desirable characteristics of the species to be managed. Certainly many of the characters used in the formulation of management decisions have a genetic component and we must be clever enough to measure and manipulate it for our own good, however that is defined.

Electrophoretic techniques make it possible to study the genetics of a variety of fish and wildlife species (Table 1). The results of the studies summarized in Table 1 have not yet had any major impact on management programs but have allowed us to better understand the spatial and temporal dynamics of populations (Selander and Johnson 1973). These studies were not designed in many cases to achieve applied objectives but they do indicate the potential in this area. Proper choice of future research should result in rapid progress towards the integration of genetic data into the management process.

Can Genetic Information be Used in Solving All Management Problems?

It should be obvious that the answer to this question is no. Genetic information should supplement other types of data such as habitat quality that are used in formulating management decisions. The usefulness of genetic data will depend upon the species and particular situation in question. It should be equally obvious that modern management can be enhanced by the incorporation of genetic data into the decision process in many instances. Techniques now exist to accomplish this goal and we need to implement these techniques in an applied management framework.

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Discussion

CHAIRMAN ODUM: We do have time for a few questions on this. This, as you can see, is another technique looking to the future.

CO-CHAIRMAN LaROE: Also, we curtailed some questions in relation to the earlier speakers and I think it would be appropriate to open it for questions and comments in relation to the earlier talks as well.

MR. S. CAROTHERS [Flagstaff, Arizona]: I have a question in regard to endangered species and the amount of genetic variability. Can you evaluate in relation to some of these species whether or not it would be futile to continue spending millions of dollars of the taxpayer's money on trying to remanage these species?

MR. SMITH: Well, let me first say that we do not have the genetic information to answer your question, but it is possible to get the information and we should address ourselves to that kind of a problem.

In answer to your last question, other things being equal, if we have allowed a species to bottleneck and essentially lose all genetic variability, everything else being equal, then if I were making a decision about what species we would continue to put an effort on, in terms of saving it, assuming we cannot save them all and do not have the resources to study them all, I would study those that still have some genetic variability left. These are the ones which we have an opportunity to make some progress on. Essentially, if we have established an inbred strain of some endangered species, all we are waiting for is a shift in the environment to wipe it out. Essentially, variation is necessary for evolution.

DAVID NELLIS [Virgin Islands]: I would like to address Dr. Wilimovsky.

Many of our fishery problems these days are being solved by greater technology or utilization of new resources. I would like to point out that in the Virgin Islands the resources are currently being harvested all the way up to the edge of the shelf fishery by using very primitive techniques which have been going on for at least 30 years.

DR. WILIMOVSKY: There is no reason to believe that it is only the technologically advanced nations or peoples that have hurt the resource. There are many examples in Southeast Asia and in the Southern Hemisphere as well as in the Northern areas, where people are using relatively primitive equipment and still have depleted the resource.

However, the time frame you spoke of, 30 years, is relatively short.

Two things enter into the constructive activities. One is the growth of numbers of people participating and the second is subtle changes in harvest that are sometimes not reported.

For example, in the Southeast, there have been major changes made in the impact of local people, the natives, who harvest the reef resources, something which occurred at about the time of World War II and this, coupled with the population increase, tended to make dangerous inroads on the stock.

Also involved are such nasty things as the use of detergents and explosives and things like that. All of this not only destroys what they want to harvest for a local contemporary consumption but the impact on the rest of the reef is tremendous.

I am sure you know this but the point I am trying to make is that some of the problems in relation to fishing and stock depletion have nothing to do with modern technology—it is just an increase of man and subtle changes for increasing the number of catch in these areas.

MR. DALE McCULLOGH [University of Michigan]: I think this is more of a comment than a question and it is addressed to the talk given by Dr. Smith. I would like to interject a bit of caution.

We are looking at relatively new information here and we don't really know what all of the rest of the genetic material looks like. We don't even have methods to approach much of the genetic material.

We know almost nothing about interaction effects and a whole number of considerations like that. That is an extremely important point to be made, particularly with reference to endangered species.

The problem might come down to something like this—that if you have a species that shows low heterozygosity and that is the one to go, for example, if you don't look at the degree of heterozygosity in terms of the kind of habitat that the animal lives in, you may be missing the whole point. It may be that way, for example, because it was in a very stable, nonfluctuating kind of environment. This would mean, in turn, that if you followed your prescription, you would automatically let the species go down the tube.

I would like to commend you from the point of view that your method may guide where we put our efforts. But if we are dealing with a specialist, then we had also better maintain a specialized habitat, and I think that distinction is worth making—that we should make our decision on other grounds, not simply on the heterozygosity factor.

DR. SMITH: Yes. In terms of the things I suggested we need to do, that was one of them. In other words, get more information about these different species so that we can evaluate them and, secondly, work on the continued development of techniques to approach this problem because I don't think this is the way to go, nor do I think that necessarily the data that we have is definitive enough to answer the kinds of questions that you are putting forward. However, I agree totally about the number of loci, even though I am not quite as skeptical as some people and it will take a long, involved argument to explain why I am a little bit more optimistic about the use of information on heterozygosity.

Lastly, I said, other things being equal, I would make that decision. What you have done is create a situation where other things are not equal and you would like to look at this case. I would certainly agree that you have to take into account the other aspects of the problem and not just the genetic aspects. What I wanted to leave you with is that this kind of information can also help you make decisions about what to do.

You may also argue that the information is not complete nor necessarily as conclusive as you would like. However, I would argue that you make decisions on the basis of available information and then proceed. If you are going to argue that this is going to apply here, I would say, "Let's get on with it and do it." These are the data we have at the moment. I think these data can be useful, given the overall situation we are dealing with.

CHAIRMAN ODUM: I want to thank the participants for presenting so much new and exciting material and under such a trying time span and I also want to thank the audience for being so patient.

Maintaining Ecological and Sociological Values in Water Projects

Chairman:
WILLIAM WHIPPLE, JR.
Director, Water Resources Research Institute
Rutgers University, New Brunswick, New Jersey

Cochairman:
PAUL W. EASTMAN
Executive Director
Interstate Commission on the Potomac
River Basin
Bethesda, Maryland

Opening Remarks

William Whipple

My name is William Whipple, and I am the Director of the Water Resources Research Institute at Rutgers University, where I have been for 12 years. I am your Chairman for this morning's session.

This Session grew out of an initiative taken entirely independent of this Conference by the American Water Resources Association and the Technical Council of the American Society of Civil Engineers for Water Resources Planning and Management. These organizations had decided that it would be a good idea to get together in a joint symposium with a wildlife group to cover some matters which were of common interest to the planners of water resources as well as to wildlife.

Paul Eastman, who is Co-Chairman of this Session, is representing the Technical Council. He is the Executive Director of the Interstate Commission on the Potomac River Basin in Bethesda.

What we are considering is, "Maintaining Ecological and Sociological Values in Water Projects."

We believe that the subject is one that is of interest to a wide variety of people, because the planners of water resources generally, and water quality as such, are working with the same things that are of wildlife interest, because when you come down to the sanction behind all of our water quality programs it is only the preservation of environmental quality.

In order to first present the various aspects in the broadest and most authoritative terms we have succeeded in getting Warren Fairchild, the Executive Director of the Water Resources Council.

Warren Fairchild is an extraordinary man who came from a state background in Nebraska where he was Director of Conservation and has had an outstanding record in trying to coordinate the activities of the federal agencies in the Water Resources Council. It is a tremendously difficult task because the agencies are lodged in power and each has its own interests. His job is to bring harmony out of chaos insofar as that is humanly possible.

Balancing Economic Development and Environmental Quality Through the Water Resources Council's Principles and Standards

Warren D. Fairchild
Director, U. S. Water Resources Council
Washington, D.C.

The need for comprehensive coordination and planning for water and related land resources management and use at the Federal level was recognized by Congress in the passage of the 1965 Water Resources Planning Act (Public Law 89-80) which established the United States Water Resources Council (WRC). Today, given the number of agencies involved, the diversity of water programs, and the dimensions of the federal commitment in water resources, that need is demonstrated even more dramatically.

Currently, within the Federal Government, there are 25 individual agencies which have planning, implementing and operating and maintenance programs relating to the nation's water and related land resources. These 25 agencies have developed a variety of approaches for carrying out, as well as financing, their programs. It should be noted that agency programs are directed towards different missions, clientele, and organizational arrangements.

In Fiscal Year (FY) 1976, an estimated $10.2 billion will be obligated by these federal agencies for water related programs as compared for a federal expenditure of $1.7 billion during FY 1965. A detailed analysis of the FY 1974 obligations of $7.1 billions shows that federal grants accounted for 46 percent (largely for water quality), direct federal programs - 41 percent, and federal loans - 13 percent. Eighty-three percent of the federal funding was for implementation, 13 percent for operation and maintenance, 3 percent for planning, and the remainder for general support.

Non-federal interests contributed an amount nearly one-half of the total of the federal investments for the implementation and operation and maintenance costs of the projects and programs that have federal involvement. In addition, it is estimated that non-federal interests annually expend for projects and programs which receive no federal support sums much larger than the Federal Government's obligations for federally financed water projects and programs.

Water Resources Council

To help bring needed coordination of planning for water and related resources, the Congress included in the WRC's duties the "... continuing study ... of the adequacy of administrative and statutory means for the coordination of the water and related resources policies and programs of several federal agencies."

The WRC is composed of the heads of eight major federal departments and agencies having various water and land resources planning, management, and regulatory responsibilities. Other entities at the federal and regional (interstate) levels serve as observers on the WRC.

As set forth in the Planning Act, the WRC, is to: (1) prepare a national assessment, (2) recommend water policies, (3) establish planning standards, (4) coordinate and manage comprehensive planning, (5) recommend federal-state river basin commissions, (6) review river basin plans, (7) assist state planning, and (8) carry out other Executive Office assignments.

Principles and Standards

To respond to the stated directives of the Act to establish planning standards, the WRC developed revised principles and standards for planning water and related land resources to replace earlier policies and procedures. The development of principles and standards took several years of effort by the WRC. After extensive study, review, field testing and public hearings, the WRC on December 21, 1971, published "Proposed Principles and Standards for Planning Water and Related Land Resources" along with a draft environmental statement, and invited public comment on the proposal. Extensive views and comments were received through oral statements at the public hearings held on the proposal and through written submission to the WRC during the period allowed for comment.

After careful consideration of the public response to its proposal, and in consultation with all concerned federal agencies, the WRC made its decisions on the proposal and forwarded its recommendations to the President who approved the "Principles and Standards for Planning Water and Related Land Resources" (P&S) which became effective October 25, 1973.

The Principles provide the broad policy framework for planning activities and include the conceptual basis for planning.

The Standards provide for uniformity and consistency in comparing, measuring, and judging beneficial and adverse effects of alternative plans.

WRC procedures are being developed to provide more detailed methods for carrying out the various levels of planning activities and will be within the framework of Principles and the uniformity of Standards but vary with the level of planning, the type of program, and the state-of-the-art of planning.

As indicated by these definitions, the concepts of principles, standards, and procedures will evolve and change. Principles, reflecting major public policy and basic public investment theory, will change and evolve slowly. Standards, representing the best available techniques for the application of the Principles, will change more frequently than the Principles, as progress in the development of planning and evaluation techniques takes place. Procedures, detailed methods for the application of the P&S, will be subject to even more frequent revisions as experience, research, and planning conditions require such revisions.

These P&S are now being used for planning of federal and certain federally assisted water and related land resources projects and programs to achieve objectives, determined cooperatively, through the coordinated actions of the Federal, State, and local governments; private enterprise and organizations; and individuals.

The planning process recognizes and accounts for two coequal objectives: (1) National Economic Development (NED), that is, increased production of goods and services, and (2) Environmental Quality (EQ), the enhancement of physical, ecological, and aesthetic characteristics. In addition, the beneficial and adverse effects of alternative plans on Regional Development (RD), and Social Well-being (SWB), are displayed. Properly accounting for and displaying the effects on NED, EQ, RD, and SWB gives planners, the affected public at large, Congressional members, and others, an opportunity to evaluate fully a given plan or set of alternative plans.

Basically, at least two alternative plans—one maximizing the objective of increased NED and the other maximizing EQ—must be developed. Then, based on preferences expressed by the affected public, a recommended plan is selected, either from one of the two required alternatives, or more probably a compromise. In the plan selection process, the monetary and nonmonetary differences between and tradeoffs among each alternative plan are clearly shown, thereby providing a rationale for choosing the preferred alternative plans to meet the two-objective system.

For example, a plan may emphasize contributions to the EQ objective and, in addition, include complementary contributions to the NED objective, such as water supply for municipal and industrial needs.

Another plan might include significant contribtuions to the NED objective and, in addition, include contributions to the EQ objective, such as consideration of water quality, fish and wildlife, and open space provision.

It should be mentioned that agencies are preparing procedures for implementing the P&S. These procedures are reviewed by the WRC for consistency with the WRC's P&S. When procedures are received from all appropriate agencies, they will be reviewed for consistency with each other.

Section 80(c) Study

Section 80(c) of the Water Resources Development Act of 1974 (P.L. 93-251) provided that the President conduct a full and complete investigation and study of the P&S, as these relate to federally financed water and related resources projects, including but not limited to planning objectives, discount rate, and cost sharing, and report his findings, with recommendations, to the Congress. The President, on September 23, 1974, assigned to the WRC the responsibility for conducting this investigation and study. The study called for in the Act was a direct outgrowth of concern on the part of Congress relating to the P&S. The Section 80(c) study has been completed and was transmitted to the President by the Chairman of the WRC on December 5, 1975.

The data base and other factual information developed during the Section 80(c) study has been printed by the Government Printing Office and is now available. Following are a few of the highlights from the study which, incidentally, excluded consideration of water research and data collection programs.

Study findings indicate that nearly 60 percent of the federal funds used for water and related land projects and programs are for projects that are not evaluated under the P&S. During the period of development of the P&S, the emerging role of grant and loan programs in the planning and development of water and related resources was recognized. However, because of inability to fully ascertain the impacts of these growing programs and in the interest of moving forward with implementing a common set of principles and standards for the then major water programs, the WRC recommended to the President the adoption of the P&S which excluded coverage of the grant and loan programs.

The Council of Members (COM), during its deliberation on the Section 80(c) Presidential Study (P.L. 93-251) took the following position on coverage:

> " . . . all Federal and federally assisted water and realted resources programs must relate to a national policy framework. It was decided that . . . a set of principles will be developed, and then consideration will be given to appropriate standards by the Council of Representatives to be completed within a four-month period for submission of a draft to the Council members of the Water Resources Council."

As a first step in initiating this WRC position, the five Federal departments with major water grant and loan programs (Interior, the Environmental Protection Agency, Commerce, Agriculture and the Housing and Urban Development) have prepared papers and transmitted them to WRC on the nature of their grant and loan programs, problems envisioned by coverage under a common set of principles and suggestions for resolving such problems. These departments also transmitted to WRC, administrative orders, rules and regulations, and guidelines that have been developed to date for program administration of these grants and loans. This material was used as a starting point for discussions leading to a common set of principles. On a point of clarification, COM specifically referred to coverage under a common set of principles. Ths must not be construed to mean forced coverage of all federally financed water programs under the existing WRC Principles and Standards.

It should be understood that agencies presently covered under the existing P&S are not to take this as a signal to go easy in implementing the P&S. The Council of Members in developing the position on coverage also stressed that application of the existing P&S would continue unabated during the period of rewrite.

The study also provides program cost information for 12 major purposes (grouped from 32 minor purposes) for 21 water resources regions. For example, in 1974 federal obigations for water quality management was greatest in the Middle Atlantic region and was of major significance in several of the other regions, and expenditures for rural flood damage reduction was the major program in the Lower Mississippi region.

Water Assessment and Appraisal Program

The WRC recognizes that the weak link in effective coordination of individually funded and administered Federal water and related resources programs is a working system that enables the WRC to better carry out its responsibility of policy and program appraisal as authorized, but never fully implemented, in Section 102(b) of the Act. The members of the WRC feel very strongly about this and have given top priority to development of such a system. which has been titled the Water Assessment and Appraisal Program (WAAP).

An effective WAAP will give the Executive Branch of the Federal Government, through WRC, an analytical system for the appraisal of existing and proposed water and related land programs and policies. From the output of such a program, the Council will be in a better position to make sound recommendations to the President and the Congress and serve as a guide in the allocation of federal resources to meet the water requirements of the Nation.

WAAP will build upon a hierarchy of state and regional plans as they relate to a continuing national assessment. As the regional plans (comprehensive, coordinated, joint plans—CCJP's) are developed, programs, goals and objectives for the regions or basins are outlined. Requirements for federal assistance, and relative priorities for such federal assistance, for implementing the CCJP's will be indicated. State water plans are also input to the CCJP's. At the national level, a continuing national assessment is to be developed that will determine the water requirements of the nation and the water supplies that are available to meet those requirements. Federal officials will take the outputs from the state plans and CCJP's and relate them to the National Assessment and other national products as a basis for allocating federal resources.

WRC has developed a schedule for this program. In FY 1976, (1) every river basin commission (RBC) is to define and develop a program outline for the CCJP and (2) give the WRC a "first-cut" of a priorities report. In FY 1977 RBC's are to submit revised priorities reports and "first-cuts" of CCJP's. A WRC/RBC technical task force is developing guidelines for these FY 1976 efforts.

WRC has recognized the problem associated with development of CCJP's in non-RBC areas by proposing a program for implementation of WAAP in non-RBC areas. Specific activities proposed are (a) redirection of selected ongoing studies, (b) initiation of a CCJP type activity, (c) standardized proposals for Level B studies, and (d) priority reports. However, with the limited funding that may be available for this activity, a lag in effective implementation is expected. Also, program responsibility for WAAP in non-RBC areas is a matter that will require early consideration by the WRC.

Summary

The Water Assessment and Appraisal Program and program coverage of all federally financed water planning programs under a common set of principles should result in a more highly coordinated national water program. Principles and standards are an essential element of this planning process. A basic concept in the application of these principles and standards is the equal consideration of two planning objective—national economic development and environmental quality. It is envisioned that a net result of these priority program thrusts of the WRC will be a further improved balancing of environmental and economic consideration for a broader array of water programs and projects.

Discussion

CO-CHAIRMAN EASTMAN: I have looked around quickly to see how many federal bureaucrats were applauding and I did not make a count, but certainly Steve's remarks must have opened a lot of eyes. Do you have any questions for him?

MR. JOHN BASLOSTER [Wildlife Service]: Mr. Chairman, I found that both papers presented this morning do not confront reality. I think Theodore Roosevelt, in the early 1900's recognized that most water development projects, to go forward, have to be subsidized by the Federal Government. I can talk about projects out West. They would like to spend $45 million for irrigation today on the desert area around the five county seats, which would raise the amount to $1.3 billion, with industry's cost detailed to the extent of about $400,000 a year. The farmer, the beneficiary, will take back less than 5 percent of the cost of the project.

The point I would like to make is that these are not covered by the standards authorized by the Water Resources Council and it is plainly not within the criteria of the last speaker. How do we face the reality of this situation?

MR. HANKE: I do not have any particular advice on this particular project, per se. It seems to me that you have just lost the game you are playing with that one. It would be insane economics to say it is a cost that you forget.

What I would like to reiterate is that I was not talking about a theoretical world. I was talking about the institutional structure that government is set up under right now, that in fact creates the subsidies that you have just alluded to.

I would say that unless the institutional structure is changed and more emphasis is placed on financing which is oriented towards the state and local levels with user fees and benefit taxes, you will encounter this problem again and again and again.

MR. FAIRCHILD: I think I know the project you are talking about. That particular project was evaluated and formulated before the Principles and Standards. It was considered by Congress and included in an Omnibus Bill.

I would tell you quite frankly and candidly, however, that this is the prerogative of Congress. Congress can authorize any project they see fit regardless of the environmental costs or economic benefits as a consequence of what is involved. This is part of our political process and we need to be aware of it.

Certainly, these people, to the best of their knowledge are attempting to reflect the values and the preferences of the people who elect them. If they are not doing that, surely they will certainly not be in that position for long because they will not be re-elected.

We can talk about such things as the theoretical approach. We can talk about the fact that there should not be a role for the Federal Government; that there should be total payment of 100 percent of the cost by the beneficiaries. This, basically, was the report of the National Water Commission.

I tell you, however, that if you want a dead report right now in Washington, D.C., just start building your philosophy or program on the National Water Commission Report. There is a need for pragmatism that we all have to understand and recognize in the water field. I think it is very important that we do this.

Certainly there are trends, and there are ways that things can be accomplished. This is one of the things we are trying to do on the Water Resources Council. You do not accomplish all of these overnight. I would point out that in the case of irrigation, as one example, that if the farmer is going to pay all benefits of the irrigation project, the benefit evaluation for federal irrigation projects is figured on net farm income. This is a profit. If there is not any profit, why would a farmer want to become involved in an irrigation program? Obviously, you would not have an irrigation program.

Also, we want to be careful when we talk about some conservation aspects. As a matter of fact, if we push very hard for economics the day will probably come when we have improved methodology for quantifying some of the environmental opportunities. You should be aware of this because there are many of these environmental benefits that are not quantifiable. Quantifiable benefits can be discounted by the discount rate. But if you pursue the economic theory, and we get the methodology for some of these environmental consequences, they also will be covered by future discounting of benefits.

What I am saying is there is need for pragmatism. There is certainly politics. I say these are the prerogatives of Congress. We have to do the best job we can of informing them with the Principles and Standards to show them what are the tradeoffs. But in the final analysis, they are the ones who make the decision. They are the policy makers.

Options for Financing Water Development Projects

Steve H. Hanke
The Johns Hopkins University
Baltimore, Maryland

> The greater part of such public works may easily be so managed, as to afford a particular revenue sufficient for defraying their own expense, without bringing any burden upon the general revenue of the society.
>
> Even those public works which are of such a nature that they cannot afford any revenue for maintaining themselves, but of which conveniency is nearly continued to some particular place or district, are always better maintained by local or provincial revenue, under the management of a local and provincial administration, than by the general revenue of the State . . . .
>
> The abuses which sometimes creep into the local and provincial administration of a local and provincial revenue, how enormous soever they may appear, are in reality, however, almost always very trifling, in comparison of those which commonly take place in the administration and expenditure of the revenue of a great empire. They are besides, much more easily corrected.
>
> Adam Smith, 1776, *Wealth of Nations*

It was 200 years ago, March 9, 1776, that Adam Smith published the *Wealth of Nations,* a treatise that remains the foundation for modern economic analysis. This paper examines, in the context of today's water economy, two fundamental propositions that were developed in Adam Smith's classic work:

(1) the use of and investment in water resources should be financed and administered at the state and local level, and

(2) the users of water resources should be required to finance them. It is argued that, if these policies were adopted, the efficiency and equity with which resources are allocated would be improved, and environmental values would be enhanced.

Bureaucratic Supply and Legislation Demand

To understand why resource allocation and equity would be improved if state and local governments would administer and finance water resource developments, one must understand the bureaucratic-legislative environment in which decisions are made in the public sector (see Hanke 1975). The bureaucratic-legislative environment is one in which goods are supplied by public bureaus and demanded by congressional committees working through representative government. To understand this environment and the behavior of suppliers and demanders, one must be aware of the preferences and incentives of bureaucrats and committee members.

There are three basic models in this regard. The first model is one in which bureaucrats and committee members strive for a socially optimum level of output and spending. Benefit-cost analysis and information significantly influence investment decisions. The analyst is a hero. But this is not the world in which we live. How many analysts are heroes?

The second model is one in which neither bureaucrats nor committee members strive for a socially optimum level per se. Instead, they act embarrassed when outcomes diverge from the optimum. Here, benefit-cost analysis and information, because they can improve resource allocation, prove embarrassing. Bureaucrats and legislators, however, are included to suppress sound analysis and promote "good" analysts. Although not applicable in all cases, this model has its uses. How many "good" analysts have been promoted? How many studies have been suppressed or "revised"?

The third model is one in which bureaucrats and committee members are not particularly concerned with a socially optimum level of output and spending. Moreover, they are not embarrassed when outcomes diverge from the optimum. Benefit-cost analysis and information are unimportant in this model. The analyst is superflous. This is the world in which we live. How many analysts are tokens?

If bureaucrats and committee members do not seek a socially optimum level of output and spending and are not embarrassed by divergencies from it, what are they concerned with? On the basis of William Niskanen's work (1971), one can argue that bureaucrats are most concerned with their own earnings and the discretionary budgets they control. Committee members are primarily concerned about the vote they receive from the jurisdictions they represent. Given these concerns, several hypotheses concerning bureau-supplied goods and the demand for them by committee members can be contructed.

On the supply-side of the demand-supply equation, there are five basic hypotheses concerning expected outcomes in a bureau-supplied environment:

(1) *Overspending hypothesis.* Government budgets will be too large, that is, larger than most voters would prefer.
(2) *Production inefficiency hypothesis.* Overspending will, in part, produce a given set of outputs with too many inputs.
(3) *Oversupply hypothesis.* More units of output will be produced than most voters would prefer.
(4) *Overcapitalization hypothesis.* Bureaus will use more capital-intense methods of production than private firms to produce the same output.
(5) *Bureaucratic structure hypothesis.* To protect themselves from competition with other bureaus, bureaucrats will prefer to consolidate bureaus and obtain monopoly power. Consolidated bureaus will partake of the fruits of this power by over spending, inefficiently producing, oversupplying, and overcapitializing more than if there were competition among bureaus.

William Niskanen (1975) impressively supports these hypotheses, as does the literature in the water resources field (see Ferejohn 1974 and Hanke 1973).

On the demand-side of the demand-supply equation, one must understand what motivates members of congressional committees that oversee budgets. These committees could monitor and control the bureaus that supply public outputs, thus reducing bureau biases, but congressional supervision falls short of the ideal for several reasons. One reason is that legislators want the votes of their constituents. As members of budgetary committees, they generally represent jurisdictions that have high demands (higher than most) for projects "controlled" by the committees. As a result, the committees rarely press for full control. Because the benefits of good budgetary control are spread over all the nation's taxpayers and not concentrated in any one jurisdiction, the individual legislator has little incentive to use his staff for budgetary control since most of those benefiting will be free riders residing outside his jurisdiction.

Regardless of the analytical apparatus used to evaluate programs, the bias of bureau supply and legislative demand generates too many water resource projects. This bias reaches its highest level in the federal establishment where a bureau's monoply power and the costs of controlling its budget are greatest. It is not suggested that bureaucrats are unprofessional or that members of budgetary committees are evil, only that bureaucrats and committee members, given their preferences and incentives, will not seek the socially optimum level of outputs and spending at the federal level.

To change this bureaucratic-legislative environment (reward structures) and enhance the roles of benefit-cost analysis and efficiency, more competition is recommended in providing water resource projects. Reducing the budgets of federal water agencies by 10 percent a year, gradually dismantling the federal establishment, would accomplish this goal.

State and local governments would then assume the financing of water resource projects. With more potential suppliers and demanders, under conditions of competition, a more desirable allocation of resources and a more efficient provision of water projects would result. This is not to imply that there would be no federal involvement, only that there would be no federal financing. For example, federal agencies would bid for state financing to provide states with technical assistance. Federal agencies might also act as brokers, at the states' expense, bringing states together in interbasin compacts or similar arrangements. The important point is that federal agencies would have to bid for the right to provide the states with goods and services—goods and services that the states would be required to pay for.

In this competitive environment the bureaucrats would be more efficient. Information about production efficiency would become widely available since it would be relatively easy to compare production costs per unit of output across jurisdictions. Hence, committees would more effectively monitor state and local bureaus. Knowing this, bureaucrats would be forced to adopt more efficient production techniques.

Monitoring costs would be relatively low because the geographical area would be smaller and the number of voters fewer, thus inducing more monitoring. Moreover, the free-rider problem associated with good monitoring would be less severe because the benefits of good monitoring would be visible in the legislator's own jurisdiction.

In their attempt to remain in office, state and local legislators, in contrast to federal legislators, would have to be more sensitive to the voters they represent. Because tax costs cannot be exported as easily at the state and local level, there would be a closer tie between those who benefit from public products and those who pay the costs at the state and local level. State and local legislators would also face the prospect of users moving from their service areas to others ("voting with their feet") where the package of public services and taxes is preferable.

Specific Financing Options

If state and local governments were charged with the responsibility for developing and managing water resources, the next set of issues concerns the methods for financing water resource activities. To facilitate an understanding of these issues, several functional areas (irrigation, fish and wildlife recreation) are used to illustrate methods of accomplishing sound state and local financing. (For a discussion of other functional areas, see Hanke 1972 and Hanke and Davis 1973 and 1974.)

Irrigation

The purpose of a public irrigation project is to increase productivity of land to which the irrigation water is made available. The value of farmland reflects the present discounted value of the annual income stream, resulting from the land's use. If irrigation induces an increase in net income derived from a given plot of land, the value of land increases by the present value of the prospective increment to the annual income stream.

Should a landowner begin irrigating when water becomes available, he realizes income gains as crops are sold. He also realizes capital gains, the increased value of land that is the result of claims on a potential future stream of income. In the case where a landowner declines to use irrigation water at the outset, no visible benefits accrue from the project in the form of an increased cash flow. The availability of irrigation water increases the value of the income stream which the land could potentially generate. A prospective buyer, intending to use the irrigation potential, would be willing to pay the preproject price of the land, plus the present value of the potential increment to the land's income stream. Even though a farmer may not use the available irrigation water, capital gains are realized in the form of increased land value. It is important to note that benefits of an irrigation project accrue to land which becomes potentially more productive. These benefits are primary benefits.

As productivity of agricultural land increases, with use of project-supplied irrigation water, economic activity in local urban areas increases as well. The increased agricultural productivity induces increased activity (net income) to economic units producing and handling supplies for agriculture and processing the added output resulting from irrigation. These benefits are secondary benefits.

The most desirable way in which capital costs of irrigation projects should be financed can be examined by first focusing on the most appropriate way in which to charge those receiving primary benefits for their appropriate share of the project's capital cost.

Since primary benefits are reflected in increased property values, they become prime candidates for tax base. Three variants of property tax deserve consideration:

(1) A tax based on capital gains of all potentially irrigable land (land which the project is designed to serve)—a general land tax. This alternative would place a tax on all agricultural land benefiting from the increased availability of project water;

(2) A tax only on capital gains of land using water from the project—a selective land tax. In this case, landholders using irrigation water would be subject to taxation. The tax would be based on the increment of land value resulting from use of project water; and
(3) A tax on land which is potentially irrigable and buildings on this land—a general property tax. The tax would be based on the increment in property (land and buildings) value resulting from project water availability.

Of these three, a general land tax is most desirable. Such a tax:

(1) taxes all land benefiting from the project;
(2) encourages irrigation, putting land to its "highest use;" and
(3) encourages landowners to compare project capital costs, in the form of land taxes, to project benefits, in the form of increased land values.

As described, benefits from an irrigation project accrue to land made potentially irrigable. If taxes are to be based on the value of land which benefits from the project, it is appropriate to include all land which could potentially use project water. Of the three taxes under construction, a general land tax is the only one that encompasses all potentially irrigable land.

A tax based on all land in the project area has the beneficial effect of encouraging all landowners to irrigate or shift land to its highest use, when water is made available. Under a general land tax, each landowner pays for availability of water regardless of whether he uses it. However, the "benefits" of the project, in the form of increased net income, are not realized until the land is irrigated. By requiring a landowner to pay his share of the irrigation potential, the land tax encourages the landowner to irrigate and "get his money's worth." By encouraging irrigation after project completion, the tax has an incentive effect of moving land to its most value use.

A general property tax is not only based on an increase in land value, but also improvements. Whereas the availabilty of irrigation water increases land values (productivity), it does not directly affect the value of other inputs owned by the landholder. Since benefits from public undertaking do not directly accrue to other production inputs, their increased values are not an appropriate tax base.

A general property tax which falls on capital improvements raises the cost of improvements by the amount of tax and inappropriately discourages investment. Before benefits of increased production from an irrigation project can be realized, substantial private investment is often necessary. Much of this investment is in the form of water distribution systems on private land. A general property tax effectively raises the cost of such improvements and distorts the farmers' investments away from fixed capital. The outcome is to discourage the least costly mix of farm inputs.

Secondary benefits, unlike primary benefits, do not occur "on the farm," but in urban communities adjacent to newly irrigated lands. For purposes of this paper, the urban communities receiving secondary benefits are assumed to be those in the counties served by a project. As economic activity throughout the area increases, local suppliers and processors experience increased net income. The increase in economic activity initially boasts returns to all factors of production in the urban community: land, labor and capital. These benefits represent another possible base for taxation, and could be used to finance a portion of the project's capital costs. However, due to its inelastic supply, only land enjoys increased value over time, and is an approximate tax base for secondary benefits.

In the short run, economic returns to land, labor and capital increase in urban areas experiencing secondary benefits. As returns to local labor and capital increase, they are attracted from other regions where returns are lower. The influx of these factors begins to lower the return received locally. Economic rent accruing to local inputs is short-lived, and disappears as suppliers of new labor and capital increase. The result is a greater supply of labor and capital in the urban areas than before irrigation, and a rate of return to both factors that is similar to that enjoyed by labor and capital elsewhere.

In this situation, it is land's inelastic supply that is unique. The returns to local labor and capital increase and then decline with prosperity. However, the level of income generated by urban land increases and remains at a higher level with the influx of labor and capital, since the supply of land is limited. New families need homes, and new businesses need space to operate. This increases the rents generated by urban lands in the project's area.

As is the case in the agricultural sector, the increased productivity attributable to the irrigation project results in higher land values. This increment in value reflects added productivity of urban land and provides an appropriate tax base for financing a portion of the capital costs of an irrigation project.

For capital expenditures to be economic, benefits must exceed costs. In the private sector, the investment decision is straightforward, since the evaluation of costs and benefits is reflected by prices for inputs and outputs that are observed in private markets. Depending on the method of finance, evaluation of benefits and costs in the political market can be heavily distorted (Hanke 1973). Often, public investments are financed from general tax revenues, and these taxes (costs) are raised by slightly increasing taxes in the jurisdiction. The taxes used to finance an investment are spread thinly, while benefits are concentrated. As a result, the beneficiaries reflect their preferences for projects and those paying costs have little incentive to make their desires known, resulting in uneconomic investments. This problem can be overcome by requiring beneficiaries to pay project costs through specific, instead of general, financing.

If costs of financing a project fall upon the same individuals who receive benefits, capital expenditures that are justified will receive political support. If costs are greater than prospective returns, the undertaking will be abandoned for lack of support. It is only by requiring beneficiaries to pay costs that the political market appropriately functions to screen investment opportunities.

The benefits of expanding irrigation potential accrue to individuals owning agricultural and urban land in the project area. Financing the capital portion of irrigation projects through land taxes distributes costs of the undertaking to those who benefit. If a project proposal is put to a vote, the results will accurately reveal wheather capital expenditure is appropriate.

To summarize, if results of a referendum are to accurately reflect desirability of an investment in a public irrigation system, it is important that:

(1) Both urban and agricultural land be used as the tax base. Both receive benefits. If one is excluded, land left bearing the capital cost will be

allocated a greater portion of costs than is commensurate with benefits received. Voting behavior of these landholders may not reflect overall benefit-cost ratio of the project, resulting in a level of support below an efficient level; and

(2) The cost allocation between urban and agricultural land should be in proportion to benefits they receive. For example, if 50 percent of the benefits are primary and 50 percent secondary, capital costs should be allocated equally between urban and rural landowners. If distribution of capital costs was not in proportion to benefits, voting behavior would be distorted and proper investment information would not be forthcoming.

These land taxes should be collected annually to finance local bonds (actual instruments used to finance the project), and increments in land values should be used as collateral. This has advantages over the customary practice of offering the general revenue raising capacity of a jurisdiction as security. If general taxing capacity of a community is offered as collateral for bonds, less analysis of the project on the part of potential private underwriters is required, since the community's overall taxing authority can be relied on as security. This is not the case if the increment in capital value of taxed land is offered as collateral. The collateral is narrowly based, requiring underwriters to evaluate the benefits and costs of any project before determining the attractiveness of financing it.

In order to justify expenditures, a three-stage system of checks exists under the proposed system. First, water planners conduct a local benefit-cost analysis. If a project passes, it is evaluated by private lending institutions and underwriters to see if net project benefits, reflected in increased land values that will be taxed and used as collateral, exist. If so, rural and urban landowners will be faced with a vote to weigh benefits from the project with their tax price (a tax on their land to repay bonds of a specific rating). By going through these checks, it is unlikely that projects will be constructed that are not economic.

There are two costs that should be reflected to give irrigators the incentives to make proper decisions with regard to amount of water used. The first is a computation of operating and maintenance costs associated with the project. These will vary as a function of the amount of water used and intensity with which the project is utilized. A water price or user fee per unit of water delivered can be easily calculated and charged. If an irrigator wanted more water, he would have to weigh the benefits against the user fee, to see whether the value exceeded or fell short of the cost his use imposed on the project.

The second cost is more complex. It is not a direct cost, but a cost associated with benefits (opportunity costs) foregone of using water in alternative uses. For example, water can be consumptively used by processes of evaporation and transpiration. If this occurs, water will not be returned to groundwater aquifers and regional surface waters, so that it may be used by irrigators, municipalities, industries and recreationists. Although this cost does not reflect direct cost, it does reflect foregone benefits by alternative uses of water that are displaced by irrigation. Another opportunity cost is related to water quality. Return water from irrigation projects contains suspended solids and various salts making it less suitable for alternative downstream uses.

When ground water is utilized, one must consider the opportunity cost of depletion. This factor depends on past history of the amount of water that has been pumped. The more pumped in the past, the lower will be the water table and rate at which water can be pumped, for any pumping capacity, age of equipment and delivery head. Additional pumping by one well will reduce the amount pumped by the system as a whole in later years. This involves a cost. The extra pumpage by one well necessitates a fractional increase in pumping capacity in susbsequent years, in order to avoid reduction of water available in the future. The cost of installing and operating the fractional extra capacity is part of the cost of an extra unit of water today. This complies with the concept of incremental opportunity cost, since it affects the system cost of providing more water now, given the amount to be provided in future years.

Once the incremental cost of depletion is computed, one can also place an incremental user fee, equal to the incremental cost, on the amount of water utilized in irrigation via groundwater pumping. This is essential not only for new projects that involve groundwater, but for all groundwater pumping in any region. This is due to the fact that ground and surface water must be managed together. If the irrigators, who must purchase water from newly developed surface water sources, pay the full incremental cost, but are not required to pay a "pumping" tax (user fee) for groundwater, it will mean that they will have an unwarranted incentive to extend groundwater operations relative to surface water operations. This can have detrimental effects for efficient use of water resources in a region. The principle of opportunity cost pricing, to reflect appropriate incentives, is necessary if water and land resources are to be used efficiently. In the case of groundwater depletion, a pumping tax or user fee is easy to compute and is a matter for hydrologists, engineers and economists. It is relatively easy to impose, because one can compute (given the rated capacity of pumps as well as electric bills) the quantity of groundwater being pumped by a farmer within an aquifer. With this information, a user fee per unit of water pumped can be imposed to give irrigators who are utilizing groundwater appropriate incentive to conserve it.

The revenues derived from these opportunity cost based fees (as opposed to those based on out-of-pocket costs) should be earmarked for management of a regions's water resources.

Irrigators should be charged user fees that reflect the relevant incremental cost of water that they use. When this occurs, farmers have appropriate signals for efficient water use. For example, if user fees are less than the relevant incremental cost, which are $15 per unit of water, farmers who have productivity per unit of water of $10 would choose to use another unit of water. This would create a net loss of $5 to the region, in terms of the value of their alternative uses of water in the locale. If farmers were charged $15 per unit of water, they would continue to apply water up to the point where its productivity in agriculture was equal to $15, which is equal to its productivity in alternative uses. By making appropriate user fee charges, one can guarantee that the incremental benefits in all forms of water use are equated which results in total value of water within a region being maximized.

A system of finance for irrigation projects showing merit includes the following elements:

(1) a general land tax on rural and urban land in the project area, to cover capital costs;
(2) an incremental commodity charge, to cover operating and maintenance costs; and
(3) user fees, to reflect opportunity costs of using water for irrigation.

Fish and Wildlife

Use of fish and wildlife services offered on wetlands, estuaries and other water areas presents problems of both user exclusion for those unwilling to pay a price and user identification of beneficiaries of the service. Administrative costs are so high that they limit possibilities for pricing much of the output from fish and wildlife habitats, a result of the nature of the resource and its uses. This fact creates significant difficulties with respect to attainment of efficiency and equity.

Fish, birds and mammals are mobile animals spending their life (or at least annual) cycles in several different areas. Waterfowl nest in small intermittent potholes, rear their broods in larger potholes, and are hunted, photographed and watched for enjoyment hundreds of miles from breeding areas. Under these circumstances, it is difficult to contrive a transaction between beneficiary and producer that ties compensation to the breeding area.

Hunting and fishing licenses and fees on public wildlife areas are generally accepted and should extend to all shelters. State fish and game departments have incentives to set license and user fees at proper levels and to direct revenues into productive areas. This is the result of the fact that these departments have incentives to maximize the difference between revenues (licenses and fees) and out-of-pocket cost. Under these conditions, user fees will be set appropriately. If they are too high, evasions of payment will become a problem and enforcement costs will rise; therefore; reducing the net for the departments. If they are too low, the reverse will occur.

The investments by game departments to improve habitats will probably be optimal, since the demand for licenses is highly correlated with quality of fish and wildlife services. Investments will tend to be directed toward those activities with highest productivity, so that demands (user fees and license revenues) are maximized for a given expenditure. Again, maximizing the net yield to the department.

Sole reliance upon hunting and fishing licenses and user fees will not solve the problem of fish and wildlife services. Opportunities to enjoy wildlife are so widespread, that it is difficult to imagine an enforceable licensing system for photographers, bird watchers and casual observers.

Two possibilities for augmenting the financing of fish and wildlife services beyond licenses and user fees are justified under these circumstances. First, complementary goods to fish and wildlife services, such as camping and outdoor equipment, could be taxed by a specific excise tax. This would tap some beneficiaries who do not hunt or fish, but who enjoy fish and wildlife services. A small portion of a state's gas taxes might also be used for financing of fish and wildlife services. Since one has to drive to partake in this activity, there is a loose connection between those who consume gas and those who enjoy wildlife. People who do not hunt, fish or camp enjoy fish and wildlife in an indirect way by observing them from automobiles.

Because fish and wildlife habitat produces goods and services for which rent is not collected, the owners of these resources consider them of no economic value. Given an opportunity, people convert these lands into a paying form of use. The operation of market forces encourages conversion of fish and wildlife habitat into other more profitable uses. Filling or draining swamps, estuaries and other wetlands for agricultural, industrial, commercial and residential uses has been rapidly progressing. These facts justify the use of a portion of funds generated by specific excise taxes on gas and goods that complement fish and wildlife, to encourage private landowners to maintain habitats. This could be accomplished by a direct subsidy for maintaining habitat or the indirect incentive of property tax relief on lands retained for habitat.

Recreation

As with other public investments, financing of recreation facilities poses two problems. First, the issue of setting a price, when feasible, to reflect incremental opportunity cost associated with that activity. By doing this, use of facilities is rationed to the highest valued users and benefits derived from its utilization are maximized. The second issue concerns generating enough revenue to cover the cost of a facility. Two situations exist with recreation facilities that require different modes of finance. If a recreation facility is not congested (where congestion is defined as use beyond the designed capacity), one does not have to ration capacity to obtain highest and best use of parks. Net benefits will continue to rise as use increases up to the point of congestion. In the uncongested case, faced with a situation in which user fees detract from efficiency, other revenue sources may provide funds for the facility. Annual license fees provide an efficient or equitable way of financing the cost, since they require users of state-owned and managed recreation facilities to pay for them. Although not as efficient or equitable, specific excise taxes on recreation and camping equipment might also be utilized as there is a loose connection between those who use recreation facilities and those who purchase recreation and camping equipment.

In addition to license fees and perhaps an excise tax for the finance of a portion of all areas, congested recreation areas should utilize user fees to ration use and equate supply with demand. Utilization of user fees not only rations use to the highest valued users but gives signals to recreation planners for investment planning. If revenues produced by user fees which equate supply with demand generate significant surpluses, this will signal planners that facility expansion is warranted.

It is recommended that financing of recreation facilities, owned in part or operated by state and local governments, be accomplished by a two-part system. The first would involve purchase of an annual license permitting the recreationist to use any facilities within the state. The second would be a user fee to equate supply and demand where recreation facilities were congested. These mechanisms would lead to efficiency of utilization of existing facilities and would help to generate signals that would aid planners in developing investment plans for additional facilites. These mechanisms also have the advantage of being equitable in the sense that beneficiaries of recreation facilities would be required to finance them.

Conclusions

Currently, the institutions that manage and develop water resources are located in Washington, D.C. The bureaucratic-legislative environments in which decisions are made create an excessive supply of water resources projects, that are inefficiently used at the expense of environmental values. It has been argued that water resources developments and management at the federal level should gradually be phased out. Following the lead of Adam Smith, which was articulated 200 years ago, it was proposed that state and local governments manage and finance, by user fees and benefit taxes, water resource activities. Specific examples from irrigation, fish and wildlife, and recreation were developed to illustrate the exact nature of these proposals, and how efficiency and equity would be improved by switching to the proposed financing options.

In light of these proposals, it is particularly noteworthy that environmentalists are quick to point out the inefficient incentives created by current financing mechanisms in areas such as irrigation. In fact, most would applaud the analysis of the bureaucratic-legislative environment, and the recommended policy changes for financing irrigation projects presented in this paper. However, many environmentalists fail, when it comes to their own portion of the pork barrel, to accept the principles developed here. Only when this oversight is corrected, will their proposals for reform gain the political attention they deserve. It is then that we might expect to see some movement toward the world of Adam Smith.

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Environmental Objectives and Water Quality Control Programs

William Whipple, Jr.
Director, Water Resources Research Institute
Rutgers University, New Brunswick, New Jersey

For about a decade now, influential exponents of environmental interests have led a powerful crusade against pollution - a crusade which mobilized overwhelming political support, and which resulted in impressive accomplishments. There is no doubt that so far these accomplishments have been moving in the right direction. Nonetheless, my studies of water pollution and of environmental impacts have convinced me, and I hope that I can convince you, that a change of concept would be more useful for the next decade, that is, more useful to the nation as a whole, and also more effective in the protection of ecological or other environmental interests.

In order to explain my viewpoint on water quality control, I would like to ask you to recall what the ultimate objective of it is, not legally, but in physical and biological terms. Of course, the U.S. Water Resources Council (1973) in its famous "Principles . . . . " has the official answer: all water resources planning should be aiming at the two multiple objectives of economic efficiency and environmental quality. As far as the water quality program is concerned, it is quite clear that the main objective is environmental quality. The only real difficulty here is that there are two aspects of environmental quality, which are sometimes incompatible, namely, the preservation of natural ecosystems and the preservation or improvement of water and adjacent land for man's enjoyment. On land, the incompatibility is often acute. Park recreation facilities generally require space entirely separate from areas reserved for wildlife in a natural habitat. However, for a water quality control program, the differences between the two objectives are less acute, since both require reasonably pure water in the streams. Of course, the coliform count and the presence of jellyfish require to be given much more attention for certain recreational uses (e.g. bathing) while heavy metals in sediments are much more damaging to natural ecosystems, particularly filter-feeding benthal fauna. But water supporting a healthy fish population is also usually required for recreational purposes, and there is a considerable similarity in requirements designed to meet the two environmental viewpoints.

Moreover, a properly conducted planning process can determine what the basic environmental objective should be for any given area. For the Salmon River in Idaho, there is no doubt that preservation of natural species and the wilderness may have absolute priority; but for the Delaware Estuary and the New York Bight, the preservation of recreational amenities for nearby urban populations is of at least equal importance. To define the details of dual-aspect environmental goals may require some study, but in either kind of area the outlining of desired water quality is quite feasible. Legally it has already been done for all states, although in view of recent knowledge, a closer definition covering more types of pollutants would be desirable.

You may be thinking by now, "But this is all obvious!" If so, you have missed my point. The fact is that under present law and practice, most of the water quality decisions made are not being aimed directly towards this sort of environmental goal, but towards the "surrogate objective" of controlling point source pollution. You may think that this amounts to the same thing in the end; but let us consider whether or not this is so.

To put my concept in somewhat different terms, there are two ways of going about the nation's program of water quality control. The approach adopted so far under PL 92-500 is to fight pollution; in practice, this means to control the pollution coming from point sources of industrial wastewater and municipal sewage. This approach mandates treatment of wastes to "best practicable" or "best available" standards; but control of heavy metals or of hydrocarbons is not included. There is some talk about also controlling urban runoff and unrecorded wastes; but so far although such aspects are to be considered in areawide planning, there is now no federal support for implementing any such programs, and no indication that there will ever be any support under the present law.

By 1985 the law suggests a goal of "zero-discharge," the elimination of all pollution from wastewater discharges. This is completely unworkable, and EPA has made no preparations to incorporate any such provisions in its planning. No one pretends any longer that there is any real intention of moving to "zero discharge." If any of you have believed that this provision of the law was being taken seriously, I'm sorry to disillusion you. The real questions involve the 1977 and 1983 goals, and particularly their application uniformly across the country.

As I am sure you know, the National Commission on Water Quality (NCWQ) has been reviewing the present pollution control program and is charged by law with recommending any changes to be made. Although the Commission has not yet decided what recommendations to make, the commission staff has been allowed to publish in draft form the results of exhaustive commission studies and consultants' reports,[1] which provides a far better basis for analyzing the impact of the present law than has previously been available.

Taking first the publicly-owned works, the NCWQ staff estimates a Federal outlay of $118.5 billion (without inflation) to contribute towards construction of waste treatment plants, and collector and interceptor sewers, to meet both the 1977 and 1983[2] goals of the 1972 Act. The non-federal cost would be one-third more, or $39.6 billion. At the same time, the industrial treatment plant costs would be a minimum of $74.7 billion more to meet the "best available" treatment goal of 1983.[3] These are only the capital costs. In addition operations and maintenance costs for publicly owned and industrial plants would increase by a total of $15 billion annually from what they are today.

Of course you realize that it is entirely infeasible to obtain federal grant appropriations for EPA amounting to $118 billion by 1983. But supposing that it were, and that the entire program could be completed, what results would be achieved?

[1]National Commission on Water Quality, "Staff Draft Report." Nov. 1975.

[2]The 1977 goals are interpreted to require practically the same outlay.

[3]$44.3 billion to meet the 1977 goals, plus $30.6 to 36.9 billion more to meet the 1983 goals.

According to the NCWQ staff, again the best and most objective source we have for nation-wide estimates, the most important results would be the improvement of dissolved oxygen levels in our presently polluted streams.

Carrying out the 1977 program would improve "nearly half" of the water now showing levels of dissolved oxygen below 4 mg/1, sufficiently to meet that standard. Completing the full 1983 program would make some further improvement. Over-all, the 1983 program would result in restoring a desirable sport fishery to from 30 to 50 percent of areas where it does not now exist. In other words 50 to 70 percent of waters where sport fishery is presently denied by pollution would still be so denied after completion of the 1983 goals.

The 1983 program goals would be relatively ineffective in remedying pollution by toxics and "pulse loads" due to storm runoff. There would be little improvement over present conditions as regards total or fecal coliform counts, since for 70 percent of the sites studied, coliform counts are little affected by point source control or treatment requirement. There would be no major change in sediment problems. The extent to which the program would contribute to control of heavy metals pollution is unknown. The chlorination of municipal effluents to reduce coliform counts, if continued as at present, "can adversely affect aquatic organisms."

When it is considered that this would be the complete result of a program estimated to cost the United States an additional $232 billion in capital costs, plus an additional $15 million annually in operations and maintenance costs, I think that it is high time to ask whether or not some more effective program cannot be developed, which would go further to meet our national environmental objectives without requiring all of this immense investment in treatment plants, materials and energy.

But first let us consider what else would be required to completely achieve the fishable, swimmable waters nationwide which the 1983 goals were supposed to have provided for us. In the first place, the nation's combined sewers would have to be cleared up and their polluting discharges treated. This would cost $79.6 billion.[4] A program of detaining urban runoff temporarily followed by removal of suspended solids and disinfection (no other treatment), would cost $199 billion. The cost of changing the present system of disinfection by chlorine to a much more expensive alternative, probably ozonation, has not even been estimated. Nor has there been any estimate of the cost of disposing of all the additional sludge created by the treatment programs, which is estimated to rise from 4.7 million tons (dry weight) in 1972 to 16 million tons in 1990, or 20 million tons if urban runoff is included. (To urbanized areas such as the middle Atlantic states, which find it very difficult to dispose of present volumes of sludge, the prospect of increasing it five fold would be something of a nightmare.)

These estimates are fantastic. The mind boggles at the thought of such burdens being placed on a nation which is economically not as strong as we once thought we were. Yet they come from a well financed and objective study, with supervision by a commission including such stout protagonists of environmental

[4]This program provides primary treatment of outflows to effluent limited waters and secondary treatment for water quality limited waters.

protection as Senator Muskie and Congressman Bob Jones. I am not leading you to draw the conclusion we cannot afford to have a clean environment, but rather that we cannot afford to go after water quality control by the approach used to generate these estimates. What is wrong with the figures, what accounts for the fantastic totals, is that they represent the application across-the-board (and across the nation) without considering the circumstances of each basin and the most economical solution to environmental problems. Unfortunately, the 1972 Act calls for the specified approach to be applied uniformly and arbitrarily. It calls for planning, but the key decisions are made in advance before the planning is done. In practice the EPA may ease treatments requirements in certain cases where rigid application would be unreasonable; but the law does not provide for varying the degree of treatment depending upon the conditions in any given stream or estuary; and it is not satisfactory to have to rely upon administrative deviations from the language of the Act to provide the needed solutions.

I would like to tell you a little more about the so-called nonpoint sources of pollution, some of which are huge pipes you could drive a truck through. My associates and I have been studying them for about eight years now. In metropolitan area streams, we usually find that once the stage of secondary treatment has been reached, at least half of the organic pollution remaining comes from sources other than the treatment plant effluents. As regards nutrients, coliform counts, and sediment, even higher proportions of pollutants usually come from nonpoint sources. Also a great deal of heavy metals pollution comes from storm runoff from municipal and industrial areas. As you know, the original assumption of sanitary engineers was that treatment of municipal sewage and industrial wastewaters would solve the pollution problem. We now know that this is only the first stage in the battle. Where does the remaining pollution come from? Obviously a major part comes from dirt and dust which accumulates on streets and a lot from combined sewer overflows. Also agricultural activities such as poultry farms and cattle feed lots are major contributors. In the West, irrigation return flows often add great loads of salt and other minerals. However, a great deal of the urban "runoff" pollution comes from leakage from sanitary land fills and previous sewer systems, and a multitude of minor dumpings and disposals of polluted materials from small industrial, commercial and individual sources. Some of this material goes into storm drains; but a lot of it is flushed or seeps into minor tributaries or gulleys and swales, from which it is washed down when it rains. Many small industries (and some large) have established routines for storing objectionable wastes and releasing them when it rains. These minor sources slip through the net of the NPDES permit system, or simply cannot be caught because the monitoring is done much too infrequently. I have two sets of data, obtained entirely accidentally in the course of research operations, which clearly indicate that dumping occurred. In one case, the time of the dump can be indicated almost exactly.

The hydrocarbon pollution situation is a particularly interesting one. Rutgers University has been working for two years jointly with the Philadelphia Academy of Natural Sciences on a program of investigating petroleum pollution in the Delaware Estuary.[5] Petroleum pollution has not been much studied previously,

[5]An NSF-RANN project. The author is project director; Dr. Ruth Patrick of the Academy of Natural Sciences of Philadelphia, is principal scientist. Results cited are from the research of Drs. Haskin, Hunter and Scheier.

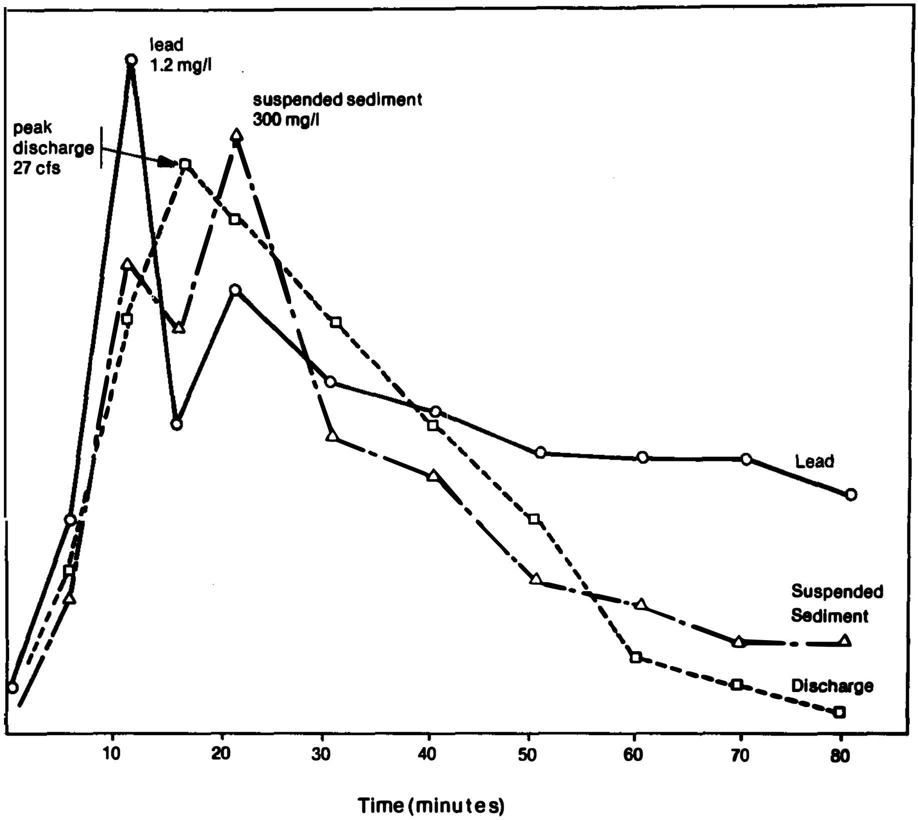

Figure 1. Typical rainfall event discharge and pollution concentrations.

because the chemistry of hydrocarbons is extremely complex. Various petroleums and their components have tremendous differences in their toxicity to different species. Some of them are toxic in quantities of only a few parts per billion, especially to certain stages of the life cycle of oysters, fish and bottom fauna. The oyster larvae for example are extremely vulnerable. Adult oysters seem fairly resistant to soluble extracts of petroleum; but, when the petroleum is absorbed on clays, the mortality is quite heavy. Given these facts, what should be the attitude of ecologists towards a proposal made last year to tighten up the standard of petroleum refining effluents from 10 mg/l of oil and grease to 1 mg/l? I am sure that your first reaction will be a vigorous affirmative. But there are quite a few other things to take into consideration before an informed decision can be made.

The present standard limiting oil and grease in petroleum refinery effluents to approximately 10 mg/l, as embodied in NPDES permits of EPA, will reduce the effluent waste load of the seven oil refineries in the Delaware Estuary from an original level of 26,000 lbs daily to a maximum of 2000 lbs a day. However, other types of industry are not so closely controlled. One single industrial plant now operating will release 5000 lbs of oil and grease a day even after fulfilling its

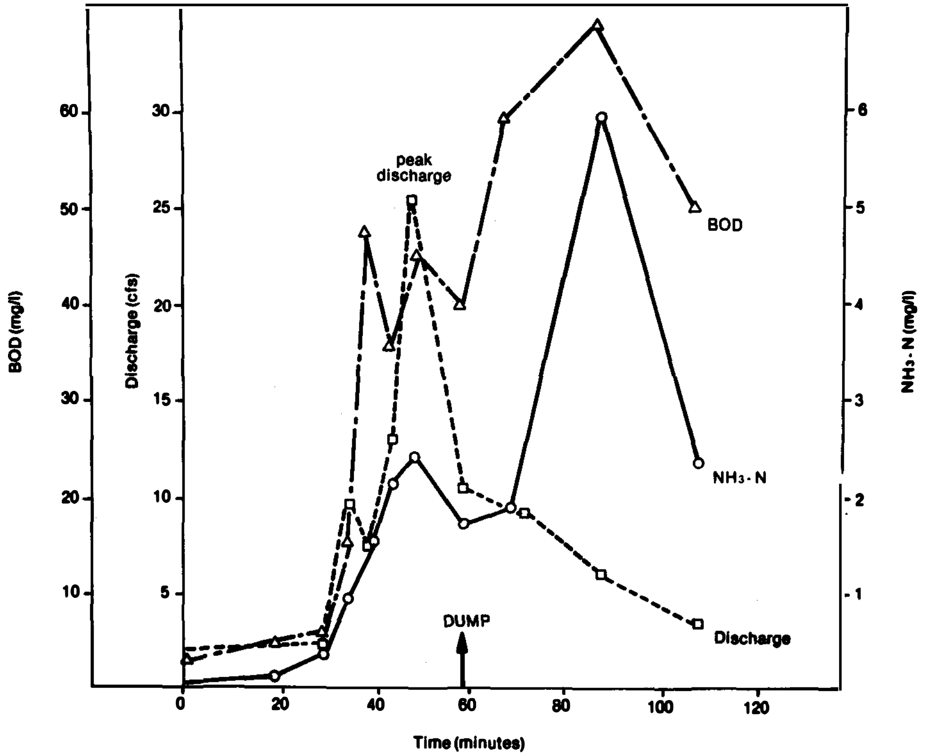

Figure 2. Rainfall event discharge and pollution concentrations with dumping.

permit requirements. Another large industry will produce oil and grease which is evaluated at 48,000 lbs a day by applying one technical standard of measurement and only 2000 lbs a day by applying another equally applicable technical standard, a situation which virtually cries out for scientific investigation. Moreover, urban runoff from a relatively clean section of North Philadelphia, without combined sewers, is found to have a mean petroleum content of 3 mg/1, and a Trenton, N.J., downtown section has even more. If the 3 mg/1 is accepted as typical of urban runoff, the mean output of petroleum from urban areas tributary to the Delaware Estuary would be 10,000 lbs daily. But there are still other environmental hazards involved. The municipal wastewaters from Trenton, Philadelphia, Camden and Wilmington all contain hydrocarbons, in amounts which are unknown but are believed to be substantial. Much of this waste is given only primary treatment, but all of it is chlorinated. It is very probable that toxic and persistent chlorinated hydrocarbons are produced by this process. This is not only environmentally hazardous to fish and shellfish, but some of this chlorinated wastewater, possibly containing carcinogenic materials, flows down to Philadelphia's Torresdale water supply intake a few miles below. As far as I am concerned, before I suggest that the oil companies change further the treatment methods which they are now implementing, I want to evaluate fully the other sources of hydrocarbons, and also to test the toxicity of hydrocarbons from each source. It may turn out to be more urgent, more economical, and environmentally more important to first go after the other industries, to try to cut off the dumping of used oil into small tributaries and storm drains, and to check up on the chlorination of petroleum-containing urban wastewaters by the cities concerned. This is not just talk. Ruth Patrick and I are conducting research to obtain more information and by next year we will know a lot more about this situation. My basic point is that an arbitrary lowering of the boom on the most obvious and politically vulnerable target is not a very intelligent approach if what you are really after is to improve the quality of water.

I will here allude briefly to the sordid question of money, of the costs of pollution control programs. Some people seem to think that federal money is almost free, and that money spent by industry for pollution control is not a charge on the public. If you will pardon my blunt language, such attitudes are sheer prejudice, which are costly to the nation. We all of us pay taxes to contribute to federal expenses; and if an oil company has to spend millions of dollars more annually for some environmental purpose, the cost of heating oil, electricity and gasoline to the public will rise another notch. If we really want to obtain the maximum protection to the environment, we had better set out our objectives in clear language and then look hard for what are the lowest costs to society of obtaining them.

What might such an approach mean on the Delaware? A petroleum loading objective for the Delaware Estuary would set an overall limit of so many thousand pounds a day of hydrocarbons from all sources, with more specific limits (in parts per billion) of certain toxic components such as phenols and chlorinated hydrocarbons, sampled particularly at the head of the Delaware Bay

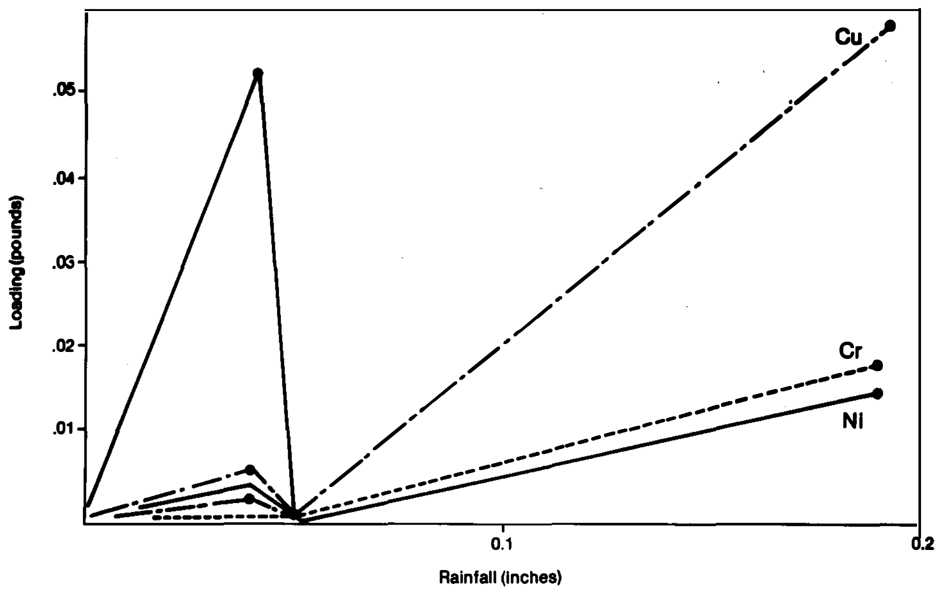

Figure 3. Aggregate heavy metals loadings for rainfall events of different magnitudes, one with dumping.

(the major industries and cities are all above this point). Then analyses and cost estimates would be made to examine what limitations might be placed upon what sources in order to meet such a standard. It might well be that refineries in one part of the estuary would be much more dangerous environmentally than in other parts. There would certainly be other industrial facilities more urgent to give attention to, for the purpose of reducing oil and grease waste load allocations, than the oil refineries. A campaign to insure controlled disposition of used crankcase and industrial oil might well be more effective in reducing hydrocarbons in the estuary than any further control of effluents. It would almost certainly be found that chlorination of effluents would be more or less damaging depending upon location, i.e. - distance above the oyster spawning grounds, or location above the water supply intake. In fact, chlorination of effluents might have to be changed for ozonation at all points.

I would particularly like to stress that there is absolutely no reason to assume that any source of pollution will do the same harm regardless of where it is located. Of course, gross pollution is environmentally damaging anywhere. I know of no part of the United States where gross pollution should be permitted; but as regards levels of treatment above secondary, it seems to me such proposals should be carefully considered, and only carried out when required to meet an environmental objective, after consideration of the alternatives which might achieve the desired results at less cost.

Some of you may feel that the crusading spirit which motivated passage of PL 92-500, which has admittedly accomplished a great deal, is a sufficient guide to the future. Personally I read the future a different way. Protection of the environment is still a valued public objective; but in the present state of the economy the provision of jobs and social services for the poor and disadvantaged, the limiting of inflation, and the provision of adequate energy supplies are coming more and more to the front. Politically, environmental quality is no longer automatically the preferred position; various tradeoffs must now be considered. There is a pendulum swing back the other way, and you cannot allow it to gather too much momentum. If you are wise, you will make it easier for the nation to continue to support your program by encouraging planning approaches and research which reduce the costs of achieving environmental goals to the public, and spend the available money more effectively. Instead of automatic nationwide standards of treatment, we should have regional standards of water quality; but these standards should then be planned for and enforced. In the end, this approach will give us the water quality we want, at costs the nation can afford.

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Discussion

MS. ANDREA WARD: Mr. Chairman, I would like to know if you are aware of the specific variation in the style of waste water treatment which has been suggested be changed from chlorination?

MR. WHIPPLE: Are you alluding to ozonation for disinfectant purposes?

MS. WARD: Yes.

MR. WHIPPLE: The difficulty here, one of the many difficulties, is that municipal effluents and surface water runoff both contain appreciable amounts of hydrocarbons. We have been doing studies. We find that the ordinary runoff from urban residential areas has from 2 to 3 milligrams of hydrocarbons on the average.

We have not yet measured the hydrocarbons in municipal effluents. We all start on it this summer. We know, from previous knowledge, that there are hydrocarbons in municipal effluents. In the City of Trenton, after the water is chlorinated, just a few miles down the stream is the intake to the Philadelphia Water Supply Plant. Some of these chlorinated hydrocarbons are carcinogenic and should not go into anybody's water supply. Some of the others are among the most dangerous toxics for such things as shrimp larvae.

Ozonation is the process most used in Europe as the alternative to chlorination, but we are not absolutely sure what ozonation does to these waters, either and it is considerably more expensive. So I am not in the position of recommending exactly what to do.

EPA has withdrawn their absolute requirement that municipal waters be chlorinated. The situation is still there, but now each state has to decide for itself what to do. Most of them have continued what they were already doing, which is to chlorinate because they do not know what else to do.

This is just one of the many, many problems in the pollution control field where it is absolutely imperative that a great deal of knowledge be obtained in a short space of time. The main consideration is the specifics of environmental consequences, both on man and on ecosystems, of the chlorination of these effluents.

CO-CHAIRMAN EASTMAN: I might just add one remark before your next question. Mr. Whipple referred to the National Commission on Water Quality Staff Report, and the conclusions and recommendations that are pending. In connection with his earlier remarks I have the advantage or disadvantage of living in the Washington Metropolitan area, and I know the Commission's conclusions and recommendations were transmitted to the Congress on March 18th.

MS. WARD: Mr. Whipple, I would like to have you give us a little idea concerning the time issue. What is your judgment concerning the chances of Congress acting in the direction of treating these other points, rather than just the one-point type of approach?

What is the potential for timely action under the Section 208 activities in meeting any kind of deadline within the reasonable future?

MR. WHIPPLE: I cannot tell you what the prospects are for getting further action from Congress on the question of the non-point sources. I would suspect, however, in view of the great costs involved, they would be rather slow to authorize it, simply because there has been totally inadequate study and research done in this direction.

This has been, unfortunately, a "tunnel vision" approach on the pollution of wastes. The very well-designed effort to get this point source pollution controlled has been such that they have neglected some of the other activities which I think erroneously are considered peripheral. They are not peripheral, they are extremely important. I do not think Congress has been briefed and has adequate information to know what to do, because any general program that you would put together for nationwide application, as far as I am concerned, would be totally inadequate.

The only thing I can see is that each of these situations appears to differ tremendously from the others, and I cannot think of anything better than to go into each area and study it very hard and try to find what the best solution is without preconceived rules that bind you to any one set of actions.

The other question, which is related, concerns the area-wide waste water studies under Section 208. The original deadline for area-wide waste water studies, which have just been started, was two years. A great deal of preparatory work, however, is required in setting up the studies because in most cases absolutely no data have been taken on non-point sources. So the data gathering has to be in there. Very lengthy processes of coordination of the final result and public participation are also required, and this will take perhaps eight or nine months in the latter part of the two-year period.

So the original two-year period, in my opinion, was completely unrealistic as specified by Congress. EPA is now making some extensions. In general, however, the studies for which $160 million was appropriated for EPA, are being conducted in too short a time.

Lastly, there was no previous data gathering on nonpoint sources, including urban areas except in very small parts of the United States. Unfortunately the Section 208 studies are not going to bring us, in most cases, much of the analysis, which we need. These questions I think are going to require a second generation of studies to do what the 208 studies should have done, and would have done, if they had more time and more preparation before they were undertaken.

Assuring Ecological Integrity in Water Developments

John Cairns, Jr. and Kenneth L. Dickson
Biology Department and Center for Environmental Studies,
Virginia Polytechnic Institute and State University,
Blacksburg

Introducing anything into a water ecosystem incurs an element of risk—particularly when this material, such as an industrial waste, may contain components alien to the ecosystem. Except for compounds which undergo biological magnification, there is a substantial body of circumstantial evidence that indicates most wastes at proper concentrations may be introduced into water ecosystems without significant damage. Further, many of these wastes may be transformed into less harmful and perhaps even useful material. If no effect from a potentially toxic material discharged into a water ecosystem is detected, one is always vulnerable to the charge that the tests were not sophisticated enough, the wrong parameters were measured, the tests were not carried out for a sufficient period of time, or that tests were analytically inadequate. This is merely a variation of the "more research is needed" theme that has been used by ecologists for years to avoid the consequences of making a prediction which might prove damaging to their careers. Although ecologists who fail to give advice to industry and planners other than "don't do anything" may have saved their professional reputations, their impact on decision making—other than a few successful delaying actions—has been very small. Instead of being distracted by the white hat-black hat argument over whether assimilative capacity does or does not exist, the academic community might well address the task of developing a protocol which would enable decision makers to estimate the risk of discharging a particular waste into a particular water ecosystem. One can also estimate the impact of non-point source discharges, but with more difficulty due to their cyclic nature and mechanisms of dispersion. Site specific analyses may be unpalatable to administrators and legislators who would prefer a uniform water quality standard for the entire country; however, this simplistic approach would be no more successful for the diverse water ecosystems existing in continental United States than would a recommendation from the U. S. Department of Agriculture for a single fertilizer application rate for all soils in the United States.

A necessary sequel to the risk analysis is an ecological monitoring program consisting of biological, chemical, and physical data gathering. This would enable ecologists and others to check the validity of the predictions and to generate the necessary feedback of information to make effective corrections and alterations in the models developed. This information will also tend to reduce ecological catastrophes and would provide an earlier warning than has been possible in the past when the catastrophes were announced by dead fish, massive algal blooms, and other symptoms of ecosystem dysfunction.

This paper is divided into two major sections. The first is a simplified risk analysis subdivided into three components: (1) an estimate of ecosystem inertia (the ability to resist structural and functional displacement); (2) a means of estimating ecosystem elasticity (the ability to snap back after displacement); and (3) a determination of ecosystem resilience (the number of times an ecosystem can snap back after displacement). The second section is devoted to a biological assessment program consisting of: (1) an ecological inventory or baseline of chemical, physical, and biological conditions both before and after waste material is placed into the receiving system; and (2) an ecological monitoring program consisting of biological, physical, and chemical monitoring designed to give an early warning of ecosystem dysfunction or the threat of ecosystem dysfunction. These discussions are necessarily limited because of space, but additional references are provided for those wishing further details on the points of view expressed in this paper. There has been no attempt to present a literature review or include other points of view due to space limitations.

Simplified Risk Analysis

Inertia or Ability to Resist Displacement of Structure and Function

Inertia can be defined as the ability of an aquatic community or ecosystem to resist displacement or disequilibrium in regards to either structure or function. This is an ecological statement of assimilative capacity which is broader than the engineering definition. Assimilative capacity is not constant and will change both regionally and seasonally. The factors influencing inertia are listed in order of importance in this discussion. This rank ordering is substantially less scientifically justifiable than is the recovery index which follows. However, it seems clear that the factors are interacting and the justification for multiplying the ratings is considerably stronger than for the rank ordering. The time element is exceedingly difficult to address when evaluating inertia because there may be a substantial lag between the onset of stress and the subsequent symptoms of displacement recognizable to ecologists. Therefore, one should view this index with considerably more caution than the recovery index which is only used following recognizable displacement.

Although time lag and displacements removed from the onset of stress are a serious problem, they are not as hopeless as they might at first appear. One can make estimates of the probability of effects not surfacing initially by going through the protocol outlined in *Principals for Evaluating Chemicals in the Environment* (National Academy of Sciences 1975). Such procedures would, with some modification of the methodologies, enable one to categorize other stresses and estimate the probability of a lag response. A brief discussion of the primary factors producing inertia follows:

a. Indigenous organisms accustomed to highly variable environmental conditions. Rating system: 1 - poor; 2 - moderate; 3 - good.

One would intuitively expect organisms in an estuary, certain deserts, and other environments where temperature and other environmental conditions may shift rapidly, to have developed various physiological, behavioral, and structural capabilities for resisting the deleterious effects of these stresses. Some, but not all, of these mechanisms (such as the ability of a clam to isolate itself from the environment for brief intervals) provide protection against both naturally occurring stresses and those induced by human activities. While it is highly unlikely that one would be able to categorize every organism within a system in regard to its tolerance of highly variable environmental conditions, a person knowledgeable about the system should be able to make a sound estimate of the degree of resistance to changing conditions for the majority of indigenous organisms.

b. System has high structural and functional rendundancy. Rating system: 1 - poor; 2 - moderate; 3 - good.

As Odum (1969) has shown, early stages of ecosystems evolution are relatively simple systems, and as a consequence, have relatively low functional redundancy. That is, the loss of a particular species might well mean the loss of a particular trophic level or function because no other species capable of fulfilling this role is present. On the other hand, a mature system with great complexity, and one in which the fractionation of activities and roles is substantial, is likely to have a high functional redundancy. This minimizes the impact of the loss of a single species; although the exact role or function may not be entirely replaced or taken over by other species present, a substantial portion may be. A system with a high functional redundancy should, therefore, be less vulnerable to a loss of a single component than one with low functional redundancy. Therefore, it should be better able to resist displacement of both structure and function.

c. Stream order, flow dependability, turbulent diffusivity, and flushing capacity. Rating system: 1 - poor; 2 - moderate; 3 - good.

These characteristics essentially have to do with the volume of water available for dilution, the rapidity with which a waste or other form of stress would be dissipated, and the rate at which it would be removed from the system. A system in which these characteristics are very dependable would be less vulnerable to structural or functional displacement than one which periodically has substantial losses or reductions in one or more of these characteristics. In considering these characteristics in relation to the inertial stability of a system, one should not lose sight of the fact that wastes which are not degraded or transformed, but are merely mixed and carried away, will have an impact elsewhere. Those that are degraded and transformed may also have an impact, but most probably a lesser one.

d. Hard, well-buffered water antagonistic to toxic substances. Rating system: 1 - poor; 2 - moderate; 3 - good.

The literature on water pollution is replete with illustrations of alterations of the impact of toxic chemicals to aquatic organisms due to differences in water quality such as hardness, pH, temperature, and so on. Some hard, well-buffered waters may substantially reduce the impact of many toxic materials; whereas, very soft, well-buffered waters may not. With some knowledge of the causative factors of pollutional stress, one should be able to estimate whether or not water quality will significantly affect the toxicity or dose-response curve. In addition to utilizing the literature for this purpose, it is always well to carry out the site-specific tests with indigenous organisms which also will enable one to define the relationship between the organisms, water quality, and dose-response curve to a particular pollutional stress.

e. System close to a major ecological transitional threshold (e.g., from a cold to a warm water fishery). Rating system: 1 - close; 2 - moderate margin of safety; 3 - substantial margin of safety.

Considering thermal loading, one might say with reasonable confidence that the Columbia River is closer to a major transitional temperature threshold (which might cause the loss of salmonid fisheries) than the Savannah River (which would cause the loss of the channel catfish, bass, and other organisms characteristic of that system). Long-term continuing studies are necessary to estimate when a system is beginning to approach a major transitional threshold; consequently, for those systems where such studies do not exist, such an estimate will be extraordinarily difficult. Even when data does exist, the task will not be easy.

f. Presence of a drainage basin management group with a water quality monitoring program. Rating system: 1 - none; 2 - weak organization; 3 - strong organization.

The river basin management group can protect against displacement or disequilibrium in two primary ways: (1) Ongoing studies which will enable the investigators and decision makers to know when a major ecological transitional threshold is being approached; and, (2) the development and maintenance of an environmental quality control system with rapid information feedback to detect the onset of a pollutional stress which might cause displacement or equilibrium (Cairns et al. 1970; Cairns 1972).

In order to be effective, this management group would, of course, have to possess the capability of taking immediate remedial action, either before the waste enters the receiving system, or, if it has already entered, of taking appropriate measures to reduce the impact upon the system. For loadings, long-term studies to provide information about the system which would enable the identification of ecological transitional thresholds would appear to be the most important task. However, since industries frequently use chlorine, slimicides, and other toxic materials, and since heavy metals may be found in the waste discharges, the biological-chemical-physical monitoring system which would enable the group to detect the appearance of toxic materials and take remedial action immediately is also important.

INERTIA INDEX	$= a \times b \times c \times \underline{d} \times e \times f$
400+	: high degree of inertia
55-399	: moderate inertia
less than 55	: poor inertia

Elasticity

Some means of estimating the elasticity of an ecosystem (its ability to recover following displacement of structure and/or function to a steady state closely approximating the original) is badly needed. This information would be useful not only following accidental damage to an ecosystem to predict the rate of recovery, but it would also be valuable in estimating the ecological vulnerability of various sites proposed for development. Some approximation of the relative vulnerability of the proposed sites could be made and incorporated into the series of factors considered in site selection. The factors which we consider important in the development of a recovery index follow, with a brief discussion of each:

a. Existence of nearby epicenters (e.g., for rivers these might be tributaries) for providing organisms to reinvade a damaged system. Rating system: 1 - poor; 2 - moderate; 3 - good.

In a study of the Clinch River following one massive and one minor spill of toxic material (Cairns et al. 1971, 1973a; Crossman et al. 1973; Kaesler et al. 1974), it was clear that in the initial stages of the recovery process some tributaries contributed more organisms than others. It was also evident that some of the organisms recolonizing damaged areas came from the headwaters of the main stream. These comparatively healthy tributaries and headwaters which furnished organisms to recolonize damaged areas were a key factor in the very rapid recovery which occurred. The tributary and headwater areas might be considered epicenters from which organisms departed to invade and subsequently colonize the damaged areas. A substantial reduction in the sources of potential recolonizing organisms would have undoubtedly altered the recovery pattern of the Clinch River. Therefore, the epicenters are a prime factor in the recovery pattern of a damaged ecosystem; for without new potential colonizers, the process cannot occur.

b. Transportability or mobility of dissemules (the dissemules might be spores, eggs, larvae, flying adults which might lay eggs, or other stages in the life history of an organism which permit it to either voluntarily or involuntarily move to a new area). Rating system: 1 - poor; 2 - moderate; 3 - good.

The Clinch River studies showed quite clearly that some groups of organisms have a greater potential for becoming reestablished in a damaged area than others. Fish, for example, moved into the damaged areas relatively soon after the fly ash pond spill occurred which temporarily destroyed the biota of over a hundred miles of the Clinch River. The same was true for the acid spill which occurred sometime later but which affected a more limited area. Aquatic insect larvae which "drift" downstream and are, therefore, good recolonizers also became reestablished rather soon. On the other hand, the molluscs are rather slow to reinvade damaged areas. At the time this manuscript was being prepared, there were species of the molluscs which had not returned to the damaged areas although five years have passed since the last spill. If the damaged community consists almost entirely of organisms with a high degree of transportability of dissemules, the prospects for rapid recovery would be high. Whereas, if it consists primarily of those not easily transported, and thus less likely to reinvade, the prospects of rapid recovery would be rather poor.

c. Condition of the habitat following pollutional stress. Rating system: 1 - poor; 2 - moderate; 3 - good.

The fly ash pond spill and the acid spill on the Clinch River had marked effects on the indigenous biota, but they had only small short-term effects on the physical habitat of the river and on the chemical characteristics of the water. On the other hand, had extensive siltation blanketed the riffle areas, this would have resulted in marked alteration of the habitat which might have persisted for a substantial period of time.

d. Presence of residual toxicants following pollutional stress. Rating system: 1 - large amounts; 2 - moderate amounts; 3 - none.

The two Clinch River spills changed the pH of the river—the first to a high pH, the second to a low. In both cases, the "slug" of water differing markedly from the ambient pH passed through the river system leaving no residual effects. On the other hand, the intrusion of biocides (e.g., dieldrin, aldrin, mercury, or lead) would almost certainly have left residuals which would probably have persisted in the system for a considerable length of time. In a study of a creosote spill on the Roanoke River (Cairns et al. 1973a) the presence of ethylbenzene-creosote in the sediments caused toxicity to aquatic insects below the site of the spill. The presence of residual toxicants might well impair the recovery of a damaged ecosystem by maintaining toxic conditions unsuitable for potential colonizing organisms. Thus, the presence of such residual toxicants should diminish the recoverability potential of a system.

e. Chemical-physical environmental quality following pollutional stress. Rating system: 1 - in severe disequilibrium; 2 - partially restored; 3 - normal.

Pollutional stress may, either through alteration of the substratum (or other portions of the ecosystem) or elimination of certain biota (which affect chemical-physical environmental quality), put the chemical-physical environment of an ecosystem into severe disequilibrium. For example, a reservoir or lake with a substantial algal growth might normally have a dissolved oxygen concentration at saturation during daylight hours and well above two or three ppm even during the longest periods of darkness. If, however, these plants were destroyed, the additional decaying organic load, together with the absence of the plants as a source of oxygen, might alter the system from aerobic to anaerobic. This change might be of considerable duration if recovery were left entirely to natural processes. (However, artificial aeration would almost certainly accelerate the return to an approximation of the original condition.) In systems such as the Clinch River and Roanoke River where the flow-through rates are quite high, the restoration of the quality of the physical-chemical environment required only a few hours because the toxic materials were rapidly removed from the original spill site. On the other hand, a substantial portion of the river biota was damaged during the passage of the slug. The return of an approximation of the original chemical-physical conditions is an important prerequisite for the reestablishment of a community characteristic of that particular system.

f. Management or organizational capabilities for immediate and direct control of damaged area. Rating system: 1 - none; 2 - some; 3 - strong enforcement possible.

In some cases, river drainage authorities or other management groups exist which may be capable of aiding the recovery process. For example, if an oxygen disequilibrium exists in a reservoir or lake, an approximation of the normal oxygen regime might be achieved by artificial aeration (Fast, in press). This would presumably enhance the conditions for reestablishment of organisms characteristic to that system, and thereby, enable the natural balance to be restored more quickly than might otherwise occur. The cleanup of oil following spills (excluding ecologically damaging cleanup methods, e.g., Nelson-Smith, in press) by organizations charged with the management of a specific ecosystem is another example of such an activity. Reintroduction of certain types of species not likely to reinvade the area on their own is another rather simple example of management intervention in the recovery process. Probably the most valuable contribution a managerial organization might provide is the establishment of baseline or "normal" conditions so that the degree of disequilibrium can be documented when an accident occurs (Cairns and Dickson 1974). When the displacement from normal is known, the necessary corrective steps are usually reasonably clear, and the resources available to aid the recovery process can be more efficiently directed to achieve the desired goals. As the organizations charged with ecosystem management become politically and operationally stronger, their role in the recovery process will become increasingly important.

The corrective actions used as illustrations are relatively simple and straightforward. However, knowing which corrective action is appropriate requires a fairly substantial knowledge of the system and a relatively large pool of background data regarding its "normal" condition. This is probably where most ecosystem management groups fail.

Using the characteristics listed above and their respective rating systems, a recovery index can be developed. Using this index, one can arrive at a rather crude approximation of the probability of relatively rapid recovery. This would mean that somewhere between 40 and 60 percent of the species might become reestablished under optimal conditions in the first year following a severe stress, between 60 and 80 percent in the following year, and perhaps as many as 95 percent of the species by the third year. Natural processes, with essentially no assistance from a management or a river basin group, accomplished this recovery following spills on the Clinch River and Roanoke River. These were studied by the Aquatic Ecology Group at Virginia Tech, and the usefulness of this estimate has also been checked with data provided by some acid mine drainage studies (Herricks and Cairns 1972, 1974) and seems adequate in this regard as well. The equation for the recovery index follows:

$$\text{RECOVERY INDEX} = a \times b \times c \times d \times e \times f$$

400+	: chances of rapid recovery	excellent
55-399	: chances of rapid recovery	fair to good
less than 55	: chances of rapid recovery	poor

During the development of this simplistic equation, considerably more complicated equations were considered but rejected because the refinements seemed meaningless in view of our present state of knowledge. However, there seems to be a definite need to formalize the estimation of recovery, and one hopes that more precise equations, properly weighted, will evolve from this modest beginning.

Resiliency

Resiliency was defined earlier as the number of times a system can snap back after displacement. A very informative illustration of resiliency has been provided by Brian Dicks (in press) in his investigation of the effect of oil spills on salt marsh plants in Great Britain. Simulating a series of rather small oil spills restricted to a limited area, Dicks found that the salt marsh organisms could recover relatively rapidly after two or three spills in reasonably close succession. Even four or five exposures in reasonably close sequence allowed subsequent recovery. However, when 16 or 17 insults were given with about the same frequency and at the same volumes to a comparable area, there was no recovery—at least within a time span considerably larger than that in which recovery had been previously demonstrated. This suggests that the salt marsh ecosystem had a "reserve" which would carry the system through repeated stresses but that the number of these which could be tolerated was finite even though the area exposed and the volume of oil spilled were kept constant for each exposure. Thus, the resiliency of this system could be determined by a field bioassay with repeated exposures in which the exposure intervals and volume of oil used in each were controlled but in which nothing else in the natural system was modified. Perhaps there are other systems for which resiliency could also be easily determined. It is quite evident that for the Great Lakes, oceans, and other large and complex ecosystems, the determination of resiliency would be difficult. Recognition that this problem exists, and even a crude estimate of the degree of resiliency, may be enormously useful in developing management plans.

Biological Assessment Program for Water Quality Management

The time has come to go beyond merely responding to one environmental crisis after another and to managing all ecosystems on a regional basis. Control measures applied to aquatic ecosystems in the absence of information on the condition of the system are apt to be inappropriate. They may overprotect the receiving system at times and underprotect it at other times since the ability of ecosystems to receive wastes is not constant. A major determinant of the effectiveness and efficiency of ecological quality control is the lag time in the feedback of information. Present techniques for measuring the responses of aquatic organisms and communities require days or weeks; whereas, information for ecosystem quality control and prevention of ecological crises should be generated in minutes or hours as is the case for other quality control systems.

Viable systems for continuously monitoring water quality are of critical importance for the future management and use of our watersheds. There are two reasons why it will only be through such continuous feedback information systems that sensible and efficient controls can be designed: first, a watershed's ability to receive waste fluctuates on a daily or even hourly basis; second, without constant monitoring, industrial spills do much damage to aquatic ecosystems before anyone is aware of the problem. It is significant that Section 308 of the Federal Water Pollution Control Act Amendments of 1972 states that the administrator of the Environmental Protection Agency shall require the owner or operator of any point source to "install, use and maintain such monitoring equipment or methods (including where appropriate, biological monitoring methods) as the administrator may require in fulfilling the objectives and requirements of the Act." Continuous monitoring systems using aquatic organisms as sensors may come to supplement the stream surveys and standard bioassays that are routinely used at present for biological monitoring.

The value of a regional monitoring program using chemical and physical measurements has already been well established by ORSANCO's (Ohio River Valley Water Sanitation Commission) successful operation of automated monitoring devices for nearly ten years on the Ohio River (Klein et al. 1968). These devices record such things as dissolved oxygen and pH. They have become indispensable in the management of the watershed and are stimulating similar developments in a number of countries. The major difficulty with this type of monitoring system, however, arises in the analysis of the data and in making evaluations of a complex ecosystem from the measurements of a few physical parameters. A possible solution to these problems involves the use of biological monitoring techniques (Cairns, Dickson and Westlake, in press).

All industries discharging waste are using the environment as an extension of their waste-disposal system. If this were not true, each industry could recycle wastewater since its quality would be equal to that of the water entering the plant. Once this simple fact is recognized and accepted by the general public and industrial management groups, a new perspective in our relationship with environmental problems is possible. Conservationists may not like industrial and municipal use of the environment as a receiving system for wastes, but this situation is the rule rather than the exception in all industrialized societies and many developing societies as well. However, each group must compromise if we are to have a gradual transition from our present environmental situation to a more amenable one. A better working relationship should be possible when conservationists recognize that a technological society with no environmental impact is impossible, and industrialists realize that their survival depends upon well functioning natural systems.

If we are willing to regard the environment as an extension of the plant waste-disposal system, then it seems quite reasonable to extend the quality-control practices which exist within the plant to the area outside the plant. The essence of quality control inside the plant is the continuous or regular collection of data regarding the process quality at different points in the operation and alteration of the management practices as necessary to maintain the desired quality. The same principle can be applied in the natural environment, although the techniques would be somewhat different. For example, in Figure 1 there are industrial agricultural, and wooded areas, as well as one small city. There are two reservoirs marked X and Y in the upstream areas and several small tributaries, one running through an agricultural area containing two fruit orchards and a hayfield, and another running adjacent to a hayfield which is next to Industry 3. Two types of biological or environmental monitoring systems (Cairns et al. 1970) could be used: (1) an in-plant system uses a mixture of the plant waste and water from the receiving river to see if this will prove harmful to one or more representative aquatic organisms. The in-plant monitoring systems are designed to tell something about the biological quality of the wastes before they actually enter the receiving river or stream; and (2) the in-stream monitoring units provide data from the receiving system itself because our ultimate objective is to protect it. In-stream monitoring units should utilize ecological data that is derived from the complex interlocking cause-effect pathways characteristic of natural systems. At present these are based on diversity indices or modifications of these (one infers that a high diversity of species indicates a large number of cause-effect pathways), although ideally they should be based on the function of the system as well as on the structure. The justification for maintaining the diversity characteristic of a particular locale has been discussed elsewhere (Cairns 1967).

Early Warning System

A number of papers have been published on the use of aquatic organisms as "sensors" in an early warning system associated with an industrial waste dis-

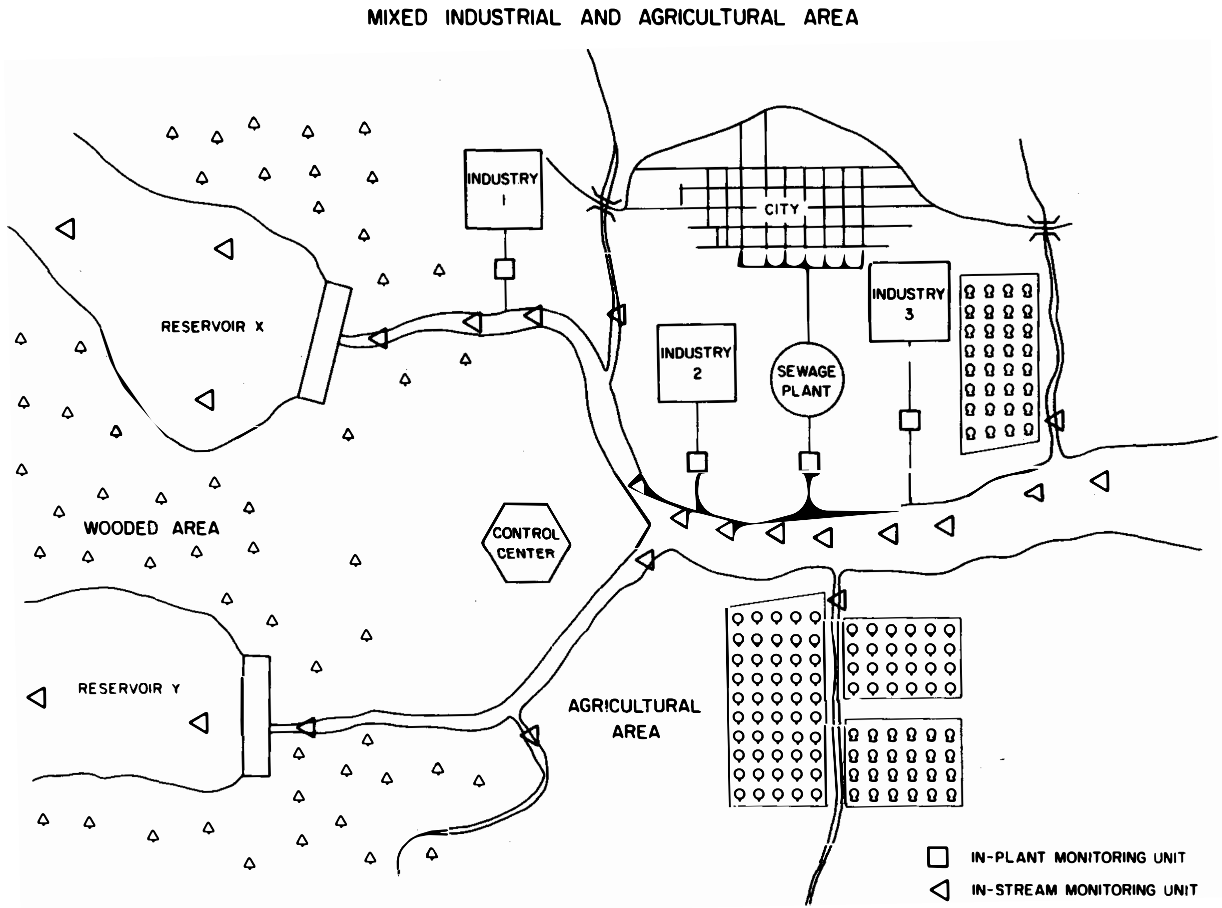

Figure 1. Mixed industrial and agricultural area.

charge before it reaches the receiving system (e.g., Cairns et al. 1970, 1973b, 1974 (in press); Besch and Juhnke 1971; Shirer et al. 1968). A simple schematic is given in Figure 2 for readers unfamiliar with this field.

Receiving System Monitor

Aquatic microbial community structure has been used for years to assess the effects of pollution on aquatic ecosystems. Patrick et al. (1954) have obtained excellent results by fitting the structure of diatom communities to a truncated discrete lognormal model. By comparing the parameters of the model, evaluations can be made regarding the response of diatom communities to varying degrees of pollution. In addition, Kaesler and Cairns (1972) have shown that a portion of the microbial community (diatoms) is useful for estimating the response of the entire aquatic community. Generally the response of the microbial fraction of the entire aquatic community to adverse environmental conditions is more rapid than that of the macroinvertebrates and fish. Therefore, in terms of ecological quality control measures, it is probably more efficient to look at this fast response of the community, especially if we use changes in community structure as the basis for decision.

Unfortunately, using traditional taxonomic methods, the time required for proper identification of organisms is too great to permit a rapid response time which is the essence of an efficient quality control system (Cairns et al. 1970).

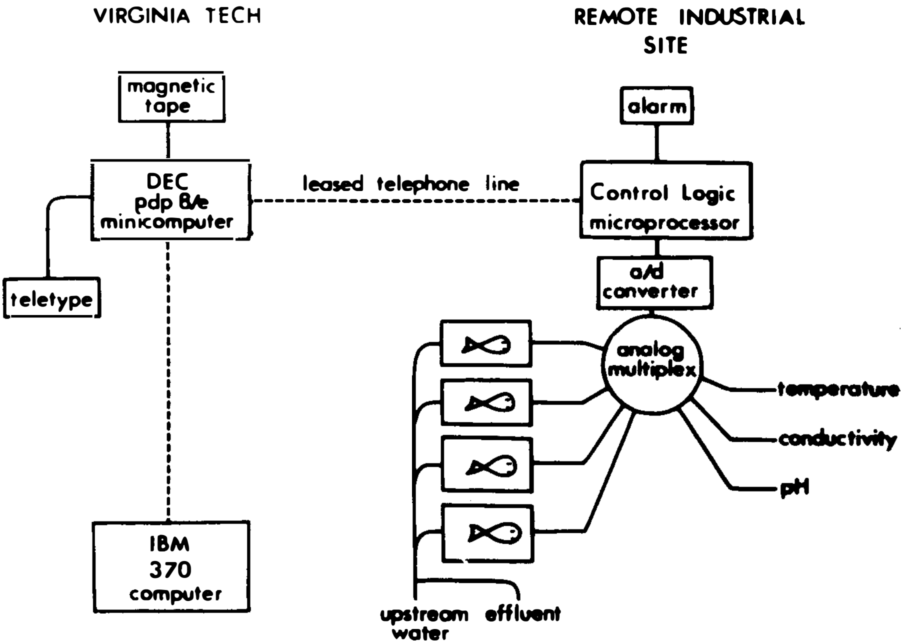

Figure 2. An in-plant monitoring unit, showing how the test fish are exposed to waste diluted with upstream water and the control fish are exposed to upstream water alone.

Hohn (1961) reports that to fit a diatom community to the theoretical model would involve 25-30 hours from beginning to end of the analysis. This time lag is far too great for a rapid corrective response to the sort common to most effective quality control systems. A rapid biological monitoring system with a short information feedback time should be coupled with the physical-chemical monitoring systems now becoming commonplace. The interfacing of these systems would alleviate the dangers of attempting to predict the biological consequences of complete waste discharges based solely on a few chemical and physical parameters (Cairns et al. 1973b). A simple schematic of an optical processor for identifying diatoms (Figure 3) is provided for readers unfamiliar with this field.

Conclusions

The ability of a stream or river to assimilate wastes is governed by the capacity of the system to transform them before they reach deleterious levels. If an overload occurs, the system is disrupted and the transforming capacity may be substantially reduced. Recovery may be rapid or slow depending upon a number of factors including: (1) the severity and duration of the stress; (2) the number and kinds of stresses; (3) the residual effects on non-biological units (e.g., substrate); (4) the presence of epicenters for recolonizing organisms; (5) the inate vulnerability of the system; (6) the inertia of the system, and; (7) the resiliency of the system. Recognizing that aquatic systems differ in their ability to recover

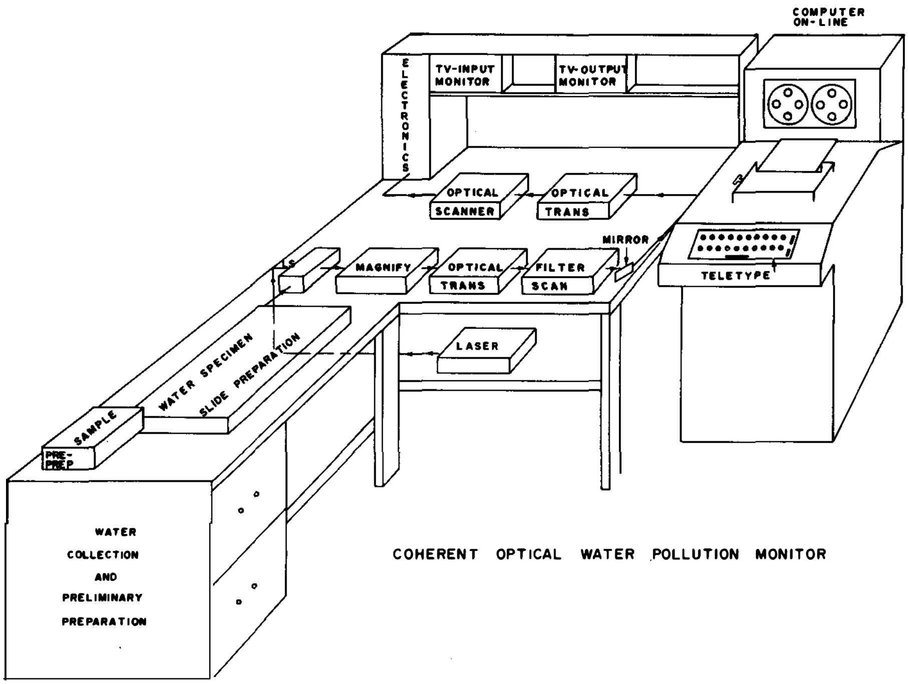

Figure 3. Drawing of the optical process for identifying diatoms.

following stress, it is necessary to develop methods for predicting the recovery response of our aquatic systems so that we can establish priorities for their management and protection. In this paper we have attempted to present a first effort at defining and measuring several characteristics of aquatic systems which are important in the recovery process. We hope this paper will stimulate additional efforts to better understand the roles of ecosystem vulnerability, elasticity, inertia, and resiliency to the process of ecosystem recovery.

It appears likely that a family of biological monitoring methods (both early warning and receiving system) and that techniques for automatically analyzing the data and making decisions will make it feasible to help control quality in effluents and river basins.

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Flood Control and Wildlife Preservation in Los Angeles Water Projects

Gordon A. Reetz and Dale A. Pierce
Biologists, U. S. Army Corps of Engineers, Los Angeles District, California

The role of the U. S. Army Corps of Engineers in providing flood protection for the American public is generally well-known. Equally well-known is the reputation of the Corps of Engineers as a destroyer of all wildlife habitat unfortunate enough to be in the way of a flood control project. Fortunately, this reputation is based on history, not the present. Some recent Corps actions, however, have resulted in the preservation, reestablishment and management of wildlife habitat.

These actions have resulted from recent involvement of the Los Angeles District of the Corps of Engineers in wildlife habitat preservation and enhancement through special programs for recreational development at existing flood control facilities in the Los Angeles area. Prior to discussing the examples of wildlife preservation, a brief description of the flood problems in the area appears appropriate as background.

The Los Angeles area is a semi-desert; rainfall averages less than 10 inches (25 cm) on the coast and over 30 inches (76 cm) in the nearby mountains, which reach elevations of 10,000 feet (3,048 m) less than 45 miles (72 km) from the coast. During the rainy season—December through March—storms produce ephemeral high volume, high velocity runoffs. The natural stream courses have vacillated widely over the alluvial coastal plain.

Settlement of the south coastal plain, where today over 7 million people live, created major problems with flooding of structures and property and loss of lives. To help alleviate this flood problem, the Corps of Engineers and local interest built five dams and flood control reservoirs, 22 debris basins and almost 300 miles (483 km) of channel improvements. The phenomenal urban growth and associated flood control work have destroyed much of the native vegetation, especially riparian habitat, and wildlife.

Today, California is dramatically different from when the first Spanish explorers arrived in 1542. However, pockets of natural vegetation still exist in this urban desert, perhaps as tiny "oases" that may be somewhat similar to what the first Spaniards observed. Ironically, these "oases" are on Corps flood control lands. Land areas behind Corps of Engineers flood control reservoirs in the Los Angeles area totals more than 18,870 acres (7,640 ha), with about 10,000 acres (4,049 ha) of good wildlife habitat. With 7 million people in the Los Angeles area seeking recreational opportunities, the Corps open-space lands are prime locations for recreational development. Thus, Corps biologists and planners are trying to accommodate the demand for open space and recreational areas on flood control lands while trying to preserve and enhance as much wildlife habitat as possible without encroaching on the flood control functions so vital to the basin.

Three examples show how wildlife habitat preservation and enhancement have occurred in the Los Angeles area on Corps lands. These examples are: (1) The Los Angeles River channel—where a riparian habitat developed accidentally; (2) Santa Fe Flood Control Reservoir—where planning was responsible for retaining a unique habitat within the reservoir; and (3) Whittier Narrows Flood Control Reservoir—where the Corps planned and designed the total re-creation of a wetland habitat to mitigate for the loss of a natural habitat.

Los Angeles River

The Los Angeles River today bears no resemblance to its historical character. Forty-three miles (69 km) of the river are concrete channel, except for a 2.6-mile (4.2 km) stretch of earth-bottom channel, allowing ground-water percolation (see Figure 1). Somehow, a highly contained riparian community manages to persist in the 2.6-mile earth-bottom reach that provides a tiny haven for many local and migratory wildlife using the Los Angeles urban area.

Wildlife species, those tolerant and also nontolerant of man's presence, manage to find food, shelter and water amid the atmosphere of urban activity lining the river. Given the accidental seclusion provided by protective fences, this area has become a sanctuary for some interesting wildlife species. This facsimile riparian habitat has been created by benign neglect.

During the dry season, usually May to October, the highly modified, yet adapted, riparian habitat consists of mostly 4- to 8-foot-tall (1.2-2.4 m) herbaceous plants and grasses and a limited number of small shrubs and trees. The dominant species are cattail, *Typha* spp.; bulrush, *Scirpus* spp.; nut sedges,

Figure 1. An atypical section of the Los Angeles River

Cyperus spp.; mule fat, *Baccharis viminea*; willow, *Salix* spp.; water smartweed, *Polypogon* spp.; and grasses.

Cattail and bulrush growth is heavy where water ponds in up to 3- to 4-foot-deep (.9-1.2 m) depressions scoured in the earth-bottom channel by floodflows. Mosquito fish, *Gambusia affinis,* planted for mosquito abatement, inhabit the pools along the river. Frogs and toads have also found these havens and manage to continue the line of succession in a basic riparian ecosystem capable of sustaining many larger animal forms.

Water in this reach of the river is limited during the dry season to a small flow, composed mostly of urban and some agricultural irrigation runoff. The continuous water flow and high water table contribute to the success of the riparian growth.

Winter floodflows usually scour the vegetation to a bare minimum of its summer form, yet this habitat still manages to attract many wildlife species. On surveys made in February 1974 and January 1976, such species as cinnamon and greenwinged teals, mallards, American widgeons, American coots, California gulls, mourning doves, Brewer's blackbirds, and cowbirds were observed. During surveys made by us in early September 1975, we observed 35 species of birds, including least sandpipers, great blue and little green herons, coots, blue-winged teals, belted kingfishers, yellowthroats, and American kestrels.

The area has elements of risk for the wildlife. The bodies of dead coots along the river attested to the fact they must combat high-intensity powerlines during night flights along this riparian corridor.

Considering the circumstances and area—a concrete-sided earth-bottom channel with freeways and heavy industrial or residential development along the channel—it is remarkable that wildlife utilize this habitat to the extent they do. This area certainly will never win an aesthetic award for natural appearance, but, without planning, a riparian habitat has developed. Qualitatively, this habitat probably seems very poor, but, in an area with severely limited riparian habitat, it serves as a valuable refuge for local and migratory wildlife. So, despite the lack of planning for wildlife values when the Los Angeles River was captured in concrete, some wildlife habitat amenities have accrued for local and migratory wildlife along one tiny reach of the river.

The next example demonstrates how recent Corps planning has been responsible for the retention of natural habitats accidentally preserved from destruction by urban development when the Corps constructed a flood control reservoir.

Santa Fe Flood Control Reservoir

Prior to completion of Santa Fe Dam (see Figure 2) across the San Gabriel River in 1949, the area behind the dam was in rural and residential uses. This is evidenced by the ruins of streets and a few houses that are still visible within the flood control basin. Since the federally-owned area is afforded protection from any signficant modification, it has, through natural succession, reverted to a highly productive stand of natural vegetation. An Audubon official visiting the area in October 1975 said, "In just a quarter of a century nature has reasserted itself. (It) has created a wildlife community here close to what it must have been like 300 years ago."

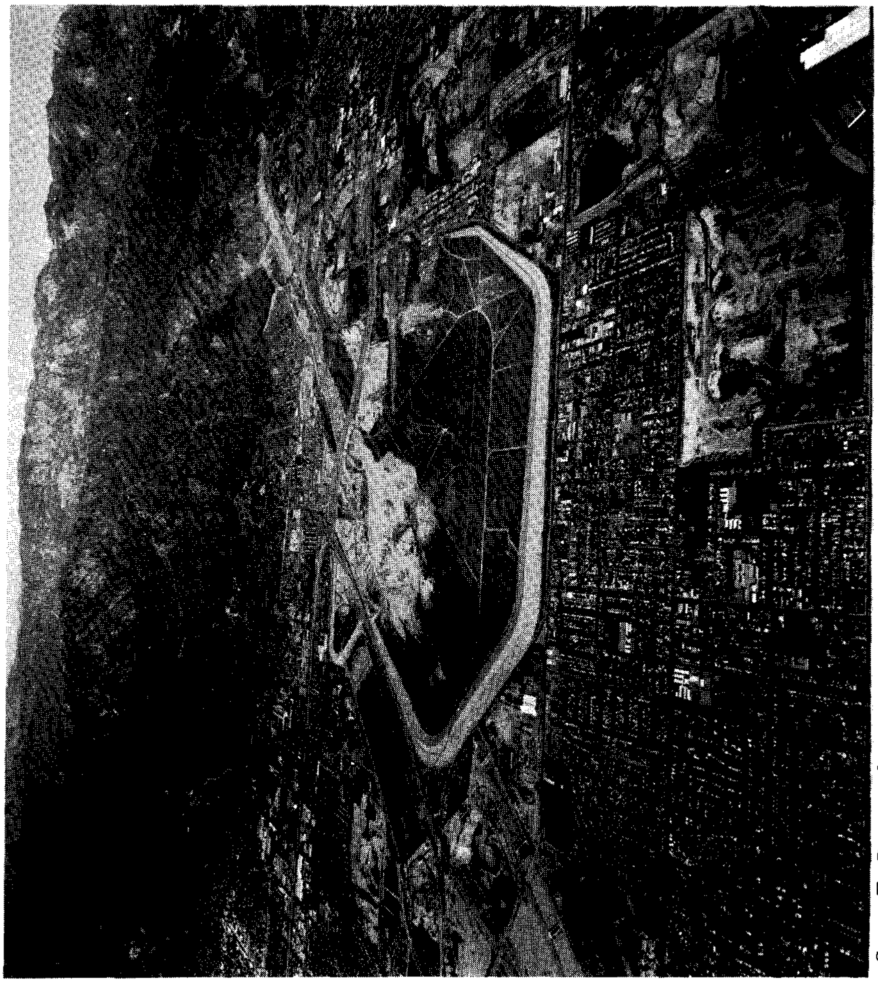

Figure 2. Santa Fe Dam and Reservoir

The 1,900-acre (769 ha) Santa Fe flood control basin, which is usually dry, is located only 16 miles (26 km) from downtown Los Angeles. Although this area is bounded on three sides by heavy industry and gravel mining operations (the north side is a narrow river channel leading up to the over 8,000-foot-high (2,438 m) San Gabriel Mountains), it has, because of the isolation of the dam, become a biological bonanza for Los Angeles County in the most unlikely of areas. Fifty-one species of mammals and 168 species of birds have been observed in the area.

This flood control basin supports five distinct biological communities (disturbed wash, riparian, upland chaparral, ephemerally inundated and coastal sage scrub). The lushness and diversity of vegetative growth are due to a combination of factors including the large size of the flood control basin, its isolation and protection from general public intrusion, varied depths to ground water, and proximity to the San Gabriel River channel, which leads to high mountains and down to high desert, thus acting as a corridor for plants and wildlife from various habitats.

This area has one of the richest assemblages of native plants and animals of any of the urbanized southern California areas. The biological richness results from the ecotonal effect of the intermixing of the five plant communities. The coastal desert sage scrub community looks like a desert flower garden and has components that include sages, *Salvia* spp,; California sagebrush, *Artemisia douglasiana*; prickly pear cactus, *Opuntia littoralis*; valley cholla, *O. parryi*; whipple yucca, *Yucca whipplei;* cactus wren; roadrunner; kangaroo rat, *Dipodomys* sp.; and wood rats, *Neotoma* spp. The chaparral-type community is represented by laurel sumac, *Rhus laurina*; sugar bush, *Rhus ovata*; redberry, *Rhamnus crocea*; various sages, *Salvia* spp.; California buckwheat, *Eriogonum fasciculatum*; toyon, *Heteromeles arbutifolia*; California quail; rufous-sided towhee; and desert cottontail, *Sylvilagus audubonii*. The riparian community consists of a dense stand of willows, *Salix* spp., supporting numerous raptors, woodpeckers and warblers.

The ephemerally inundated community is found at the foot of the dam and is composed of mostly 4- to 6-foot-high (1.2-1.8 m) field mustard, *Brassica campestris,* with an intermixing of salt cedar, *Tamarix chinensis* and some mule fat, *Baccharis viminea*. The disturbed wash vegetation is periodically scoured and removed by winter streamflows. Primary successional species such as mustards, *Brassica* spp.; tree tobacco, *Nicotiana glauca*; and Russian thistle, *Salsola iberica* predominate. Wildlife diversity and numbers are low.

Many times in the recent past this biologically rich area came very close to destruction. The potential cause was not fires, floods or diseases but the great demand in urban Los Angeles for open space land with recreational potential. A few of the recreational development proposals for the area that fortunately were dropped were a 72-hole golf course and development of the entire basin into a manicured park, filled with ornamental trees and shrubs, and play and athletic fields. All these proposed developments would have destroyed the natural biotic communities.

In early 1974, the Los Angeles County Parks and Recreation Department, lessee of the Corps land, proposed a plan to develop Santa Fe flood control basin. Their initial plan tended toward formal recreational uses, leaving only a token wildlife area. Corps biologists and planners and Los Angeles County biologists were jointly responsible for the rejection of this plan and for the study of other plans. After much discussion between the two agencies and local chapters of the Audubon Society and Sierra Club, a plan was formulated that would meet the needs of most users. This plan, accepted by all concerned, will begin construction in April 1976.

The plan calls for the preservation of the most valuable habitats within the basin, an area totalling over 400 acres (162 ha). The plan specifies buffer areas to protect wildlife habitats from recreational user. Also, an interpretive nature center and a few nature trails will be provided. Another 380 acres (154 ha) will be developed for recreational facilities, including a 70-acre (28 ha) lake for fishing and nonpowered boating, open field areas, group camping areas, picnic areas, active sports areas, equestrian facilities and parking areas. The remaining 1,100 acres (445 ha) will be retained as flood control operational lands.

Santa Fe Dam flood control recreational development is a carefully planned project that allows for the preservation of natural habitats and provides multipurpose recreational use of the area. Environmentalists and recreational planners worked closely to produce a coordinated developmental plan that maximizes the human benefits of the Corps' lands without compromising the natural values of the area.

Whittier Narrows Flood Control Reservoir

Whittier Narrows recreational development (see Figure 3) demonstrates how proper planning can be utilized to turn an area without natural habitat into what should become a highly productive urban area wetland habitat and wildlife sanctuary. It would be pointed out that this planning for the re-creation of a riparian habitat evolved from a possible litigation against the Corps of Engineers.

Whittier Narrows Dam is located about 10 miles (16 km) east of downtown Los Angeles across the main channels of the San Gabriel River and Rio Hondo. The dam, which was completed in 1957 to serve as an important component for flood control within the Los Angeles County drainage basin, controls a 554-square mile (1,435 km^2) drainage area. Whittier Narrows, a dry flood control reservoir encompassing about 2,865 acres (1,160 ha) of land, is bordered by five cities and dissected by the Pomona Freeway and several major boulevards or avenues.

The primary purpose of Whittier Narrows Reservoir is flood control, but since 1944, multipurpose uses, including water conservation, agriculture and grazing, recreation and wildlife enhancement have been encouraged. Part of the land within the flood control reservoir has been leased by the Federal Government to the County of Los Angeles for public park and recreational development. In addition, some land is leased for agricultural and grazing uses.

The Whittier Narrows Recreation Area is a regional park of about 1,400 acres (567 ha) featuring primarily dryland recreational activities. Recreational developments by the County of Los Angeles, started in 1958, include fishing and boating lakes (Legg Lake complex), athletic fields, picnicking areas, trap-and-skeet shooting areas, a hobby area (model airplanes), equestrian and bicycle trails and a nature study area that was transferred by the Audubon Society to the County of Los Angeles in 1970. The recreation area attracted an estimated 1.5 million visitors in 1973.

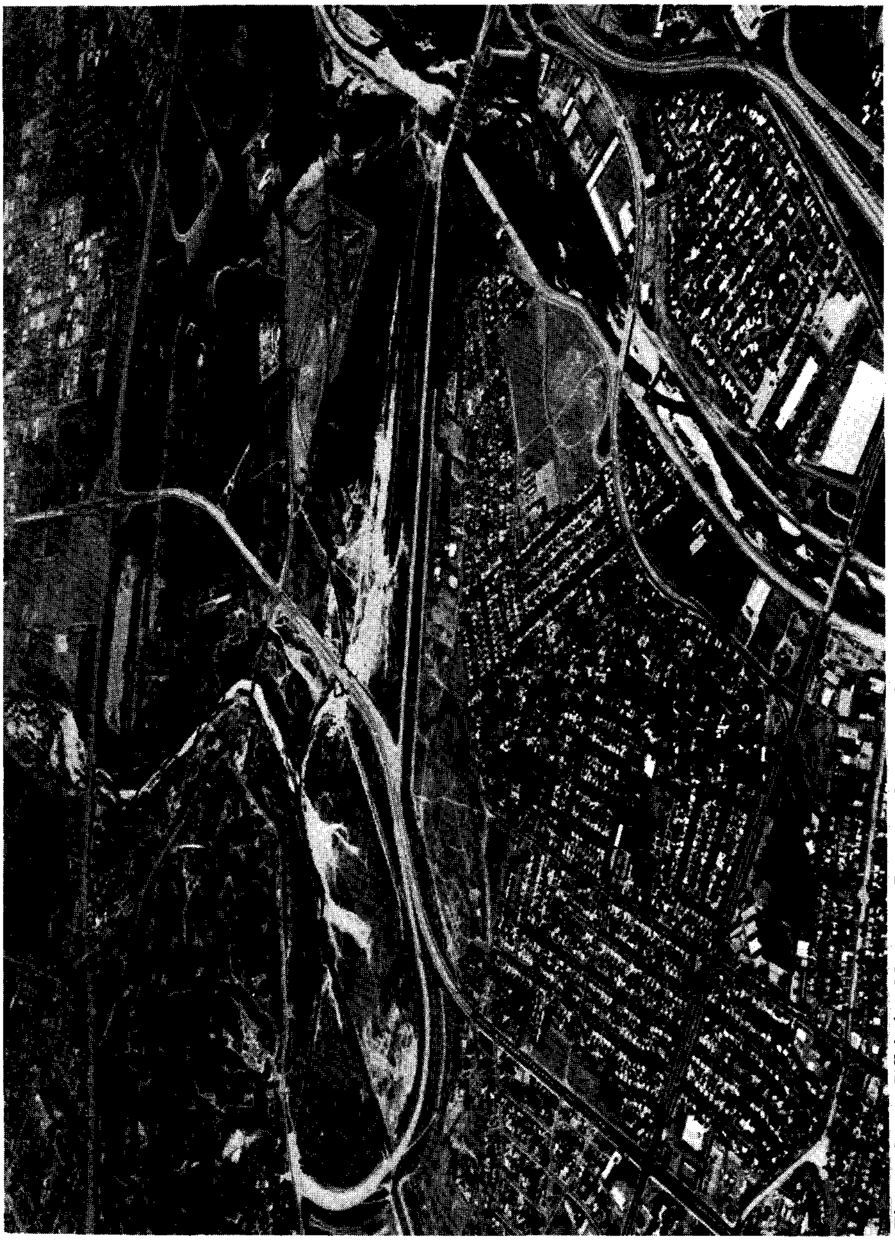

Figure 3. Whittier Narrows Dam and Reservoir

In 1974, implementation of a new program where the Federal Government participated with local interest on a 50-50 cost-sharing basis for provision of recreational facilities, precipitated a controversy with local environmental groups. The development of much-needed additional recreational facilities, including a new fishing lake and play and picnic areas, would have resulted in the destruction of a highly unique 20-acre (8 ha) wetland habitat, known as North Lake, which originally had been an area used to obtain borrow materials for construction of the Pomona Freeway in 1966. The borrow material had been removed from the area in 1966 with the intention of making this into the third and last fishing lake, as part of the Legg Lake complex, whenever funds became available. The area, which was fenced to limit public access, developed into a valuable wetland wildlife habitat that was heavily utilized by wintering water-associated birds. Local birders documented the presence of 190 species at North Lake, including such unusual species as the trumpeter swan, peregrine falcon, osprey and European widgeon.

When County of Los Angeles funds became available in 1974 to convert North Lake into a fishing lake, the controversy erupted. Local chapters of the Audubon Society and Sierra Club and the Southern Council of Conservation Clubs (mostly hunters) formed a coalition and initiated legal action against the County of Los Angeles and Corps of Engineers to stop the proposed destruction of the unique North Lake habitat. After a series of out-of-court negotiation meetings initiated by the Corps of Engineers and Los Angeles Parks and Recreation Department planners, an agreement was reached with the environmental groups that allowed the development of a reasonable mitigation plan.

Corps biologists worked with county biologists from the existing Whittier Narrows Nature Center to develop a plan that would provide replacement habitat for the North Lake area, which would be developed into a fishing lake. The planning involved a unique approach to providing wildlife habitat benefits since we were not working with the preservation or enhancement of an existing wildlife habitat; instead, we had to totally re-create a natural habitat starting with a rhubarb field and pasture land.

The mitigation plan was implemented in February 1975 with the expansion of the existing 97-acre (39 ha) nature area by 150 acres (61 ha). Two- and three-acre (.8 and 1.2 ha) ponds and a 20-acre (8 ha) lake with five resting-nesting islands were constructed on a 70-acre (28 ha) area desgined to serve primarily as a wetland habitat and wildlife sanctuary. An existing well in the area was utilized to fill the lakes and also provide the future water source. An 80-acre (32 ha) raptor management area was established on grazing lands.

Utilizing lake excavation material, protective berms were provided around the lake and ponds to reduce traffic noise from an adjacent heavily traveled highway and to minimize visual disturbance to wildlife from nearby recreational users. In addition, the entire area was fenced to restrict public access, thus further guaranteeing sanctuary status to the new habitat.

The entire habitat has to be developed starting from bare ground. Using native riparian shrubs and trees, many of which were provided by the Nature Center, the berms and pond and lake perimeters were landscaped. The initial plantings included such species as emory baccharis, *Baccharis emoryi*; mule fat, *B. viminea*; arroyo willow, *Salix lasiolepis*; western sycamore, *Platanus racemosa*; and black cottonwood, *Populus trichocarpa*. The Nature Center biologists plan to incude additional species in future plantings. Following irrigation of the area in the late spring-early summer of 1975, a thick cover of weedy annuals, including many species of pigweed, *Amaranth* spp., and goosefoots, *Chenopodium* spp., flourished to provide a basic ground cover in addition to the thousands of native shrubs and trees. Irrigation of the area is only an interim measure to guarantee successful establishment of the vegetation. Several species of aquatic plants were planted in the ponds and lake to initiate development of the aquatic ecosytem. Also, selected species of fish were removed from North Lake and introduced into the ponds and lake.

By mid-summer 1975, in spite of the limited vegetative growth, two species of wildlife, a black-necked stilt and mallard, successfully fledged young in the newly created wetland habitat. By January 1976, Nature Center biologists had recorded 111 species of birds utilizing the ponds and lake, including the cattle egret, whitefaced ibis, wood duck, chimney swift and bobolink.

Given several years, this wildlife habitat should develop into a highly productive wetland habitat for local and migratory wildlife. Under the competent and careful management of county biologists at the Nature Center, this re-created wetlands habitat should sustain a wildlife carrying capacity greater than occurring at the unmanaged but naturally developed North Lake area, and thus more than adequately mitigate the loss of the North Lake habitat. Because careful monitoring studies of North Lake were completed by county biologists before it was developed into a fishing lake in September 1975, empirical data will be available to compare this area with the new ponds and lake area.

Viewing blinds have been provided on elevated ground around the ponds and lake so that wildlife may be observed by interested people. The new sanctuary is now available under controlled use for birding, nature study and any other form of study that does not conflict with its primary function of serving as a refuge for local wildlife and migratory species passing through the heavily urbanized Los Angeles area.

Corps of Engineers planning at Whittier Narrows flood control reservoir has demonstrated that man can successfully provide flood control, recreational facilities and wildlife habitat enhancement and management within planning constraints that are unavoidable in a highly developed and urbanized area.

Conclusion

We have provided several examples of successful wildlife habitat preservation and enhancement on Los Angeles District flood control lands. Planning on several future coastal projects proposes the purchase and preservation or rehabilitation of some coastal salt marsh areas that provide valuable habitats for some endangered wildlife species. The acreages involved in these purchases would go beyond normal acquisition of the land for mitigiation of adverse project effects, demonstrating the Corps' awareness of the need to protect and enhance natural environments within its planning jurisdiction.

We are not trying to portray the Corps of Engineers as the leading conservation agency, but we certainly hope to convey that, at this time, Corps' planners and decision makers have an ecological conscience and are aware of the benefits of conservation and preservation.

Migratory Bird Management: Attitudes, Plans, and Cooperative Approaches

Chairman:
JOHN S. TENER
Assistant Deputy Minister
Environment Canada
Ottawa, Ontario

Cochairman:
ARTHUR S. HAWKINS
Consulting Biologist to U. S. Fish
and Wildlife Service
Twin Cities, Minnesota

Opening Remarks

John S. Tener

Welcome, ladies and gentlemen to this Special Session on "Migratory Bird Management, Attitudes, Plans and Cooperative Approaches."

The protection and management of migratory birds under the treaties between the United States and Canada on the one hand, and the United States and Mexico on the other have produced immense benefits for the people of the three nations and for the resource itself. The far-flung ranges of the migratory birds, the multiplicity of jurisdictions involved, the increasing and too often threatening activities of man, which challenge the ability of the birds to survive in numbers and in places desired by man, as well as the change in social attitudes toward resource harvesting, have resulted in very complex management problems, which only can be addressed by international cooperation. The treaty provides a formal opportunity for such cooperation.

Much has been accomplished in the past but the very dynamism of society and the resource make it imperative that a fresh look be taken at what we are doing, how we are doing it and what we should be doing in order to achieve our common national objectives and to realize our individual national goals. Your speakers today will be addressing some of these issues.

The first speaker this afternoon is Dr. Robert I. Smith who cooperated on a paper with Roy J. Roberts on "Waterfowl Hunters' Perceptions of the Waterfowl Resource."

The Waterfowl Hunters' Perceptions of the Waterfowl Resource

Robert I. Smith
Chief, Branch of Migratory Bird Research, U. S. Fish and Wildlife Service, Washington, D.C.

Roy J. Roberts
Senior Study Director, National Analysts, Philadelphia, Pennsylvania

In a recent study by John D. Copp, the motivations and behavior of a group of waterfowl hunters in California were examined. The concluding comments of Dr. Copp's publication (1975) entitled "Why Hunters Like To Hunt," are as follows:

> The beauty and perhaps the appeal of duck hunting is that it raises play to ritual. The gathering of hunters in the pre-dawn darkness at Delevan resembles an encampment of Plains Indians just prior to a buffalo hunt: rattling weapons, barking dogs, bird feathers worn as symbols of achievement, mimicking of animal sounds, tales of previous expeditions, masculine bragging, and anticipation. Like Indians, hunters more than the rest of us, may be communing with nature's Great Spirit.

This statement contains a great deal of insight into the hunting of waterfowl. Today, more than ever, it is important that we gain this insight.

Over the years most management decisions concerning migratory birds have been made by specialists who devote entire careers to the study of birds. Much less time has been devoted to understanding people who utilize the resource. Since 1972, the U.S. Fish and Wildlife Service has attempted to correct this deficiency by learning more about waterfowl hunters. We are most interested in the waterfowl hunter's perception of the waterfowl resource and his knowledge and opinions of waterfowl management. This study is being conducted under contract with National Analysts. Today's presentation was prepared jointly by Mr. Roy Roberts of National Analysts and myself.

In an initial phase of the work a group-interview technique was used. Waterfowl hunters were gathered in small groups to discuss waterfowl issues. Sixteen group-interviews were conducted at widely scattered locations throughout the United States. Subjects that preoccupied hunters were identified, and hypotheses about hunter orientations and behavior were developed from these tape-recorded sessions. Researchers acquired familiarity with the language of hunters and this was an aid in wording questions to be used later. These discussions were for developmental purposes, and the 150 participants were not a representative sample of all waterfowl hunters, but their taped conversations proved interesting and informative. Moderators of these sessions were highly skilled at creating an atmosphere in which points of view and differences of opinion were expressed openly.

In another phase of the study a questionnaire was mailed to 6,000 waterfowl hunters whose names were selected systematically from lists of Federal Duck Stamp purchasers in the 1973-74 hunting season. One hundred thirty questions were included in this contact by mail; an unusually long questionnaire. Thirty-six hundred completed questionnaires resulted from the 6,000 contacts. The primary purpose of the questionnaire was selection of questions to be used later in contacting a larger sample of waterfowl hunters by mail. No attempt was made to measure characteristics of those who did not respond. A portion of these nonrespondents are stamp collectors and others who do not hunt waterfowl. In drawing inferences, we do not know if the nonresponse represents a serious bias, but it is a source of bias on certain questions.

In the presentation today we have extracted some preliminary results that might be of interest to you. Half the hunters lived in rural areas or small towns, but only 5 percent were farmers. Twenty-three percent lived in large cities or the suburbs of large cities. Others resided in towns of intermediate size.

We explored how people came to be waterfowl hunters. What set of circumstances created their initial interest in the activity? Seventy percent had participated in waterfowl hunting prior to 18 years of age. One would assume that parental guidance played a role, and this proved to be true, but the father was not as influential in the process as you might suspect. The father received credit 31 percent of the time. The father or an older friend or relative was responsible for the initial participation in about half of the cases.

Over the years the number of waterfowl hunters has varied widely. The factor or factors actually responsible for changes in participation have never been isolated. We explored this subject in terms of strength of commitment expressed by various components of the hunter population. Hunters who made fewer than five trips or spent less than $34 on waterfowl hunting in 1973 were isolated from the remainder of the sample. Only 20 percent of this group saw waterfowl hunting as an important aspect of their lives. When hunters who made 12 or more trips or spent over $100 that year were identified, about 60 percent of this group saw waterfowl hunting as a very important part of their lives. In the total sample about 40 percent expressed a strong commitment to the sport. The other 60 percent expressed weaker interest and their decisions to participate each year must be influenced by a variety of factors. In a related question, 53 percent did not rank waterfowl hunting as their first choice among hunting activities; a further indication that participation of at least half the waterfowl-hunter population can be influenced rather easily. About half indicated that they have not always hunted waterfowl in consecutive years; however, they rejected the idea that poor hunting was a factor in decisions not to participate. We have more to learn about factors influencing participation, particularly participation of those who are not highly committed to the activity. Evidence suggests that publicity about the upcoming season influences a fairly large segment of the potential waterfowl hunter population. We asked hunters how they obtained information on the upcoming waterfowl season. Newspapers ranked highest as a source of information followed by "talking to friends" and magazines.

Commitment to waterfowl hunting is closely related to the value one places on the activity. Food obtained in the process is one element that has obvious value, but the primary benefits for most hunters must relate to satisfactions other than food. The average bag in the United States varies between one and two waterfowl per day of hunting. What is the value of this experience to the hunter? Hunters who were interviewed expressed a sense of accomplishment in bagging a duck or goose. Ducks and geese were described as wary and intelligent with extremely acute vision. Concealment of the hunter must be nearly perfect and decoys must be set properly. The hunter sees the duck or goose as a worthy adversary in a contest that requires great skill. Much satisfaction is derived from outsmarting the animal. Many other sources of pleasure were identified in discussions with hunters, but none approached in importance the contest between man and animal. Emphasis placed upon the contest has many ramifications. For example, in response to one question, 76 percent of the hunters preferred to work all day for a bag limit rather than obtain it quickly. As in any contest, a person must win from time to time in order to maintain enthusiasm. Killing ducks and geese is the payoff. Mastery of the game through hunting skills can be demonstrated only in this manner.

In another series of questions the price of the Federal Duck Stamp was explored. One question was as follows:

How high would the price of a duck stamp have to go to make you stop hunting?

The current price is $5 and 4 percent said they would stop at that price. At $10 an additional 37 percent claimed they would drop out. The median value in this distribution was $12. That is to say about half of the hunters are claiming they will not participate if the price of a duck stamp is $12.

We questioned hunters to determine how much they know about waterfowl. The duck hunter has unique problems in identifying the species he is shooting. In some parts of the United States a hunter might have opportunities to shoot one or more of 20 to 30 species of waterfowl. Also, plumages of birds can vary depending on their sex or age. We asked hunters to agree or disagree with the following statement:

I can recognize the three or four most common ducks occurring here, but I have trouble if it is not a common duck.

Eighty-one percent of the respondents agreed with this statement. In a waterfowl identification test given to participants of the group-interviews, the average score was four correct answers out of a possible 10. Color photographs of common waterfowl were used in this test. The test gave results similar to the questionnaire, thus it appears that most hunters can identify three or four waterfowl species common to their area, but have trouble identifying other species. We have to conclude that the hunter's ability to identify waterfowl is rather limited and this is not surprising. Accurate identification of birds is a skill that requires a great deal of practice.

In another question the hunters were asked to rank six management activities in order of importance. High scores reflect importance in the opinion of hunters. The activities and their corresponding scores were as follows:

Activity	Score
Protecting nesting grounds	92
Providing refuges for waterfowl	75
Providing more land for public hunting	70
Raising ducks for stocking hunting areas	47
Hiring more wardens	30
Training and testing programs for hunters	26

Dollars expended throughout the United States each year on the six activities were not determined, but management priorities and the hunter's priorities would seem to be reasonably close.

You will note that training of hunters was not very important in the opinion of hunters, but this topic was explored further. We asked:

If you could take a free course in identifying ducks, would you take it?

Thirty-five percent said they definitely would and an additional 34 percent said they probably would. Apparently the low rank for training did not mean that hunters were opposed to it.

In a situation in which more liberal regulations are possible, 72 percent of the respondents preferred longer hunting seasons while 29 percent preferred larger bag limits. Twelve percent preferred seasons that open and close earlier, while 49 percent preferred seasons that open and close later. The remainder were satisfied with current seasons. The preference for later opening dates seems to relate to the fact that harsh weather was viewed as a very desireable component of the hunting experience. In many areas harsh weather must increase hunting success.

Some violations of hunting etiquette were judged by hunters to be more serious than some violations of hunting laws. Not retrieving a bird that fell in a place difficult to reach or shooting over another hunter's decoys were considered serious breeches of etiquette. These scored slightly higher as improper behavior than treating bag limits as a group limit, hunting without a license, or hunting at the wrong time of day.

There is an obvious difference in attitude between hunter and manger with respect to the purpose of the daily bag limit. Many hunters believe the daily bag limit represents their share of the resource. Within self-imposed restrictions, hunters use a variety of means—both legal and illegal—to obtain a bag limit. Violations of the law do not become a serious matter in the mind of some hunters until after they have obtained what they believe to be their share of the game; whereas, the manager sees the maximum allowed per day as an upper limit of success to be achieved by a small fraction of the hunters. This difference in point of view regarding the bag limit must be responsible for many of the violations of hunting regulations.

In our questionnaire, 48 percent of the respondents admitted they had violated regulations on shooting hours and 70 percent admitted they had obtained bag limits by accepting birds from other members of a group. About two-thirds of the respondents indicated that they did not think violations of regulations were necessarily an indication of poor sportsmanship.

James M. Acheson (1975) examined Maine lobster fishing in both social and biological contexts. Though lobster fishing is a vocation and waterfowl hunting is an avocation, there are comparisons here worthy of consideration. Both activities occur in a harsh environment and participants tend to be the rugged individuals among us. Both activities are rich in tradition. Both involve considerable investments of time and equipment. Acheson warns of the dangers of altering traditions associated with such activities when the nature and strength of these traditions are not fully understood. The rules of behavior about which he speaks do not occur in written records. This does not imply that they are not strongly adhered to by participants. Undoubtedly, imposed rules that run contrary to traditions will be met with resistance. Management strategies must be biologically sound, but managers must be sensitive to the fact that some strategies will not be socially acceptable. Better communication between managers and resource users is essential in all cases. It is obvious that lines of communication between waterfowl managers and waterfowl hunters are not strong. The time for an increased effort in this regard has surely arrived.

We would like to emphasize that this study is still in progress. A final report summarizing all results should be available in about 12 months.

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Discussion

CO-CHAIRMAN HAWKINS: While somebody is going to the nearest microphone, I might comment by saying that it is only recently that wildlife managers began to realize that managing wild animals was fairly easy. The big problem is how to manage people. Studies like the one just described by Bob Smith are a necessary prerequisite to any serious attempts at people management.

MR. TONY MAZZACCARO [Texas A & M]: I have a big concern about the fact you ignored nonrespondents. That accounts, I think, for a percentage of the sample you attempted to collect. Behavioral research—the generalized ability of behavioral research—is left open to suspicion if these nonrespondents are not surveyed somehow.

The assmptions you have taken from the data collected could be substantially changed by these people who chose not to respond to this questionnaire.

A majority of these people might hold opinions that are contrary to those of the majority of respondents had. I would like to know if you intend to contact nonrespondents and, if not, why not?

DR. SMITH: These studies are being done under contract and a study of that problem is a part of the contract. We have not reached that point in our work, and I hope I qualified my comments in the paper sufficiently to allow for any changes in percentages that will result from this bias.

I personally feel that nonresponse is going to be a factor, but not be a major factor in the final conclusions because a portion of the nonrespondents never hunted waterfowl that year. There are quite a few stamp collectors in this group, and I doubt that such things as incorrect addresses introduce a bias. In other words, the nonresponse that represents a possible bias was relatively small.

CO-CHAIRMAN HAWKINS: Bob, test after test shows that most hunters have trouble identifying ducks. In view of your findings that the commitment of at least half the hunters toward waterfowl hunting is casual, do you have much hope that duck identification skills can be improved to any significant degree?

My second question, which you may or may not wish to address, is this: If they cannot be improved, would you care to speculate what effect this might have in relation to species management?

DR. SMITH: In answer to your first question, I can discuss that. As to the second one, I am not so sure that we have enough information to discuss it. It is true that at least half of these people have a casual interest in the activity and one would doubt that they are ever going to learn to identify the various species of ducks. However, these people also are not killing very many of the ducks. They are not committed hunters and they are not the ones actually doing most of the duck shooting.

Therefore, if you write that group off, then what can you do with the other 50 percent? I think there are some interesting possibilities for training the committed hunter.

I recommend that you hear Dr. Kellert in another session tomorrow because he will discuss attitudes of the American public toward animals and types of hunters can be categorized just as the general public. There are certain types of hunters who are very eager to be trained and other types of hunters who are not.

I am concerned that many waterfowl hunters are primarily interested in mastering the skills of hunting and in outsmarting the animal. These people, according to Dr. Kellert are different from the naturalist hunter, for example whose interests are oriented to the natural environment. Naturalists are going to be interested in identification of ducks.

We don't know at this point what portion of the waterfowl hunters are dominionists, naturalists, or utilitarians or the other categories that are being identified by Dr. Kellert. This will be investigated in the last phase of our work to be completed in about a year.

A Management Plan for Waterfowl

Lynn A. Greenwalt
Director
United States Fish and Wildlife Service
Washington, D. C.

The purpose of my talk today is to present for your consideration my views on a national waterfowl management plan. For approximately 15 years the development of a formal statement outlining a comprehensive management program for North American waterfowl has been a topic of great interest among waterfowl managers. During the 1960's, representatives of the four waterfowl flyway councils, the Canadian Wildlife Service, the United States Fish and Wildlife Service (FWS) and private conservation organizations met on two separate occasions to discuss and define the goals and objectives of such a program. These meetings led to a report produced in 1967 entitled "Program for Waterfowl Management and Research." The report contained recommendations on priorities among some 30 waterfowl management activities and research projects considered important at that time. In a related effort the Migratory Wildlife Committee of the International Association of Game, Fish and Conservation Commissioners held a series of discussions during the period 1966-1972 aimed at drafting an international migratory bird policy statement.

Although these efforts did not fully achieve the objectives set by the participants, they focused attention on many of the major management problems, both national and international, and they influenced subsequent management and research activities. Some of the highlights were summarized and presented in a paper by Dr. John Gottschalk and Allan Studholme entitled, "Waterfowl Management in the Seventies," at the 1971 North American Wildlife and Natural Resources Conference.

Their paper set forth, in general terms, waterfowl management goals, and major elements of program implementation as they were viewed by the Fish and Wildlife Service at that time. With a few exceptions I believe these are still useful in defining the broad outline of a comprehensive waterfowl management plan and identifying the general concepts and activities that should be included. However, there is a long felt need to put flesh on this outline—to be more specific about program objectives, priorities and responsibilities. This is what I intend to address today.

Your program indicates that I will be discussing a new plan for managing waterfowl but I want to point out right now that much of what I say will not be new in the sense of never having been discussed before. Perhaps the main thing new about this is that I am personally concerned that we complete this task soon and I am committed to following through on it.

Responsibilities

The Federal Responsibility

The first topic I want to discuss is the matter of management responsibility. In the United States the management of waterfowl and other migratory birds is a federal responsibility by reason of international treaties with Great Britain (for Canada - 1916), the United States of Mexico (1936) and the Government of Japan (1972). These treaties are designed to protect and perpetuate migratory birds, and regulate their use for the benefit of the citizens of the several countries. All of them are implemented in this country by the Migratory Bird Treaty Act. This most important piece of legislation was passed by Congress in 1918 as a means of implementing the treaty with Great Britain, and was later amended to implement subsequent treaties. Along with the treaties it may be regarded as the cornerstone of the federal responsibility for migratory birds.

Various other federal legislation such as the Lacey Act, the Migratory Bird Conservation Act (1929), the Migratory Bird Hunting Stamp Act (1934), the Coordination Act (1934), the Fish and Wildlife Act (1956), and the Wetland Loan Act (1961), further define and establish federal activities in wildlife management. I will not comment further on these now except to note that in one way or another they all influence the federal role in managing waterfowl.

International Cooperation

It is obvious from this that responsibility for managing waterfowl in North America is shared with other countries. It implies that we in the United States must coordinate and cooperate with our treaty partners in managing the resource on a continental basis. In fact, we have been doing this in varying degree for many years. Traditionally we have worked most closely with our friends and counterparts in Canada. Thus, Canadian and United States biologists conduct cooperative waterfowl population surveys, we jointly operate a North American bird banding program which is highly important to waterfowl management, and we cooperate in numerous other research and management activities.

We have worked in a similar fashion with Mexico. But the work has been less extensive because most of our concerns and priorities in regard to waterfowl management have been directed to the north.

It is my intention that the FWS will develop closer liaison and cooperation with Mexico, Canada, and other countries that support and share a common migratory bird resource with us. I believe this is not only desirable but necessary if we are to discharge our management responsibilities in a continental environment which subjects migratory birds to increasing pressures from human population growth and associated agricultural and industrial expansion.

In line with this, Director General Allan Loughrey of the Canadian Wildlife Service and I have recently established a joint CWS/FWS Wildlife Program Review Committee. We have instructed the committee to review wildlife activities of mutual interest to our two countries—with particular emphasis on waterfowl and other migratory birds—and make recommendations to us about common goals, policies, and procedures that will enhance our joint management of the resource.

In a similar vein the Fish and Wildlife Service has recently developed a cooperative wildlife agreement with the Mexican Wildlife Department. Waterfowl problems of mutual interest and concern will be included in the joint activities pursued under this agreement.

Our primary efforts in developing closer international management cooperation and coordination are directed toward Canada and Mexico since it is they to whom we are most closely related in the sharing of a common resource. However, we have begun and will continue to develop similar liaison with other countries where there is a mutual interest in some segment of our migratory bird resource. I have already mentioned the migratory bird treaty with Japan. We also have a working relationship with the Soviet Union that involves certain waterfowl and other migratory bird population segments for which both countries have a high degree of interest and concern.

Federal-State Cooperation

In addition to these international aspects there is another level of cooperation that is essential to the effective conduct of any comprehensive waterfowl management program in the United States. I refer to the Federal-State management partnership that has been developed over the years in this country. Waterfowl are migratory birds that cross and recross many State boundaries during their movements each year. Thus, there is an obvious Federal role in their management. However, State governments also have a basic responsibility and authority in this area which derives from the powers reserved to the States under our constitution. Thus, there is a clear basis as well as a clear need for shared responsibility.

For nearly 25 years federal-state cooperation has occurred through a system of flyway management. Each of the four flyways in the United States has a Flyway Council which is basically an organization of States that share in the management and utilization of a common flyway resource. They provide a means for the exchange of views about waterfowl management problems between State and Federal Governments, and for the development and implementation of cooperative management programs.

I believe this has been a highly successful system. It does not appear to me that there is any other system that would serve so well to enhance waterfowl management. I intend to foster this system, and to seek ways to strengthen and improve it. In my view, a mutual and sympathetic sharing of management efforts and responsibilities between state and federal management agencies is essential to the proper management of waterfowl in this country and, also, to the success of cooperative efforts with other countries.

To achieve this it is my intention to seek, in consultation with the states, to more clearly define those aspects of management that can be conducted best and most efficiently by the Federal Government on the one hand, and state governments on the other. I intend to work hard in this direction because I believe our resources are too limited to afford unnecessary and unproductive competition in this area.

Management Goals and Objectives

Habitat Preservation

The primary objective of waterfowl management is to maintain the waterfowl population base at the highest level possible within the constraints imposed by other overriding needs and demands of our society. There should be no doubt in anyone's mind that the most important factor affecting this objective is the quantity and quality of habitat. This in turn is affected not only by natural factors but more importantly by other demands for land use.

The more or less cyclic changes in waterfowl populations caused by natural factors, such as weather, are temporary in nature and need not concern us at this point. Those caused by man through drainage of wetlands and other forms of destruction and deterioration of habitat are for all practical purposes permanent and irreversible. The most restrictive hunting regulations imaginable will not compensate for continued serious loss of habitat.

We cannot turn the clock back—we must learn to work within the conditions tht exist now. As wildlife managers, we have had only minimal control over the way society uses the land. Over the long term we must convince society of the need to use land in a way that does not further reduce waterfowl habitat in either quantity or quality. I believe that a public awareness of this need is beginning to develop. With a strong and concerted effort by all organizations and individuals concerned with maintaining the waterfowl resource there is at least a hope that this awareness can be nurtured to the point that significant habitat losses will be reduced or halted. In the meantime, a program of habitat preservation and improvement must be regarded as the highest priority element of a national waterfowl management program.

There is not time now to review in detail the losses of wetlands that have already occurred in the United States. Suffice it to say that the best information available indicates that we have lost between 40 and 50 percent of the 127 million acres of wetlands believed to have been present originally and losses are still continuing.

According to a recent Fish and Wildlife Service survey, state agencies now own about 3.7 million acres of habitat, mostly wetland, that has significant value to waterfowl, and they control another 2.5 million acres through leases, easements, and other means. Private conservation organizations and federal agencies other than the Fish and Wildlife Service own another million acres and private waterfowl hunting clubs own or lease more than 5 million acres. Since 1961 the Fish and Wildlife Service has added nearly 2 million acres to the 3.4 million acres of waterfowl habitat included in the National Wildlife Refuge System in the lower 48 States prior to that time.

In 1975, an estimated 10 million acres of wetlands having primary importance to waterfowl were still unprotected. Only temporary protection is afforded many other wetlands of somewhat lesser importance. Under our waterfowl management plan we will seek to preserve an additional 2 million acres of the most important of these wetlands during the next 10 years. Recognizing that our resources are limited, the Service proposes to focus its primary effort on the preservation of breeding and wintering habitat. We believe this is crucial to the maintenance of waterfowl populations and should have the highest priority. A similar priority applies to states where there is important breeding or wintering habitat. Otherwise, we encourage the states to focus their efforts on the preservation and managment of migration areas, particularly in those situations where this will contribute to improved distribution of waterfowl and hunting opportunity. We hope to encourage other agencies to assist in preserving important segments of the remaining wetlands.

The recently enacted Wetland Loan Extension Act of 1976 will help by providing a continued source of funding. It extends the loan authority through 1983 and adds approximately $95 million to the original funding authority. The amount of help this will provide depends entirely on the extent to which funds are appropriated and made available. This, plus estimated duck stamp receipts of $85 million over the next 10 years, will provide somewhat less than half the amount needed to accomplish the 2 million acre objective. How to provide the additional funding needed is a major problem for management to solve in the near future.

Population Goals

One of the more difficult aspects to deal with in developing a waterfowl management plan has been the matter of population objectives. By that I mean the development of numerical goals for waterfowl breeding populations generally, and for particular species, and the development of objectives relating to the distribution of waterfowl. These matters have been discussed for many years and have been subjects of considerable disagreement and uncertainty.

It appears to me that there is little argument with the idea that management should seek to:

(1) Maintain sufficient breeding stock to effectively utilize available nesting habitat.
(2) Maintain some reasonable level of species diversity with particular attention to preserving and restoring populations of species that are endangered or threatened.
(3) Maintain or improve the distribution patterns of various populations or species.

I believe that these are sound and necessary objectives. The difficulty lies in translating them into more specific terms that will provide practical guidance to management. In thinking about these problems it is important to keep in mind that in the long term waterfowl populations must be considered in relation to available habitat. Whatever objectives we may set in terms of numbers there must be sufficient habitat available to support the populations involved.

Further, we must recognize that whatever the habitat base may be it will vary annually in quantity and quality, depending on natural factors such as precipitation, and this will affect populations. Waterfowl populations are not static—they are highly dynamic entities interacting among themselves, and with other elements of the environment in ways that result in annual numerical fluctuations.

The size of the continental population of most species of waterfowl cannot be established in terms of absolute numbers. However, we know with varying degrees of precision the general population status of most species. Although this knowledge is not as refined as we would like, it can be used for the establishment of at least preliminary population objectives for species or population segments that require management attention.

Some of this has been done already. For example, population objectives have been established for a number of years for some intensively managed populations of Canada geese, During the past two years population objectives for Atlantic and Pacific brant, and Atlantic snow geese have been developed, which will help to guide management decisions for these species, particularly relating to harvest.

This is more difficult to do for ducks because they do not lend themselves as readily as geese to the delineation of discreet population segments. Nevertheless, short term population objectives have been developed recently for some ducks such as mallards breeding in surveyed areas of the central part of the continent and black ducks in the east, and we presently are considering more specific objectives for others such as canvasbacks and redheads.

It is my intention that the Fish and Wildlife Service will continue working in the direction of developing refined numerical populations objectives for various species and populations. I do not believe that it is either essential or feasible to do this at the present time for all species. Instead, primary attention must be directed to those species and populations where it is important to have these kinds of objectives to guide management decisions.

For other species we will continue to monitor status as carefully as possible so that we will be aware of any problems that may develop and take whatever action seems most appropriate to alleviate them.

Regarding the matter of distribution of waterfowl populations I am aware that there are conflicting views among waterfowl managers. This relates primarily to the fall and winter distribution of waterfowl in the United States. Some contend that management should seek to deliberately alter distribution to bring it more in line with the distribution of people; the objective being to make the resource available to people on what is felt to be a more equitable basis. Others hold that we should seek to maintain either traditional or existing distribution patterns. I do not reject the concerns underlying these differing views, but I believe that strict adherence to any one of them is not a practical management objective.

Fall and winter waterfowl distribution is inseparably tied to habitat. In the United States there are great natural areas, primarily wetland areas, of habitat and waterfowl abundance. The biological importance of these areas is great not only for waterfowl but for other wildlife, and we should do everything we can to preserve them. I do not believe it is desirable for management to deliberately seek major changes in traditional waterfowl distribution patterns because of the risk that this will seriously weaken our efforts to preserve the habitat.

On the other hand, I recognize that some substantial changes in distribution have already occurred and others may be underway.

The so-called short-stopping of Canada geese is well known and is a case in point. Personally, I don't like the term "short-stopping." It means different things to different people and is not always a result of some management practice by state or federal wildlife agencies. These changes are directly related to the availability of food, water and sanctuary in places where they did not exist before. They are the direct result of changes in agricultural practices, water management, and other factors. For the most part these changes were not and are not under our control, although some of our management activities very likely contributed to the way waterfowl have responded to them. Some of these changes have actually created habitat and we cannot arbitrarily say that this is not good. On the other hand they may have created undesirable distribution problems that should be corrected. I believe that the Service and the Flyway Councils must work together to learn how to control these concentrations, and eliminate those aspects that are undesirable.

Utilization

One of the most important aspects of waterfowl management is providing for utilization of the resource by people. People utilize waterfowl in various ways but the principal activities are recreational in nature and consist of sport hunting on the one hand, and such activities as bird watching, aviculture, and photography on the other. Many users participate in both of these major categories of recreational activities.

Another form of utilization is subsistence hunting. In some of the more remote areas of North America, where people still live under primitive conditions, subsistence hunting as distinguished from sport hunting of waterfowl is an essential source of food at certain times of the year. I mention this at this time simply to point out that it is an aspect of utilization that we must be aware of and give consideration to in thinking about the overall management scheme.

In some years as many as 2.5 million people participate to some degree in waterfowl hunting in the United States. An even greater number enjoy waterfowl in other ways.

Management is concerned with providing as much opportunity as possible to enjoy waterfowl, whether by hunting or non-hunting activities. Non-hunting utilization of waterfowl is limited only by the availability of places to see birds, and the time, desire and interest of the participants. Waterfowl hunting on the other hand is subject to more stringent controls based primarily on estimates of the numbers of birds that can be harvested without detriment to the resource and the number of people who wish to hunt.

You are all aware that waterfowl hunting and our management of it is a controversial activity in the minds of some. Various aspects of it have been challenged in the courts during each of the last two hunting seasons. It has been discussed thoroughly in an Environmental Impact Statement on Migratory Bird Hunting prepared by the Fish and Wildlife Service and released in June 1975; and I refer you to that statement for further details. At this point I will simply say that criticism and outright opposition to waterfowl hunting is a matter that we cannot ignore in considering how hunting should be managed in the future.

Regulations governing the harvest of waterfowl are established annually based on an extensive series of surveys to determine the status of the resource and the proportion that may be harvested. Over the years a system has been established whereby this is done cooperatively by the States and the Federal Government operating through the mechanism of the Flyway Councils. We have recently sought to strengthen this cooperative arrangement by bringing the states, as represented by the Flyway Councils, more directly into the process of reviewing population status and developing population and harvest objectives, and regulatory recommendations.

I believe the Service and the states must continue this effort to work more closely in all aspects of the process leading up to final decisions on regulations. Waterfowl hunting regulations by law must be established at the federal level, but, speaking for the Fish and Wildlife Service, we are less interested in dictating the nature of hunting programs than in assuring that such are in keeping with the welfare of the resource. As agencies with formally defined management responsibilities, the States have an extremely important investment, and an extremely important role to play, in the management and control of waterfowl hunting programs. It is my desire to provide them with the opportunity to play this role and to assume the responsibilities associated with it. I am convinced we can no longer afford to pursue separate courses in this area.

Nothing I have just said should be construed to mean that the Fish and Wildlife Service does not have a strong interest and concern in the conduct of hunting programs and the quality of hunting itself. Looking to the future the Service must give priority attention to firming up the foundation for regulations and management of waterfowl hunting. Not only hunters and non-hunters, but many of the professionals working in this field need to better understand the regulations, the rationale behind them, and their role in the total management picture. We must resolve the issues surrounding species management, short-stopping, feeding programs, lead poisoning, quality hunting, and a host of other issues that are often addressed in less than objective terms. We invite and encourage the states and other agencies interested in the proper management of this resource to join us in this effort.

Conclusion

I would like to bring this presentation to a close now by touching on a few final points concerning a National Waterfowl Management Plan. I have discussed this plan today in only the broadest terms but I recognize that it needs to be presented in much more detail. I have instructed my staff to have a final draft completed for my review in 1976. I intend that this plan will present in more detail the major points I have highlighted today. In summary these include:

(1) Quantitative population (objectives) for those species and populations for which sufficient information is available to make this feasible and useful.

(2) Where we lack such information, I intend that we shall make a diligent effort to obtain it.

(3) We will continue to move in the direction of identifying and defining specific population units, particularly for ducks, to assist in guiding management decisions on the basis of population units such as we have been doing successfully for geese.

(4) I intend that we shall continue to refine our understanding and our ability to measure the effects of hunting regulations and harvests on waterfowl populations.

(5) We will pursue further the question of what constitutes proper distribution of the waterfowl resource, and identify those situations where there may be a need to effect or try to effect changes in distribution.

In this paper my attention has been focused on waterfowl management problems in the United States but I recognize that many aspects of our management have international implications and cannot realistically be confined to one country. Ultimately we must give further consideration to joint efforts with Canada and Mexico to deal with the international aspects of habitat preservation, as well as a system for international management of annual harvests. I suggest that this cannot be postponed much longer.

Discussion

CO-CHAIRMAN HAWKINS: As one who was involved in developing early drafts of a waterfowl management plan dating back to the early 1960's, as well as more recent drafts, I know how controversial components of such a plan can be. If all of these controversies had to be resolved first, we never would have such a plan no matter how badly we need one and I think you will be the first to agree that these brief efforts to develop a plan have not been wasted efforts.

Many elements of past plans already have been implemented, rejected, or have been proven impractical, and the plan which will be unveiled soon will be the result of these early efforts, plus the more recent ones.

Do we have any questions or comments? While somebody is coming to the microphone, I might throw out one here.

In view of the findings reported by Bob Smith, do you anticipate that greater emphasis may need to be placed on trying to improve communications between waterfowl managers and resource users?

MR. GREENWALT: You know, Art has never been bashful about asking me questions and they are usually tough ones.

Quite obviously, the function of such a plan—whatever form and substance its details may take—is based upon the idea that the waterfowl are easier to manage than people are, and people are managed only through effective communication.

Among the things I feel we have to ascertain for each other's benefit are things that are being identified by Bob and his work.

The study that Bob is managing, for example, has to do with society's overview of waterfowl resource management and how it should be used, how many there ought to be and in what places. These, of course, are the kinds of things that have to be understood and accommodated to the degree possible if such a plan is to be effective at all. I would suggest this should be and certainly will be an integral part of all of this.

MR. WILLIAM VOGT [Outdoor Life Magazine]: In keeping with the questions just asked, would you anticipate changes in the structure of the administration of the Flyway Councils to include more nonhunting segments, in view of the recent litigation that has come up?

MR. GREENWALT: The Flyway Council is a structure, an aggregation of states, and there are technicians at the technical level and administrators at the Flyway Council level.

The practice among Flyway Councils has always been to have these meetings opened to the general public. I know that the state directors and those who are responsible for the conduct of council activities are pleased to have expressions of concern of any kind from the general public, including those who do not share the views of others, as to hunting waterfowl, because the statement of the population of the United States which is not committed to hunting or to anti-hunting or to any other philosophy, is critical. It is critical in relation to this resource and we ought to encourage them to express their reaction to the management not only of waterfowl, but of wildlife and habitat generally. So, certainly, they should be involved in these matters.

Whether they become formal members of the council is almost academic because if there is anything inherent in the Flyway Councils, it is basic informality.

MR. ROTSCH [Missouri Conservation Program]: In talking to a lot of waterfowl hunters, I have found many who said that the point system forced many of them to become more familiar with identification of various species of waterfowl. Also, as a by-product of that, they found they enjoyed the sport more. I wonder if we could not utilize this, put it to good work somehow by expressing this thing—they might enjoy the sport more if they learned more about the identification of the various species of wildlife?

Apparently species hunting is going to be with us for some time and we need to exploit all of the tools we have to encourage this better identification. I wonder if this would be one of the ways of doing it?

MR. GREENWALT: Certainly the element of communication, of understanding the inherent qualities to be found in waterfowl hunting is extremely important. That goes without saying, whether you play tennis, chess, or hunt waterfowl—that your enjoyment is going to be in direct proportion to your understanding of the elements that go into the sport.

No one should be surprised, for example, if a waterfowl hunter discovers he likes it more if he understands what it is he is doing. This, in my judgment, is fundamental to the perpetuation of this activity or any other activity and should be part of the whole communications system which is, in fact, people management in the context of resource protection and preservation.

Trends and New Directions in Federal Conservation Law Enforcement

Clark R. Bavin
Chief, Division of Law Enforcement, U.S. Fish and Wildlife Service, Washington, D.C.

Mr. Chairman, fellow resource managers, ladies and gentlemen: It is both a great pleasure and an honor to participate with you in this special session on migratory bird management.

As you know, the Migratory Bird Treaty Act, which implements the international obligations of the United States to protect migratory birds, is enforced by the U.S. Fish and Wildlife Service. While this act represents only one of eighteen major classifications of investigative activity engaged in by our Special Agents, migratory bird violations are responsible for more than half of the annual volume of cases. I call this to your attention because, while we are in this special session on migratory bird management, I am going to talk not only about migratory bird enforcement, but about our entire enforcement program.

During the past five years many important changes have been made in the Law Enforcement Division of the U.S. Fish and Wildlife Service. These changes have been necessitated by two primary factors: First, increased environmental awareness has resulted in the Congress passing several new federal statutes protecting wildlife through both criminal and civil sanctions. Second, the modern wildlife violator himself has become more cunning, more calculating, and more inclined to conspire with others to make major commercial inroads into the wildlife resources. My remarks this afternoon will focus on the trends of modern federal wildlife statutes, as well as the new directions implemented by the Fish and Wildlife Service to cope with the changing times in the wildlife enforcement area.

In looking at the newest of the federal wildlife protective statutes and their concomitant enforcement responsibilities, it is helpful to examine briefly the history of wildlife protective measures in this country. Of course this is a whole subject by itself and I can but give a brief summary today.

Historians tell us that in pre-Columbian times there existed in America a harmony of wild things or a "balance of nature." This primitive regularity was thrown out of kilter by the eruption of European settlements. These early settlers found game everywhere and believed that the abundance of wildlife could be described as "inexhaustable." It was understandable that in those colonial days the settler would develop the conviction that it was impossible to exterminate the game. He also developed an unfortunate character trait. That trait was a prodigal disregard for not merely game, but all wildlife, similar to the solicitude which the boy with a stick in his hand feels for the weeds by the roadside. This conviction and the character trait were transmitted to the early settlers' children and to their children's children and often became a local or family tradition. Another tradition which developed in those days was the fierce conviction that the free-born American had the right to bear arms, and to "gun" pretty much where, when, and how he pleased. Thus began man's impact on the balance of nature and the wildlife resources of this continent.

By the year 1776, game laws had been enacted pretty generally throughout the colonies. While New York and Massachusetts had given some protection to wild fowl, most protection was given to deer, an important food resource. From the Revolution to the mid-1800's there were very few, if any, new developments in game protective legislation. Between 1850 and 1885 the volume of game legislation increased greatly and showed a trend towards the concern for the possible extermination of animals. By the year 1880 there were game laws on the statute books of all the states and territories. Some of these laws established closed seasons, restricted methods of hunting wild fowl, prohibited spring shooting and market hunting, incorporated the concept of hunting licenses, established bag limits on game birds, and prohibited the waste of game.

By the late 1800's, the slaughter of wildlife for the market had begun to arouse the concern of the nation. To cope with market hunting at the local level many states passed laws prohibiting the export of game killed within their borders. This nonexport device was tested and upheld by the U.S. Supreme Court in the famous 1896 decision: *Geer v. Connecticut* (161 U.S. 519). The Court held that the killing of game is a privilege and not a right, and that the ownership of game differs from that of most other property in that even after it becomes a possession it is subject to certain restrictions. This decision had immediate, far-reaching effects, clearing the way for the nonexport provisions, and by 1899 more than half of the states prohibited or had restrictions on the export of game.

In spite of the nonexport laws in some states, game could be shipped illegally from those states and sold legally in states not giving protection. By 1900 the country was ready for national legislation. In that year the Lacey Act was passed prohibiting interstate commerce in game killed in violation of state laws. The act was designed to suppress the killing of game for the market and also the taking of plumes and feathers from both game and nongame species for the lucrative millinery trade. The act also regulated the introduction into this country of all exotic species of birds and mammals, and prohibited the introduction of species which were injurious to American wildlife or to agriculture.

Market hunting did not stop with passage of the Lacey Act and federal regulation of interstate shipments. Ducks, geese, swans, cranes and other birds were still killed in large numbers for food and their plumes. Profits were high and enforcement officers few. Many states did not provide protection. Public sentiment, however, became increasingly aroused, particularly concerning the slaughter of migratory waterfowl. In response, the Federal Migratory Bird Law—also known as the Weeks-McLean Law—was passed in 1913, and on October 1, 1913, the first migratory bird hunting regulations were adopted. The 1913 law was replaced with the Migratory Bird Treaty Act in 1918 which was based on the 1916 Treaty with Great Britain for Canada. Thus began the major federal responsibility for protection and conservation of our migratory bird resources.

In 1926 the Black Bass Act, regulating interstate commerce in fish, became law. In 1934 the Migratory Bird Hunting Stamp Act became effective. In 1937 the Migratory Bird Treaty with Mexico was proclaimed by the President. The bald eagle attained federal protection in 1940.

As you can see, the history of wildlife protection mirrors that of our growth and sophistication as a nation. We have progressed from a nation of primitive settlements, with a devil-may-care attitude toward wildlife, through a transition of local control, colonial control, state control, regional control, to a form of national control where it is necessary for the states to act together in the national interest.

During the next 30 years, the only major federal legislation in the wildlife protection area covered the golden eagle. Then, in June of 1970, the Endangered Species Conservation Act of 1969, prohibiting importation of endangered species, became effective. The momentum behind this Act launched a series of related laws which again expressed a growing national concern for the protection of wildlife.

The Airborne Hunting Act was enacted in 1971 and the Bald Eagle Protection Act amended in 1972 to provide higher penalties. A Migratory Bird Treaty with Japan was signed in 1972. The Migratory Bird Treaty with Mexico was amended in 1972 providing Federal protection to 21 additional families of birds. Also in 1972, the Marine Mammal Protection Act became law. On December 28, 1973, the Endangered Species Act of 1973 became law and greatly expanded Federal responsibility for endangered and threatened species. Then, on July 1 of last year, the Convention on International Trade in Endangered Species of Wild Fauna and Flora entered into force.

These new laws have obvioulsy increased and intensified the law enforcement responsiblities of the U.S. Fish and Wildlife Service. Responding to these national and international concerns in times of fiscal and manpower constraints has presented a challenge and required an indepth analysis of the way we were organized, the way we were doing business, and the identification of major enforcement priorities.

In making this analysis of our law enforcement functions, we also had to consider the fact that during the past several years we have encountered a more sophisticated wildlife violator. Enforcing the wildlife code to regulate the harvest of resident or migratory game in a local situation is one thing, but dealing with poachers, middlemen, brokers, or shippers of wildlife for commercial gain is another. Not only does the commercialization of wildlife present a more complex enforcement problem but hunters of today are more mobile than in years gone by. Many are willing to pay large sums of money to kill a record animal illegally in one part of the country, or for that matter the world, and return to their urban environment by airplane in a rather short time. Such trophies are usually shipped in interstate or foreign commerce presenting additional monitoring and investigative challenges. Not only are we uncovering allegations of large-scale illegal operations, but state conservation officers and state directors are increasingly asking for investigative assistance. Coping with these enforcement challenges requires mobility, communications, and the use of techniques far different from the conservation officer's normal activities with which we are all familiar.

To discharge our new enforcement responsibilities contained in the battery of recent federal legislation and to assist the states in those areas where they need help the most—that is in controlling interstate and foreign commerce in wildlife—a new kind of federal wildlife enforcement officer has emerged. Now called a Special Agent, he is becoming more of a professional criminal investigator with a deep interest and knowledge of wildlife management principles.

In order to help cope with the increased enforcement workload, we have removed from our Special Agents most of the statistical gathering responsibilities and depredation control activities in the wildlife management area, such as banding migratory birds and conducting migratory bird surveys. A reduction in these and other non-law enforcement duties has enabled them to devote as much as 30 percent more time towards enforcement activities. Therefore, without an increase in staff we have been able to absorb some of our increased enforcement case load. We realize, however, that to meet our new demands we still need more agents. Our current staff of less than 200 Special Agents, spread throughout all of the states, including Alaska and Hawaii, and Puerto Rico and the Virgin Islands, is not adequate to meet our new responsibilities.

The new Special Agent is concerned about all wildlife, game and nongame. As I indicated earlier, helping regulate the migratory bird harvest is still a major activity in the fall and winter. We are now more mobile and can concentrate Special Agents in a particular area where major migratory bird problems are occurring. For example, this past January on one migratory bird strike force operation in Chesapeake Bay (Maryland) we had 27 Special Agents involved. We are not decreasing our efforts on migratory birds, but are attempting to remain effective with our limited resources by concentrating our enforcement efforts.

For years our recruiting base for federal officers was the pool of state conservation officers. This was quite satisfactory, since they were mature, had been through a state training program, had several years of practical game law enforcement experience and had passed their "baptism of fire." Generally, they had worked with federal agents and were of known quality. Now this base is no longer our sole source of recruiting. Though we have not discontinued hiring former state officers, we also recruit young college graduates with a variety of backgrounds, such as, wildlife management, law, police administration, police science, criminology, and sociology or related behavioral and political sciences. We have a new training program in which we can make a new Special Agent, regardless of his college background, an effective federal wildlife enforcement officer. These changes are bringing people into our organization with diverse backgrounds in order to cope with the changing times.

Most significant of the changes implemented by Director Greenwalt to meet our increasing enforcement challenges have been the reorganization of our field enforcement staff and initiation of a case management and reporting system. Field and regional organizations of the Division of Law Enforcement were restructured in October of 1973 to introduce managerial tools and supervisory strengths necessary to further professionalize our enforcement program. Enforcement operations were decentralized by delegating broader responsibility and authority to the manager, and locating his headquarters closer to the scene of action. The country was divided into 13 law enforcement districts, each with a manager called Special Agent in Charge (SAC), who replaced the previous regional supervisor position. New law enforcement district boundaries are confined to the normal Fish and Wildlife Service regional boundaries (Figure 1). In an individual region there may be from one to three law enforcement districts.

Because of the sensitivity and complexity of our law enforcement function today, the SAC is a senior field official and reports directly to the Regional Director.

At first glance it might appear that we have simply taken the former six regional law enforcement organization entities and divided them into 13. That is not the case, for we have eliminated the old Agent in Charge (AIC) position previously existing in most states. We did this because the former organization tended to localize our enforcement operations on a state-by-state basis. Each AIC had his own budget and from zero to several agents assigned under his control. Interaction between states, even within the same region, was not too common and while this arrangement proved satisfactory for regulating the annual migratory bird harvest, it is not conducive to our new federal wildlife enforcement needs.

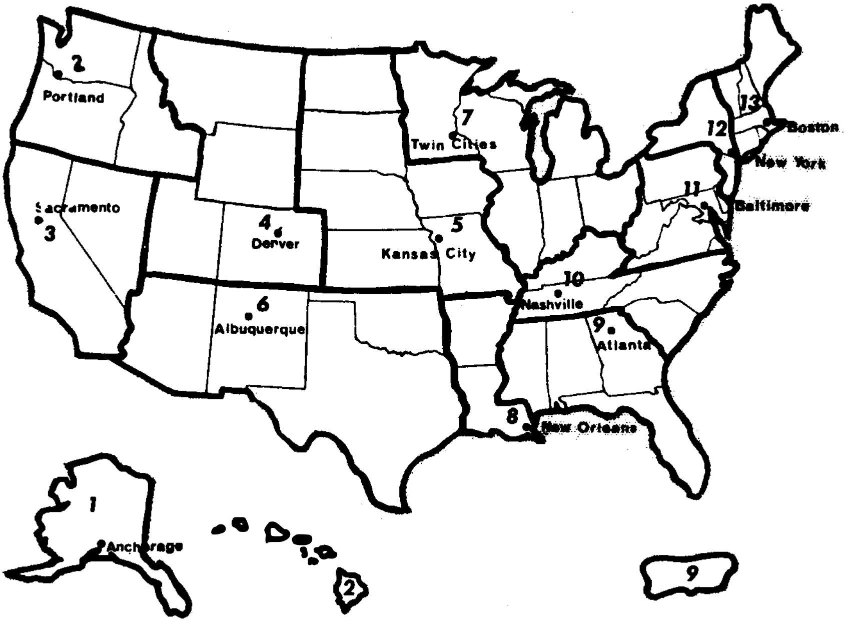
Now we have instead 13 districts, each with a manager, the SAC. The budget and administrative support functions are maintained at the district office freeing the majority of field agents from routine administrative duties. The SAC is responsible for all field investigative activity within his district and has several senior agents strategically located to assist in supervising the Special Agents assigned to the district on either a permanent or strike force basis.

Our law enforcement restructuring has accomplished a realignment of responsibilities into more manageable combinations which are conducive to group problem solving. Smaller geographic areas of responsibility, a more reasonable span of control, closer executive coordination with the states, no constraints on state boundaries, and closer local contact with state officers will continue to enhance our capability to address all facets of our law enforcement obligations. This restructuring has welded enforcement functions into a more cohesive structure from the Regional Director downward. It provides a harder hitting, more efficient, and more effective federal force. And provided we continue to have the excellent cooperation of the states, we can be more responsive to current wildlife protection problems.

The other major change, the new case management and reporting system, has been designed to enable us to more effectively assign priorities to investigative matters and to coordinate intradistrict as well as interdistrict investigations. While the system is patterned after that used by other federal investigative agencies, it was tailored specifically to our needs which include the handling of a simple duck stamp violation as well as that encompassing a major commercial transaction. Our new case management and reporting system has been field tested and is now implemented throughout the entire country. We are still going through growing pains, as is normal with the implementation of any new system, but in the long run it will be a major management tool.

In addition to the major changes I have identified here, many steps have been taken to develop appropriate support capabilities necessary to serve the field force. Many of these investigative support services have been centralized in the headquarters office in order to serve the entire country and are available for assignment to specific districts or states where operational needs dictate. We have also been emphasizing the use of investigative techniques not normally employed by state wildlife agencies. These include, as I mentioned above, the utilization of strike forces, and the increased development and utilization of informants and undercover operatives.

United States Fish and Wildlife Service
Division of Law Enforcement,
District Offices



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Telephone: (907) 278-2031

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Portland, Oregon 97208
Telephone: (503) 234-3361

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Sacramento, California 95825
Telephone: (916) 484-4748

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Telephone:(303) 234-4612

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Telephone:(612) 725-3530

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Telephone:(504) 589-2692

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Telephone:(212) 995-8613

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Boston, Massachusetts 02101
Telephone:(617) 223-2987 or 2988

Figure 1.

I have tried, during this brief discussion, to focus attention on the historic development of federal wildlife protective statutes highlighting the intense national concern expressed by a battery of new federal statutes during the past five years. These new statutes, coupled with the changing more sophisticated, more mobile wildlife violator of today, caused the U.S. Fish and Wildlife Service to examine its law enforcement function indepth. As a result, a number of changes were made and a new direction charted—that of developing a professional investigative arm capable of meeting the new challenges of wildlife enforcement of today and tomorrow.

There is no intent to predict or indicate that this is the direction that state agencies should take. Their enforcement responsibilities are more localized and the conservation officer concept is probably more appropriate. At the federal level, however, we have a different kind of responsibility, and a much smaller staff, which requires a different approach. We believe we are on the right course. As we move ahead to meet these changing times, we will be able to more effectively work with the states in our joint effort to complete a total picture of wildlife protection.

Discussion

CO-CHAIRMAN HAWKINS: Mr. Bavin has described the "new look" in law enforcement and in the Law Enforcement Division of the Fish and Wildlife Service, including new activities and responsibilities. I am sure some of you will have some questions that you will wish to ask with regard to this new system of law enforcement. Are there any questions?

MR. WILLIAM KIEL [Texas]: I would like to ask Mr. Bavin if about one-third of the time of some of the former game management agents has now been taken from their time in the field for banding ducks and running surveys and if these have been replaced with waterfowl management surveys and banding activities or has all of that effort been lost?

MR. BAVIN: My area is not in conducting surveys. As you know, Mr. Rogers is in charge of that but it is my understanding that the same survey level has been maintained but simply other entities of the Service have absorbed this responsibility. I really cannot comment beyond that.

We are doing some of this work. Some of our pilots are still going to Canada but, in the meantime, the agents have been relieved of this kind of responsibility. That is about as responsive as I can be to your question at this time.

CO-CHAIRMAN HAWKINS: While somebody else is coming to the microphone, I might ask you this.

You made some comments regarding the sophisticated violator of today. I am wondering if you are talking about waterfowl hunters? Are they included in this, or are you talking about other types of hunters? I wasn't aware, for example, that waterfowl hunters were becoming that much smarter today.

MR. BAVIN: Art, I think they have been smart for a long time. I am referring to the commercial inroads that have been made and have been called to our attention in recent years. I am sure this has gone on for many years. However, in the past five years, we have been encountering a much different kind of violator.

Where there are large profits as there are today, they use a variety of new techniques. One simple illustration, for example, would be someone who is a smuggler, whether this involves the smuggling of narcotics, diamonds or furs. He really doesn't care what he smuggles—he is in it for the profit and he knows the business. In turn, he is presenting new challenges for our agency.

MR. CARL NEWLING [U. S. Army Corps of Engineers]: I would like to know if you can offer any suggestions to members of the public in general as to what we can do to assist you?

MR. BAVIN: There are two things that the public can do. The first is to become aware of wildlife protection laws themselves and voluntarily comply. That is our goal in relation to the enforcement business—to seek voluntary compliance with the laws.

Secondly, the public, through their state agencies or through us, can provide information about offenses which they see or have reason to believe occur to us and we will be very pleased to look into it. As you may know, any police department thrives on the information of the public and we likewise encourage public participation and support.

MR. WILLIAM ROGERS [Naval Air Station, Maryland]: I am interested in the type of in-service training programs you have for your people regarding wildlife identification and management.

MR. BAVIN: We have an eight-week basic criminal investigation course and a three-week basic fish and wildlife course that we teach our new agents. Therefore, they go through 11 weeks of training and during the three week course there are many hours of wildlife identification involved.

In terms of in-service training, it is more, at this time, on-the-job training, depending on where the agent is stationed. In other words, if he is working, for example, in New York City, he encounters a different kind of wildlife identification problem than in some other parts of the country. Therefore, more of the in-service training is localized and not particularly formalized.

Improving International Cooperative Efforts: Accomplishments and Needs

Aquatic Migratory Birds in Mexico

Mario Luis Cossio Gabucio
General Director of Wildife, Mexico

The Government of Mexico through the Direction General of Wildlife has always put special interest on the protection of aquatic migratory birds. Naturally, there is always a shortage of economic resources designated for this purpose, thereby not permitting the best work on behalf of these animals.

At this time there are a few programs that are partially or totally related with the study of aquatic migratory birds, both game and nongame birds.

In the Pacific Littoral we have Sebastian Vizcaino's program with headquarters at the town of Guerrero Negro. This program has the objective to quantify, protect, and benefit these birds that arrive via the Pacific route principally to the Sebastian Vizcainos Bay from San Quintin and other closer places. Created in an artificial manner this area is called Marismas Nacionalas and is located west of Culiacan City. It is one of the places where most of the ducks and geese concentrate for wintering in all of the Mexican territory. That's why the General Direction of Wildlife struggled for a few years to get it established as an observation station for migratory aquatic birds. We have obtained great results with the quantification and study of these birds, including the residents.

On the South Coast of Mexico in a region called Laguna Chacahua there has been established another program to study wintering aquatic birds. Though not covering the total area, most of the south coast of Mexico is covered strategically.

Unfortunately, the observations completed on the Gulf Coast and the programs dedicated to this study of aquatic migratory birds are much less than on the Pacific coast. Counting is only with the one established program at the Yucatan Peninsula that is dedicated, among other things, to the study of wintering migratory birds. At the same time, in a partial way, at the Caribe Sea, we have a winter station called Bacalar Lagoon. Among its plans of study is one on aquatic migratory birds.

Not knowing the quantity of hunting of aquatic migratory birds in Mexico, as well as the arrival of species, the General Direction of Wildlife for three years has been sending technicians every weekend during the four months of the duck hunting season to the Lerma Marsh. This study has shown us the population fluctuation of migratory aquatic birds. We hope to get more facts in the near future, but those available now show that most hunters of Mexico and Toluca go to Lerma Marsh.

We have established at the Direction's laboratory a study of the feeding habits of aquatic migratory birds during their wintering stay. We soon hope to have enough information. Then we can improve many of the wintering areas, as through cultivated crops.

The Direction of Wildlife has asked hunters for a donation that goes to help the hunting of birds and small mammals, knowing that most of the hunters look for aquatic migratory birds. The amount obtained last year was almost 6 million pesos, and has been used primarily to keep an effective watchful guard over illegal hunting and, in the case of the migratory birds, over the excessive hunting, both considered major conservation problems in Mexico.

The Director is planning to establish total protection soon at different strategic points of the Republic, so that the birds can find the proper place to rest.

As we have mentioned, the area known as the Lerma Marsh is the most important one in the center of Mexican territory. For this reason, and in cooperation with DUMAC (Ducks Unlimited of Mexico) we are carrying on studies to improve the habitat in one of the Lerma Marsh areas. We are hoping to extend this study to the whole marsh and maybe in the near future to other regions of Mexico. We are collaborating with DUMAC to fight environmental water pollution in different parts of the Republic of Mexico.

In cooperation with North American authorities and technicians, the General Direction of Wildlife took part in the annual aerial census of aquatic migratory birds. This was done with the hope that in the near future we can carry out such a census not only in the small area usually visited but also on all those areas of the Mexican Republic where these kinds of birds find refuge.

To sum up, the General Direction of Wildlife, considering the biological and economic importance of the migratory aquatic birds, is carrying out a protection program. We also are managing exploitation, without imbalance between conservation and exploitation, so that national and foreign hunters of these birds can be satisfied and, therefore, help us with wildlife preservation.

Discussion

MR. R. H. BAKER [East Lansing, Michigan]: You know, many species commonly come to all three of these countries, including bighorn sheep. I have watched a number of these animals in the last few years in relation to what I regard as excellent management practices Mexico has had in providing certain hunters with an opportunity to hunt these sheep and yet, at the same time, holding down poaching. Could you tell us how many of your biologists are actually engaged in this work in Baja California at present?

SENOR GABUCIO: As to the number of biologists, I would not know how many. That is a matter that they take care of. We shouldn't be discussing that because this is supposed to be a waterfowl and migratory bird speech but it is one of the most important things for me in Mexico. I have given to that a very important consideration in my work, so important that I have worked hard to get two times the budget for the entire country in California alone at this moment.

We have some $500,000 a year being spent there. We are building more waterholes, we are building hunting lodges for quail hunters, we have a very expensive program. We also have about twenty vehicles with radio. We think we have stopped poaching by some 95 percent.

I believe we are going to have great success in that area if we continue working this way. If there is a change and we do not take care of the poaching element, we are going to lose the sheep.

The propagation of sheep is very important. We are only issuing from 50 to 60 permits a year. We have had very low kills and I think that is very acceptable. Aso, we are trying to help other states in the United States with our own technologies and programs and with our new techniques. Every hunter goes out and does what the biologist says. We take samples of blood and samples of the inside of the stomach and analyze it later. We also do some other studies and we are very happy with the results there.

CO-CHAIRMAN HAWKINS: To get back to the migratory birds, you mentioned several areas in which your biologists are studying migratory birds and I thought one important area was not mentioned, at least has been omitted to date. May I ask if you have any plans in the near future to conduct studies of the Guna in marshes around Tampico?

SENOR GABUCIO: We want to do as much as possible, but, as I tried to tell you, it is impossible without funds and without budget. However, we do have a program there, a white-winged dove program. We have given instructions to the biologists and the directors to check all they observe. It does not matter what it is. They have an obligation to study everything they see at the place where the program is.

Improving International Cooperative Efforts: Accomplishments and Needs

A.G. Loughrey
Canadian Wildlife Service,
Ottawa, Ontario

I have been asked to give a Canadian viewpoint on the theme of "Improving International Cooperative Efforts: Accomplishments and Needs." I do not wish to dwell at length on all the cooperative accomplishments and needs, but will try to highlight some of the less well known ones that I consider to be significant.

The obvious starting point for such a review would be August 1916 with the signing of the Migratory Bird Treaty between the United States and Great Britain, on behalf of Canada. That treaty and the subsequent enabling legislation passed in each country are historical and legal landmarks in the protection and management of the migratory bird resource in North America. Today, some 60 years later, the Treaty still serves as powerful and useful basis for international management of the resource.

In this United States bicentennial, it is appropriate to devote a few minutes to recognizing some of the key individuals and agencies, in both of our countries, who helped to bring about the signing of the Treaty. The need for an international treaty to protect migratory birds was recognized in the late 1800's by a few concerned people on both sides of the border. The plight of the passenger pigeon; the disastrous effects of market hunting and spring shooting on waterfowl and shorebirds; and the near extermination of many species of terns, egrets and herons for the millinery industry all drew attention to that need. While we are now well aware of those events, we are perhaps less aware of the public servants, naturalists and sportsmen who, against considerable odds and public apathy, worked to make the Treaty a reality.

Initially, the need for protection of migratory birds was recognized more clearly in the United States than in Canada. Certainly the A.O.U. and the Audubon Society were instrumental in advocating protection to stop the senseless slaughter of migratory birds in the 1890's. Individual Americans who played a significant role in pressing for legislation include: Dr. George Grinnell, John Muir, William Hornaday and George Shiras, to mention a few. The enactment of the U.S. Federal Migratory Bird Law in 1913 stimulated interest in several Canadian public servants for an international treaty between our countries. The prime initiators of the Canadian position included: James Harkin, the commissioner of Dominion Parks, Maxwell Graham of the Parks Branch, and most importantly, Gordon Hewitt, Dominion entomologist. These three obtained advice and support from Canadian ornithologists, James Macoun, P.A. Taverner, W.E. Saunders and James Fleming. Hewitt worked tirelessly for three years to gain the support of the provinces. He also worked closely with Henry Henshaw and Eward Nelson of the U.S. Biological Survey, Department of the Interior (Lewis 1974). Together, the dedicated efforts of a handful of public servants in each country resulted in the signing in Washington on August 16, 1916 of the "Treaty for the International Protection of Migratory Birds" by His Majesty's

Ambassador, Sir Cecil Spring-Rice, and the Secretary of State of the United States, Mr. Robert Lansing (Hewitt 1921). That considerable achievement deserves our lasting recognition and respect. More than that, it serves to demonstrate what can be accomplished by the cooperation of a few far-sighted, dedicated men who put the welfare of the resource foremost.

The Migratory Bird Treaty having been signed it was more or less forgotten for over 40 years, in the sense that the signatories apparently saw no need to develop and maintain any formal apparatus to monitor how it was working or to consider joint actions. No one thought it important enough to warrant the equivalent of an International Joint Commission, or a multinational commission of the kind that emerged to attempt to regulate offshore commercial fisheries. Perhaps this made sense. Having legislated to destroy trade in migratory birds and their products and having succeeded to a great extent in doing so, governments could proceed on the assumption that migratory birds were of little economic importance and hence not worth talking about.

One group of migratory birds, however, continued to interest people to the extent that a lot of money was spent in their pursuit. Ducks and geese were in as much demand as upland game in many parts of the continent. A dramatic reduction in their supply resulting from the severe drought of the mid-1930's focused attention on the need to "bring the ducks back." That led eventually to the creation of waterfowl councils in the U.S.A., with Canadian provincial representation. The U.S. Federal Government organized those Councils, which provided the Fish and Wildlife Service with a valuable way of exchanging information and opinions with the state wildlife agencies and of developing consensuses on waterfowl management. The National Waterfowl Council and the four Flyway Councils did not, and do not, form a suitable mechanism for international cooperation at the federal level. They are too large and too heavily biased towards internal concerns of the United States.

It was not until 1961 that an International Migratory Birds Committee was formed, at a high political level, the United States being represented by the Secretaries of the Departments of the Interior and of Agriculture and Canada by the equivalent Ministers. The issue that brought the committee into being was the conflict of human land use with waterfowl production. The replacement of natural habitats in the prairies by farmed land has had profound effects, both in limiting duck production and in putting ducks into conflict with farmers. In addition, the existence and capacity of staging and wintering areas have also been drastically altered, by the destruction of coastal marshes as well as the conversion of wetlands to dry land or to freshwater reservoirs. The creation of the International Migratory Birds Committee had an immediate effect on the habitat preservation program in both countries. But a committee at that level cannot be expected to do more than make changes in strategy, which must necessarily be infrequent. The need for closer collaboration at the tactical and technical level has become stronger as the competition for wetlands between migratory birds and alternative human uses has increased in intensity. In 1975 the U.S. Fish and Wildlife Service and the Canadian Wildlife Service responded to those needs by establishing two additional committees. The first of these, to deal with the development of common policies and the resolution of conflicts, consists of Mr. Lynn Greenwalt (Director, U.S. F. & W.S.) and myself. The second, the Review Committee for Wildlife, is made up of our senior advisors on migratory birds and on those other forms of wildlife which move between the two countries and so are the responsibilities of the federal as well as state or provincial governments. The Review Committee is finding plenty to do.

Paradoxically, they are making most progress by identifying the differences rather than the resemblances between the views and the needs of the two countries. For example, most of you will know that the Fish and Wildlife Service has conducted annual breeding ground surveys of waterfowl for many years and that most of the surveys are made in Canada, where most of the waterfowl now breed. The Canadian Wildlife Service has shared in those surveys. But we now see that they are not much use to us in helping to secure an adequate resource base for the ducks in the future. The Canadian Wildlife Service is trying to optimize a mix of land uses for human food production for the economic and recreational benefit of Canadians and for the perpetuation of wetland ecosystems as an integral part of the basis of life in Canada. The argument that Americans need a lot of ducks to shoot does nothing to help our case. Our approach to the assessment of waterfowl production is going to have to diverge from that of the Fish and Wildlife Service, not in order to oppose the interests of the United States but to defend the interests of the migratory birds, the resource which we are both charged to conserve.

To illustrate the point in another way, the governments of Canada and the three prairie Provinces are now spending much more money each year on programs related to the prevention of damage to cereal crops by mallards and pintails, and on compensation to farmers for such damage, than they are on wetland preservation. This is a deplorable situation. Yet, you can scarcely expect Canadians to put a high priority on increasing, or even maintaining, the production of mallards until we have made progress in reducing expenditures on depredations, so as to put the money to more constructive purposes.

Time does not permit the elaboration of some of the better known areas of international co-operation including such important areas as: migratory bird research, banding, breeding ground surveys, regulation setting, enforcement and protection of rare and endangered species such as the whooping crane. These are relatively well known. I will, however, try to highlight several problems and initiatives that are less well known.

One of our principal current concerns in the management of migratory birds in Canada stems from the claims now being made by several groups of Indians and Inuit for the full recognition of their rights. In northern Quebec, and the Yukon and Northwest Territories, where no treaties were made with the indigenous peoples in the past, these are primarily land claims, provoked by the intrusion of development (mineral and oil exploration, pipeline construction proposals and so on) and the determination of the residents both to derive a fair share of the economic benefits and to avoid the destruction of their traditional ways of life. The recognition of their prior claim to wildlife, including migratory birds, is of great importance to all these people. They stress the importance of hunting game both as a source of food and as an integral part of their culture. In both respects, of course, other people have such interests too. Hunting is a traditional activitity of many if not all the ethnic groups that have come to North

America; and there are considerable numbers of people in the remote parts of Canada who still need to supplement their supplies by using game.

Hunting claims relating to migratory birds are an international problem in two ways. First, and most awkwardly, because though the Migratory Bird Treaty included some recognition of the need of northern peoples—such as the provision to take certain seabirds and scoters for food—the imposition of a general closed season from mid-March to the end of August effectively prevents the legal hunting of migratory game birds in the north for nearly the whole period when the birds are available there. The intention of preventing spring shooting was based on a strongly—and widely—held belief that destruction of birds shortly before they are due to nest is somehow more damaging to the stock than hunting in fall and winter. That is not necessarily true for migratory birds, although if you simply add spring kill to the harvest in fall and winter the total kill may be increased to perhaps dangerously high levels. What the representatives of the northern peoples say is that their need for food, at its greatest in early spring when migratory birds are often the only accessible source of supply, should take precedence over sport hunting. The Treaty not only fails to acknowledge that claim, it prevents the Canadian Government from negotiating an equitable solution. The United States has a similar problem in Alaska, so that it would not only benefit Canada to seek a resolution of the difficulty.

Arguments on the relative importance of hunting for subsistence and for recreation are also related to the general problems of allocation which arises when increasing numbers of people are seeking to hunt a diminishing supply of migratory birds. It is fortunate that the numbers of waterfowl hunters are rising only slowly in relation to much greater rates of increase in most other forms of outdoor recreation. It has perhaps been even more fortunate that in the last few years drought has not returned to the prairie provinces according to the cycle of about 11 years which appeared to exist. When dry conditions return, as they undoubtedly will, our ability as managers will be severely tested. The whole concept of wildlife management by government agencies is already under unusually strong attack by various groups in the U.S. and Canada, chiefly by people who are opposed to sport-hunting. For all these reasons the joint FWS/CWS Review Committee is trying hard to make progress in the difficult business of defining international population objectives and goals for the principal migratory game birds.

Although in the last quarter-century waterfowl engaged most of the attention of the federal agencies concerned with migratory birds, this is now changing rapidly. The Migratory Bird Treaty deals with the full range of species. Government agencies are responding to public demands, as well as to their own perceptions, in paying increasing attention to non-game birds. An early sign of this response was the start of the Breeding Birds Survey, which has now been running for 10 years in Canada and longer in parts of the United States. The survey was intended primarily to provide "baseline data" for the detection of major population trends across the continent. Though much remains to be done by way of analysis, impressive results are already emerging, as was demonstrated at last year's conference (Robbins and Erskine 1975). In Canada, while we recognize that there are many technical limitations on what this survey can tell us, we see it as a major component in the task of keeping our fingers on the pulse of the nation's birds. The fact that the same technique is used in both countries adds greatly to the comparative value of the Breeding Birds Survey. We hope and intend to supplement it by other methods capable of being used in roadless areas and by non-intensive surveys of local problems.

Major advances have also been made in learning about the conservation of other groups of birds. The conference on seabirds in Seattle in May 1975 was a milestone, providing official recognition of the international nature of the resource and of the threats to it. Emphasizing as it did what was known about the birds of the Pacific seaboard it emphasized too how many nations have an interest in these birds and their problems. The presence of a New Zealand delegate was particularly significant, as a reminder that North America shares several bird populations with Australasia. The absence of delegates from Australia, Japan and the USSR was significant too, in reminding us of how much more work needs to be done to involve all those people who should be involved in conserving the seabirds of the Pacific.

For the northwest Atlantic, the Canadian Wildlife Service has recently published an atlas of seabird distribution (Brown, Nettleship, et al. 1975) which we hope will be the precursor of others prepared in collaboration with several European countries as well as with the United States.

The Canadian Wildlife Service embarked three years ago on shorebird studies, which have made notable progress despite the small numbers of staff involved. It has been enormously encouraging to find similar studies growing rapidly in the eastern U.S. and to see how enthusiastically and effectively the people involved are planning and working together, from James Bay to Florida. Again there is also active collaboration across the Atlantic, because substantial numbers of the shorebirds breeding in the Canadian High Arctic winter in western Europe and North Africa.

The United States has recognized the value of the International Waterfowl Research Bureau by assuming the responsibilities of full membership in 1975. Canada is particularly interested in two aspects of the Bureau's work, its emphasis on wetland conservation and its very recent attempts to organize international cooperation in Central and South America. We do not intend to lag behind American support for those initiatives.

The Migratory Bird Treaty gave us a clear mandate to protect the resource. It recognized that birds need protection during the breeding, migratory and wintering periods. We now know much more about the specific requirements of various species, including a better understanding of the effects of man's impact on the environment. The Treaty also recognized certain human needs and wants for food and sport.

In closing, I would like to leave these thoughts with you concerning the responsibilities of federal, state and provincial wildlife agencies. Currently we hear a good deal about identifying "our clients" and the need to satisfy "client demands." I believe we must first identify our responsibilities to the resource, the migratory birds of North America. We must recognize and try to meet their needs. When we are convinced that the resource is secure and thriving, then we can manage it to meet the often conflicting demands of various interest groups: naturalists, sportmen, native people, farmers and perhaps even those of wildlife managers. In my view, there has too often been a blurring of the resource needs and the people demands.

Let us not forget that our primary responsibility is for migratory birds, our most important client. Let us try to make a clear distinction between birds' needs and human demands. Are we establishing sanctuaries or refuges because the birds need them? Or are we doing it because concentrations of desirable species on these areas are attractive to hunters and naturalists? Let us remember too, that our responsibility is for all migratory birds, not just the quarry species of interest to sportsmen and the rare and endangered species of concern to naturalists.

Finally, let us not forget that the birds recognize no provincial, state or national boundaries. We can respect our various jurisdictional differences, but we must work together for the benefit of the resource. We owe it not only to the resource, but also to those men from both our nations whose selfless efforts 60 years ago brought about The International Treaty for the Protection of Migratory Birds.

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Discussion

CO-CHAIRMAN HAWKINS: The panel has discussed ways and means of getting cooperative efforts directed at the better management of North American migratory bird resources. In discussing this complex subject, we will give each panel member an opportunity to ask another panel member one question.

MR. LOUGHREY: My question was for the gentleman from Mexico but he is not here and so perhaps John Rogers or someone in the audience can help me.

He talked in his remarks about crop damage in Mexico and I would assume the damge was caused to cereal crops of small landowners, presumably, rather than large landowners. I don't know if there is anyone here who can comment on the extent of this damage.

We know it is a problem in Canada and this type of information would be useful to me.

If there are no comments, perhaps I can let that drop and take it up later with the responsible individuals.

CO-CHAIRMAN HAWKINS: John do you have a question?

MR. ROGERS: I don't think I can respond to the question just asked about Mexico, but I have a feeling it applies more to species other than waterfowl. I see Bill Kiel sitting out here in the audience and I suspect that if he has an opportunity, he may be able to address this.

However, I would want to say that I am impressed by the comments made by the other panel members. It obviously shows a great amount of thought being given to this problem of international cooperation.

I would like to pose one question that maybe all of the panelists could respond to. It relates to the United States-Canadian efforts, and I am particularly interested in this because I happen to be a member of the Wildlife Program Review Committee that both of us refer to.

We have to recognize, with particular reference to waterfowl, that we have a very large job to do because the views on both sides of the border about how we go about managing waterfowl and what the objectives are, are going to be quite different because we are facing somewhat different problems. Sometimes, as a matter of fact, these problems are far different.

However, one of the problems that constantly comes up when we discuss waterfowl management programs, at least from a philosophical point of view, is this difference between the resource needs and people needs and just from a personal point of view, I have a great deal of difficulty in making this distinction. I do sense there is perhaps a distinction there, but our management programs are designed to provide benefits to people in one way or another.

A number of us, even if it gets down to the point where we should no longer have hunting programs, are still trying to maintain migratory bird populations because they benefit people.

I don't know whether Al can further comment on how he sees us distinguishing between these two things or whether it is really all that important.

The other question I would like him to address himself to, if he desires, is the use, either through public or private efforts, of some of the Canadian waterfowl management phases.

MR. LOUGHREY: I harp a bit on the theme of resource needs and people demand. I think that is what you picked up, John. I did that because as natural resource managers, we try to meet the demands of people but I think we have tended to look to the demands of a few special interest groups, of hunters, certainly, as well as naturalists. We are all part of the same game. We do have slightly different perspectives. We, as responsible agencies, are trying to balance those demands and, by and large, the differences are great.

I mentioned the native peoples problem. This is something that we have ignored for far too long. Those people are making very real demands and they are making very heavy use of the resource. We don't know, however, how heavy. We do not have adequate surveys of the kill by native peoples. We have been trying, however, to manage the resources as if that kill did not exist and that is crazy.

I think the time is now very close when we will get cooperation from those native peoples as they see the need to protect their interests. When we have better data on their harvest, it becomes easier to put these various conflicting and overlapping demands for limited resources, in perspective.

The other point, of course, is the person who grows the resource, the farmer in our case, because I think you heard mentioned, that probably 80 percent of the waterfowl of North America is produced in Canada. You may not have heard of that particular figure, but on the other hand, probably 70 percent of certain game species, like the mallard and pintail, are produced on private lands.

The farmer may like hunting, usually does, but doesn't necessarily like the effect of waterfowl that is raised on his property with respect to his crops. So crop damage is another part of this equation of balance of people's demands. I think that until we bring these out as very separate demands we will not be able to do our job as resource managers.

At the same time, however, I would be very conscious of the fact that our prime responsibility is protection of the resource and establishing safe harvest levels and safe population goals for species or subspecies or geographic units. What I am trying to say, is that it is a matter of balance and I guess that, in the final analysis, is what wildlife management is all about.

As to your second question, I don't think I want to answer because you asked how we could contribute to the problem. Well, I would prefer to leave that for a quiet, rainy day somewhere.

I am not aware, however, that you are contributing too much to the problem now. I hope, in the final analysis, you are contributing to the solution of the problem and I think the way in which our two countries and, indeed, Mexico, can contribute to the solution, has been enumerated today and we have received some new ideas.

I personally tried to enumerate the international aspects. I think it would be only fair to say that I did not elaborate on the Canadian mechanisms and procedures for managing the resource. I did not elaborate, for example, on the Federal-Provincial mechanisms but, nevertheless, they are there. They are very similar to those occurring in the United States and are relatively effective.

CO-CHAIRMAN HAWKINS: Now we will turn it to any questions or comments from the audience.

MR. JOHN WATTON [Montreal Engineering]: I would like to direct this to Dr. Loughrey, Dr. Rogers or both. Would either of you care to comment on the potential loss of wetland habitat to power generation, strip mining and any work of this type being done, particularly with regard to the restoration of wetland habitat?

MR. ROGERS: I am not sure that I can give you a good answer to that insofar as strip mining goes. However, I suspect strip mining is more of a problem to species other than waterfowl and other migratory birds. I have lost track of the first aspect of your question, but I believe it had something to do with power generation. This is related to water resources and I think at least some aspects of power generation have created habitat or at least created some essential aspects of habitat where we did not have it before and it has, in turn, created a different kind of management problem.

They have provided means for maintaining populations of birds in areas that have never had them before and also encouraged these populations of birds to delay or actually cease their migratory movement to some traditional areas. Therefore, that may be a more important problem than any loss of habitat created by that particular activity.

International Cooperation in Migratory Bird Management: United States Efforts

Nathaniel P. Reed[1]
Assistant Secretary for Fish and Wildlife and Parks
United States Department of the Interior
Washington, D.C.

Mr. Chairman, fellow panel members, ladies and gentlemen, I'm pleased to have this opportunity to review the effort of the United States toward international cooperation in migratory bird management, and what might be done to improve these efforts.

We have long held the view North American waterfowl are an international resource and that cooperation in management with our neighbors to the north and the south is necessary if we are to properly discharge our responsibilities for protecting and maintaining it. Our involvement at the international level dates back to the 1916 Convention for the Protection of Migratory Birds which led to our Migratory Bird Treaty Act of 1918. This Convention confirmed the mutual interests and concerns of the United States and Canada in the welfare of migratory birds in North America. It recognized that these birds were valuable components of the ecosystem, and that a joint effort was needed to alleviate the "danger of extermination through lack of adequate protection during the nesting season or while on their way to and from their breeding grounds." As a result of this convention, broad guidelines were laid down for the conduct of hunting. Closed seasons were established, special protection was given to wood ducks and eiders, the taking of bird nests and eggs was prohibited, and the ground rules were established for shipment and export of migratory birds and the control of nuisance flocks.

In 1936 attention was again focused on the welfare of migratory birds when the United States and Mexico joined in concluding a convention aimed at protecting both migratory birds and game mammals of mutual interest to the two countries. The convention recognized that some bird populations were shared, that it was "right and proper" to protect these birds irrespective of their origin, and that cooperation was necessary in establishing guidelines for permitting rational use of migratory birds for "sport, food, commerce and industry." Among other things, this led to common limitations on the length and period of open seasons, the establishment of closed seasons, the establishment of refuges, full protection for insectivorous birds, and prohibition of hunting from aircraft.

A third bilateral migratory bird treaty involving the United States was concluded in 1972 with Japan. In this convention, concern was expressed for the protection of migratory birds, including those in danger of extinction, and for

[1]In the absence of Secretary Reed, this paper was presented by Dr. John Rogers, Chief, Office of Migratory Bird Management, U.S. Fish and Wildlife Service, Washington, D.C.

bird environments. The signatory nations agreed that birds were valuable for recreational, aesthetic, scientific and economic purposes; that many species migrated between areas of the two nations; and that the value of the resource could be increased with proper management. The basis was established for opening seasons, protecting species in danger of extinction and preserving bird habitats.

In addition to these three treaties, the United States has become involved in other ways with the international community to advance the welfare of migratory birds. A joint United States-Union of Soviet Socialist Republics Environmental Agreement signed in 1972 provides an opportunity to share biological knowledge about migratory birds with biologists of the Soviet Union and to pursue projects of mutual interest. To date, our efforts involving migratory birds have focused mainly on snow geese that breed on Wrangel Island and winter in the Pacific Flyway, and the development of an international protocol for marking swans.

In another area of international waterfowl activity, the Fish and Wildlife Service has frequently been represented as an observer at meetings of the International Waterfowl Research Bureau. This organization, with headquarters at the Wildfowl Trust in Slimbridge, England, exists to stimulate and coordinate research and conservation of waterfowl and wetlands. At their recent conference, held in 1974 at Hieligenhafen, Federal Republic of Germany, representatives from 38 nations and 10 international organizations were in attendance and focused primary attention on means of preserving wetlands of international importance to waterbirds. I am pleased to say that on January 1, 1976, the Fish and Wildlife Service became a full member of the International Waterfowl Research Bureau, and expects to participate fully in future activities of this important international organization.

The treaties I have just described have provided us with the basis for effectively pursuing cooperative international projects such as the conduct of surveys, bird banding programs, and a host of other less formally defined activities of mutual interest. They led to the formation of an international migratory bird committee which provided a forum for high level exchange of information on migratory bird programs and future needs.

I believe that these efforts have served our needs well and accomplishments have been substantial. However, problems relating to the maintenance of the resource appear to increase in about the same proportion as our successes. All three countries represented here today are being subjected to stresses on their natural resources caused by conversion of habitat to uses not compatible with the welfare of migratory birds. The introduction of harmful chemicals and wastes into both terrestrial and marine environments, the push for greater food production and industrialization, the daming, diversion and channelization of rivers, and the accelerated exploitation of minerals for energy and fertilizers require ever more diligent, knowledgeable, and innovative management efforts on our part.

In an effort to begin meeting these needs, I'm pleased to say that we are developing mechanisms that I believe will enable us to deal jointly and more effectively with the many and growing problems and opportunities we share in common. Last July, a newly formed United States of America-Mexico Joint Committee on Wildlife Conservation met in Mexico City to identify areas of mutual concern and to initiate projects for joint study and accomplishment. Included among the initial projects is one involving migratory birds. We plan to work closely with our counterparts in Mexico to coordinate waterfowl population surveys, and to resolve problems involving white-winged doves and other species which freely cross our common border.

To the north, a Wildlife Program Review Committee has been established by the Director of United States Fish and Wildlife Service and Director General of Canadian Wildlife Service. The purpose of this committee is to develop recommendations to the two Directors on a variety of wildlife-related issues, but one of its principal functions is to identify and communicate problems of mutual interest concerning migratory birds. The working committee is composed of senior staff members from each Service who establish action programs. Policy questions are reserved for resolution by the respective Directors of the two Services, but routine work is being expedited and a good system of communication has been developed.

While I'm sure the other panel members share my satisfaction in the success of our combined efforts thus far, I'm equally sure they share my belief that further improvements can and must be made. Looking to the future I believe the treaties and conventions we now have provide an adequate basis and authority for stronger and more aggressive efforts to jointly manage the resources we share. We need to focus more of our energy on identifying and coming to grips with the real problems facing us in our efforts to preserve and enhance migratory bird resources. We cannot avoid continuing and special responsibilities for those hunted species of migratory birds, prominent among which are waterfowl. Nevertheless, we must begin to broaden our management horizons to include the needs of a variety of migratory species for which today we have inadequate knowledge, particularly of population status and habitat requirements. Building and expanding on our excellent experience with our Mexican and Canadian neighbors in migratory waterfowl management, we must develop a program that addresses the needs of all migratory birds. And while we must give priority to North American birds, we can and should cooperate with nations throughout the world with similar interests. This is indeed a global problem.

As a case in point, in May of 1975, I was fortunate to join more than a hundred scientists, managers, and conservationists who met in Seattle to discuss the conservation of marine birds in northern North America. While emphasis was mainly on birds in the northwestern part of North America and the North Pacific, the results have global implications. This truly international resource is increasingly threatened by pollution of the seas from oil spills, ocean dumping and pesticides, fishing, both long lines and trawling, and human disturbance and introduction of predators on important island breeding habitats.

The condition of seabirds, raptors, colonial nesters and a host of other non-game bird groups is crying for attention. Existing legislation gives us the authority—and responsibility—to move forward with these groups, and we should do so. To begin, we need to cooperatively

- — review available knowledge to determine what information is lacking on a species by species basis,
- — assign priorities for projects aimed at filling information gaps,

— identify critical habitats and monitor them to detect and assess changes, and finally,
— develop a systematic means for exchanging scientific information.

Now I realize that my remarks have departed somewhat from a strictly waterfowl orientation. At this point I want to get back to waterfowl in order to express a special concern. I am highly disturbed about the continuing loss of waterfowl habitat in North America. Wetlands continue to be drained and degraded. Upland nesting habitat is in critical short supply in important production areas. Coastal marshes, lowland hardwoods and other key wintering habitats continue to fall victim to economic pressures. Surely, no one knowledgeable about the factors controlling waterfowl populations can doubt that the fate of these birds is dependent upon the amount and quality and distribution of their habitats. It is imperative that we focus international attention on preserving that habitat. We must work together to tell the public of our concern and make them aware of the multitude of values associated with wetlands. Only with public support will land use planning become a reality and funds be made available to preserve waterfowl habitats. The importance of this issue clearly identifies its international priority.

Let me conclude my remarks by making one final point. We must always remember that migratory bird management in the United States is not solely a federal activity. In this nation, the states are full partners in migratory bird affairs and this arrangement will and must continue. The flyway management concept, developed over the last two decades, has clearly demonstrated the worth of a federal - state waterfowl program, and we look forward to continuing the strengthening of that system.

Improving International Cooperative Waterfowl Management Efforts: Accomplishments and Needs

Jack R. Grieb
Colorado Division of Wildlife,
Denver, Colorado

Waterfowl are a resource shared by the three countries on the North American Continent—Canada, United States and Mexico. No one country can individually sustain this resource because waterfowl are migratory and tend to reproduce in northern latitudes and winter in southern portions of the continent. Therefore, it is reasonable to assume that if the resource is to be maintained in a manner to provide continuing recreation for hunters, birdwatchers and all others, there must be some order brought to its management which will asure its future existence.

These principles guided our nations to enact treaties to promote standards for the conservation and management of this resource. First between Canada and the United States in 1916, then between Mexico and the United States in 1934. These treaties stand as a landmark in the establishment of rules and regulations for the international management of a common resource.

The treaties have served us well, but times have changed! Our ability to produce waterfowl, particularly ducks, has decreased because of conflicts with agriculture in breeding areas, and with pollution and development of migration and wintering areas. The consequence is a dwindling habitat base combined with an increased potential for demand because of more people and increased leisure time. As a consequence, it is now proper that we examine our management activities within the scope of treaty commitments to determine how we can continue to mutually manage the waterfowl resource to provide a maximum of recreational benefits on a sustained basis.

The need for this examination is manifest by such examples as mallard management in the Mississippi Flyway. The ability of those states to attract large numbers of hunters to participate in waterfowl hunting, and the continual need to maintain restrictive harvest regulations which ride the razor-edge of eliminating duck hunting as a competitive leisure time activity. As an interested waterfowl manager, I am concerned because the Flyway Council, in recognition of this problem cannot agree how it should be solved to the end that one state separated from the Council several years ago, followed by two others in 1975. It is mandatory that all states participate in their respective Flyway Council to forge the coordinated and cooperative programs required to make management of migratory birds effective.

Another example is the bio-political boundary between the Mississippi and Central Flyways. Obviously ducks commonly migrate down the eastern Central and western Mississippi Flyways without knowing or caring which flyway they are in, thereby creating management problems. Or black ducks in the Atlantic Flyway which are being replaced in traditional breeding areas by mallards?

But my greatest concern relates to an understanding of waterfowl harvest strategy between Canada and the United States. According to our current management system, U.S. managers annually attempt to agree on the number of ducks which should be returned to the breeding grounds the following spring. This may sound insignificant, but consider that the size of the fall flight minus the number of ducks to serve as breeders equals the number of ducks for harvest that fall, you quickly understand that the establishment of breeding population goals determines the scope of the harvest regulations.

Add the fact that Canada independently establishes their waterfowl harvest regulations based primarily on their annual size assessment of the fall flight generally without considering a breeding population goal. It is apparent that unless there is some multi-nation agreement on such a goal, managers in the United States always will be placed in the position of being able to manipulate only their harvest numbers to achieve it. Much greater effort is needed to establish, wherever possible, for species, subspecies, and populations the allowable annual harvest and distribution of that harvest among and within countries.

An understanding of the need for international cooperation particularly between Canada and the United States is not new. Waterfowl managers have been discussing it for years. During the late 1950's and early 1960's when a major drought hit major breeding areas, and we felt the pinch of restrictive harvest regulations, an attempt was made to bring responsible administrators of Canadian and U.S. governmental agencies together to identify critical waterfowl problems. This was the International Migratory Bird Committee composed of Canadian Ministers of Agriculture and Northern Affairs and National Resources, and U.S. Secretaries of Agriculture and Interior. They appointed a technical committee that met several times in 1961 and 1962, continuing on an indefinite basis until 1969.

In 1966, the International Association of Game, Fish and Conservation Commissioners got into the act by instructing its Migratory Wildlife Committee to come up with a waterfowl management policy for Canada and the United States. Many of us assisted in that struggle for six long years. Although we wrote a number of versions, we could never find one agreeable to all states, provinces or federal agencies. This effort was concluded in 1972 with recommendations that the policy approach be discontinued, and that the International Migratory Bird Committee by re-activated.

This Committee met in Washington, D.C. the fall of 1973 and in reviewing the agenda and discussing results with participants I was told there was considerable interest in the need for closer cooperation in migratory bird management between our two countries. As a result, representatives of the Fish and Wildlife Service and Canadian Wildlife Service were assigned to initiate meaningful discussion in this area.

Aggressive action was delayed because of reorganization which occurred in both agencies. But a decisive step was taken by Directors Loughrey and Greenwalt in 1975 at the North American Wildlife and Natural Resources Conference in Pittsburg when they appointed a joint committee on wildlife policies and programs, instructed them to begin discussions on critical issues, and authorized them to make recommendations to both Directors on a broad range of waterfowl matters of mutual interest. The Directors have had additional meetings to discuss recommendations of the committee and related items. Obviously, there is desire and concern at the federal levels in both countries, and this is shared by many states and provinces.

To this point I have attempted to review the reasons for, and the efforts made to establish an international cooperative waterfowl management program. Now I will give you my thoughts on how such a program should be constituted. Admittedly, this was not easy because I am aware of the various options which have been discussed for years. Further, that there has been substantial progress in establishing a program framework during the past year. Lastly, comes the "real world" replete with both biological and political ramifications which must be considered.

As I pondered this subject it didn't take long to realize that in considering harvest apportionment between nations, the establishment of percentage or numerical quotas to satisfy some form of "fair share" requirements would not only be difficult to identify, but impossible to implement at this time. Nevertheless, if more effective management of waterfowl is to be achieved, we must maintain harvests within the reproductive achievements of species, subspecies, and populations.

The difficulty in allocation would come in determining for each species and even geographical populations within a species, what the current harvest distribution is, and what it should be. Thus to say that 50 percent of the mallard harvest (for example) should occur in Canada, ignores that harvest rates between our countries vary between geographical locations across the continent, being a problem in some areas, and none at all in others.

Implementing a system such as this, even if it could be done, would involve absolute agreement, annual evaluation, and require a severe departure from current regulatory practices. It would have to be administered by an international commission with strong authority similar to several fishery commissions currently in existence. However, instead of a universe composed of absolutely defined rivers or lakes, the waterfowl commission would be dealing with populations which are presently poorly defined and varying philosophies which would make it difficult, perhaps impossible, to make necessary decisions.

This does not mean we should not identify management units which describe production, harvest and wintering areas for species and populations of waterfowl. This approach has been accomplished for Canada geese almost nationwide, and for ducks in the Columbia Basin of the Pacific Flyway and the High Plains Unit of the Central Flyway. The management benefits are obvious. This approach will be mandatory in the future to permit managers to focus on specific problem areas and provide solutions without impacting other areas where problems do not exist.

The second conclusion I reached after examining alternatives was that the current management and regulatory establishment system, which has evolved over a long period of time, provides the basic framework for a realistic approach to continental waterfowl management decision making. This is particularly appropriate since the adoption of new procedures involving strong Flyway Council participation during the past year in the United States similar to Canadian practices. There are, in my opinion, some minor additions which would be necessary, but this is the base upon which we should build. Changes would involve:

1. An International Migratory Bird Committee composed of federal representatives, fully active and recognized as an essential part of the decision making system. This Committee must establish an umbrella of policies, objectives and general direction to implement a cooperative management program. It cannot exist in a vacuum as it has in the past. There must be a mechanism to provide provincial and state input on items which will impact their management opportunities and programs. An important committee responsibility would be to agree on general population goals and identify specific management problem areas, geographical or otherwise, where consideration and action must be taken at a local management unit level.

2. Flyway Councils must become the focal point for management recommendations which will implement international strategy. In this context, however, they cannot be thought of only as an organization of states, but also as a forum for provinces, states and federal agencies to discuss specific problems and alternative solutions. In many respects, this is currently occurring at Technical Committee levels where biologists from the three groups are discussing problems and prevailing upon their respective administrators to implement solutions through specific harvest regulation modifications. This is good, but as decisions become more difficult, administrators must become more knowledgeable and involved in the system or they will have a tendency to make only the "popular" decisions without full regard to their biological implications.

It is proper that provinces not involve themselves in the final harvest recommendations which states provide the Fish and Wildlife Service; and the opposite is true. But it is important these recommendations mutually reflect concern for the resource and for those who use it. Annual harvests, summed for the entire range of each species, subspecies, and population, must be maintained within allowable limits to perpetuate sustained populations at levels that permit optimum use of available breeding habitats.

3. Mexico must be involved as a true partner in continental cooperative waterfowl management. There has been significant improvement in its desire and ability to manage the waterfowl resource in recent years. Mexico is too important in terms of wintering many significant species of waterfowl not to be a part of the decision making process.

In summary, I visualize a system that combines the talents of provinces, states and federal agencies within a framework of concern, agreement and current procedures into a more effective cooperative management program. It involves an international committee to establish policy and identify problems, focus discussion, and reach agreement on solutions with implementation at the local levels. Harvest regulations should continue to be established through the currently acceptable regulatory establishment procedures. In my opinion, this is the only alternative which can provide workable solutions for the multi-species waterfowl resource on this continent and acceptable benefits for those who use it.

Discussion

MR. CHARLES NEWLING [U.S. Army Corps of Engineers]: Federal Court rulings over the last year have resulted in reinterpretation of the Federal Water Pollution Control Act of 1972 regarding Section 404, which, in effect said that it expanded the Corps of Engineer's jurisdiction of filling of wetlands. To my way of thinking, this can be one of the most significant things that has happened in recent history with regard to preservation of wetlands and, as I understand it, the Corps of Engineers does have jurisdiction over this. I would like to hear your comments on the potential for success of this program and what effect you feel this may have on waterfowl.

MR. ROGERS: I don't think it is clear just what impact this will have but it certainly has potential, it seems to me, for tremendous impact on preservation of wetlands. The matter is still in an early developmental stage and I really don't think I can cite any examples of what has happened so far. I am sure there are people in the audience who can, but it certainly does have a potential for beneficial long-term impact.

MR. GRIEB: I would agree with John's comments.

MR. ROLLINS: I would like to make a comment about the international implications of what is happening here in North America.

As a member of the International Research Bureau, you can imagine how pleased we were when you joined as a full member this year and we are looking forward to seeing perhaps Canada and Mexico join in the near future.

One of the things that the International Waterfowl Research Bureau has done is that it has developed a convention which now has been enforced since last December—an International Convention signed now by, as I understand it, seven nations, including the United States, which involves basically a conservation of wetland habitats.

Like the North American Treaty countries, once they have signed this treaty and put the wetlands on the list, they may not change the status of these wetlands without international agreement and, of course, this, at least hopefully, will maintain some international habitat or habitat of international importance.

I would like to see the North American countries using their influence with their neighbors to the south in particular. We have been in contact with the Central and South American countries to get more action on an international basis.

MR. BILL SLADEN [Johns Hopkins University]: I would just like to make a comment and add to the comment that Lynn Greenwalt and John Rogers made in relation to international cooperation.

Much of the talks today related to Canada and Mexico but the world consists of many more countries than this. I would like to stress the need for sitting down and working on protocols that are going to help find out more about the migratory movements of these birds that we little understand in relation to the whole breeding range of species.

We have now, through the International Waterfowl Research Bureau, and also in collaboration with the U. S. Fish and Wildlife Service, done banding operations and, as a result, have a certain protocol for marking different species of birds. This involves the Swedes the Finns, the Danes, the British, the Russians and Americans, as well as the Canadians, who are all working together. The code on the collar, just like the North American Wildlife Metal Band, is not duplicated anywhere in the whole of the Northern Hemisphere.

We need help from the Canadians in this with regard to white geese. I talk about white geese because you cannot easily, in the field, distinguish between the greater snow geese and the other types, so we have to have a protocol to cover the entire range of white geese. I worked this out with the banding office in 1973. However, it still needs to be activated. We should realize that one species of snow geese is just as important as another. Therefore, we should sit down and prepare protocols that relate to the entire range of that particular group of birds and until we can do that, we are not going to be very successful.

CO-CHAIRMAN HAWKINS: Your point is very well made and I suspect could be extended to the South, to the wintering regions involving the Central American countries below Mexico.

Now, Jack, I think you are getting off too easy here and so I am going to throw a question your way, if I may.

I think, as I understand your formula for successful waterfowl management programs of a continential scope, it would combine talents to be found among provincial, state and federal agencies within a framework of concern, agreement and current procedures. It does not seem clear to me in relation to this presentation as to what role, if any, conservation organizations and individuals other than those officially charged with waterfowl management responsibility, would play under your proposal. Would you elaborate on that?

MR. GRIEB: I will, in a round-about way. It should first be obvious, however, that I was trying to focus in on specific problems that I saw and which are of great concern to me.

I agree that we have to love the habitat and that has to be one of the very strong efforts that has to be made. When you consider the fact that we have a difficult time just setting regulations to manage that resource within the framework of that habitat base, then you can see where some of these concerns are.

I would say that for the private organizations, the interested conservation organizations, the focal point should be at the Flyway level. I think this is a good place for input—a good place for consideration. Any type of decision-making that is going to be actually implemented has to be implemented at the local level and that is where the knowledge is, in my opinion.

The problem can certainly be identified from an overview but if you are going to have satisfactory solutions, then these solutions have to be understood in the context of what can and should be done. I would like to see much more involvement at the council level.

On the other hand, I realize that one of the problems is that the Flyway Council has been thought of only as a series of state organizations to give the Feds help and I think that this is no longer appropriate because we now have to really consider how we are going to perpetuate not only the sport of waterfowling, but all of the other activities that are beneficial in this wonderful resource. This is where it has to be done.

CO-CHAIRMAN HAWKINS: Thank you very much.

FROM THE FLOOR: How do you view the state role in habitat preservation efforts?

MR. GRIEB: Our role is just as important as that of anyone else. You know, we all tend to think of breeding habitat as being important, but I think we have to consider the migration and wintering habitat as also being important.

Most states have either portions of both of these or all of these within their state boundaries and we have to fight at every opportunity to maintain this balance.

For example, in both Colorado and Nebraska, there has to be cooperation in terms of maintaining adequate migration habitat. The Corps of Engineers has done this, at least to some extent, by building large dams. The Bureau of Reclamation also has done this.

However, I think it is also important that more Southern States look at wintering habitats as being very important and these are being encroached upon by many developments and these type of things. Therefore, in the final analysis, we all have to be concerned about this.

We are concerned about it and we are trying to maintain it.

CO-CHAIRMAN HAWKINS: Thank you very much. Are there other questions? If not, I will turn it back to the Chairman.

CHAIRMAN TENER: Thank you, Art.

Before closing, I want to add a comment, without repeating what was said, and that is that it is extremely encouraging to see that all the speakers today were focusing on the broad issues facing the management of waterfowl and the management of migratory birds as a whole across our three nations and, indeed, beyond. Some speakers have pointed out the problems, but the translation from identification to the solution will present many difficulties to us collectively as we try to achieve these defined international and national objectives. Certainly for our part, we are going to do our utmost to achieve those solutions.

Again, I want to thank the speakers that we have listened to here this afternoon, all of them, who have labored so hard and diligently and so well.

I likewise wish to thank the audience for enabling us to have a good session.

This session is now adjourned.

Land Use: Planning and Allocations

Chairman:
ALFRED HELLER
Editor, California Tomorrow Plan
San Francisco, California

Cochairman
ROBERT E. LeRESCHE
Chief, Habitat Protection Section
Department of Fish and Game
Juneau, Alaska

Opening Remarks

Alfred Heller

Ladies and gentlemen, we are embarking on a special session entitled "Land Use: Planning and Allocations."

My name is Alfred Heller and I will be your Chairman. Your Co-Chairman, Robert E. LeResche, and I have agreed to divide the program. The first part of the program I will handle and the last portion of the program he will handle.

The program order to be followed is in your booklets.

Congressman Udall will not be here. We wlll therefore move the speakers up a notch.

I want to announce that at the conclusion of this scheduled program we have an unusual film which has not been shown before at all, on the subject of *Alaska—Land in the Balance.* The film, produced by Judy Irving of San Francisco, is one of the most magnificent that I have seen on any conservation matter. It is well worth staying to see.

The first part of this session is intended to give us insight into the broad picture of how we use our land a mere 200 years after the Declaration of Independence, and examples of new ways and new thinking about how we can beneficially control and allocate land resources.

The panel on Alaska, in the second portion, will consider the problems and opportunities faced by a huge, fascinating, new, resource-rich state in planning for the use of its land.

To get the picture in focus, Congressman Udall was to speak on the topic, "Conservation Priorities: Status and Needs." I will not presume to take on that large job. I think, however, a few comments on the subject would be in order.

In their book, *Population/Resources/Environment,* Paul and Anne Ehrlich identify two groups of conservation priorities.

First, "Population control is absolutely essential if the problems now facing mankind are to be solved. It is not, however, a panacea. If population growth were halted immediately, virtually all other human problems—poverty, racial tensions, urban blight, environmental decay, warfare—would remain. The situation is best summarized in the statement, 'whatever your cause, it's a lost cause without population control.' "

Second, "A massive campaign must be launched to restore a quality environment in North America and to de-develop the United States. De-development means bringing our economic system (especially patterns of consumption) into line with the realities of ecology and the world resource situation."

Population control, while essential, is not the central concern of this special session. "To restore a quality environment" in the United States, however, and "to bring our economic sytem, especially patterns of consumption, in line with the realities of ecology and the world resource situation," these priorities—and I think many of us in this room can agree with them—must lie at the heart of any meaningful land-use planning and land-allocation program. They have not, however, been adopted, much less implemented, as national priorities.

A great deal has been done, to be sure, to solve our most pressing problems of conservation, and much of this good work is, incidentally, summarized in the booklet that all registrants received, *The American Landscape, 1776–1976*, edited by Ken Sabol and distributed by the Wildlife Management Institute.

But consider:

- Since World War II this nation has lost millions of acres of agricultural land to wasteful urban sprawl. The decimation goes on today in spite of scattered state and local efforts to the contrary.
- Valuable and unique wetlands, and other natural areas of supreme importance for maintaining ecological diversity, are often still considered last in land-use planning and decision making when they should be considered first. There is no national inventory of natural areas. There is no meaningful national policy or program to protect them on a priority basis. Many people, even leading environmentalists, do not even know about them, do not discern the overriding importance of natural areas. They prefer to talk about "open space."
- Our national parks, the great national treasure, are still subject to overdevelopment.
- Public works of major scale have run roughshod over some of our best land and landscape, generally undeterred by coordinated policy and planning at any level.
- Resource use policies, if any, favor depletion and pollution at the expense of thrift and amenity and long-term survival.
- There is no national program limiting the size and character of urban development.
- The economic thinking of the federal government continues to be primitive and highly divisive in its uncritical support of "growth," when an attempt to encourage sound development within clearly stated environmental constraints would be an approach which would unite us, and unleash all sorts of imaginative economic enterprises, and tremendous employment opportunities.

Yet in the face of these complex environmental and economic issues, even the most tentative national land-use planning legislation is, at this point, dead in its tracks.

What is needed, moreover, if these issues are ever to be resolved, goes far beyond the kind of land-use legislation which Congress has considered in recent years, important as it is. I am speaking of the need for a highly visible, national planning capability with expressly stated and coordinated national environmental, economic and social goals; with policies and programs to see that those goals are carried out.

There is a compelling need, furthermore, for a comprehensive planning and budgeting agency at the highest level in each state and in each region, to meet local needs within national guidelines. In my opinion, it is only through the means of comprehensive and coordinated planning and budgeting—national, state and regional—that this nation can begin to meet its environmental and closely related economic and social priorities. Plainly, resource-use policy, and more specifically land-use policy, cannot be decided apart from policies having to do with population size and distribution, and economic development.

While we are still losing the war in meeting conservation priorities, we are winning some extremely important battles which give us compelling examples of what might be achieved throughout the nation.

Hawaii, Vermont, Colorado, Florida—these are some of the states which have made notable progress toward sound statewide land use planning and regulation. However, I know of no more ambitious or comprehensive planning effort than that which is now under way in the State of California under the guidance of our first speaker.

A few years ago in the San Francisco Bay area, many people became alarmed because the San Francisco Bay was being filled up and developed, and there was a clear possibility that the Bay would disappear and become little more than a river. At that time the legislature was prevailed upon to place a moratorium on all fill in San Francisco Bay and at the same time create a commission to prepare a plan for the conservation and development of the Bay lands.

The man who directed that planning effort was Joseph E. Bodovitz, who will be our first speaker.

The Bay Conservation and Development Commission came up with a plan for the Bay in approximately two years time. In the meantime, the Commission, during the moratorium, could only permit any fill which was clearly in the public interest. The Bay plan was adopted in due course by the State Legislature. The plan called for the creation of a Bay conservation zone, and a permanent commission with strict control over Bay fill. There was ample provision in the plan for appropriate economic development.

The Bay Plan and the Bay Conservation Development Commission are no longer controversial in the San Francisco Bay area. There are strong arguments periodically over decisions that are upcoming. But the basic content of the plan, and the consistent record of the Commission in protecting the Bay, are widely accepted and approved. San Francisco Bay has been saved. The Bay Conservation and Development effort is, in my experience, a unique example of successful land-use planning. It actually works.

After it was permanently established, Joe Bodovitz continued to serve for a period of time as Executive Director of the Bay Conservation and Development Commission.

In the meantime, however, Californians were becoming further alarmed by the defilement of their thousand-plus-mile coastline. Following the same general pattern that was followed for the Bay, conservationists attempted to get the State

Legislature to put a moratorium on development of the California coast, pending creation of a coastal plan. This effort did not succeed.

California has, however, as many of you know, an initiative process. Through this process the voters of the state bypassed the reluctant legislature and voted to place temporary moratorium on the development of the coast until a California Coastal Zone Conservation Commission could write a plan for the coast of California. The Commission is in existence. It has produced a coastal plan. The plan is being considered for adoption by the legislature.

At this point I would like to introduce Joseph E. Bodovitz, who is now Executive Director of the California Coastal Zone Conservation Commission, to tell us about this new plan and the effort to save the California coast.

California's Coastal Management Plan[1]

Joseph E. Bodovitz
Executive Director
California Coastal Zone Conservation Commission
San Francisco

In adopting the 1972 Coastal Initiative (Proposition 20), the people of California declared that:

"The permanent protection of the remaining natural and scenic resources of the coastal zone is a paramount concern to present and future residents of the State and nation;" and
"It is the policy of the State to preserve, protect, and where possible, to restore the resources of the coastal zone for the enjoyment of the current and succeeding generations."

But the Coastal Initiative did not provide a permanent program. Rather, it established temporary Commissions to plan for the future of the coast and to temporarily control development. Under present law, the Coastal Commissions will go out of existence at the end of 1976.

What will happen then?

One possibility is a return to the wasteful, piecemeal, sprawling kind of development that has already overrun many once-open parts of the coast, and to the overdevelopment in some coastal cities that has congested local streets and walled off coastal vistas from all but those fortunate enough to live on the immediate oceanfront.

Another possibility, the one recommended in this Coastal Plan, is for the people of California to protect the unique qualities of the coast, both in cities and in rural areas, and to guide coastal conservation and development accordingly.

The choice for California in 1976 is this: Shall the coast be abused, degraded, its remaining splendor eroded, or shall it be used intelligently, with its majesty and productivity protected for future generations?

The Legal Basis for Statewide Planning

The State of California has legal power to regulate and control land use. This regulation, using such forms as zoning, is part of the inherent power possessed by all states and is commonly called the police power—the power to regulate public and private activity to protect the health, safety, and welfare of the general public.

The California Constitution and other state laws delegate certain police powers, including the power to plan and control land use, to cities and counties in carrying our their local or municipal affairs. The State, however, retains the ability to plan, protect resources, and even control land use in areas or on subjects of greater than local concern.

As one court has said in a case involving the Coastal Commissions, "Where the ecological or environmental impact of land use affect the people of the entire

[1]Excerpted from *Summary, California Coastal Plan.*

State, they can no longer remain matters of purely local concern." The court added that "the impact of an activity which in times past has been purely local, may under changed circumstances transcend municipal boundaries . . . Where the activity, whether municipal or private, is one that can affect persons outside the city, the State is empowered to prohibit or regulate the externalities" (CEEED v. California Coastal Zone Conservation Commission, 118 Cal. Rptr, 315 [1975]).

Major Findings and Policy Recommendations

The essence of the Coastal Plan is that the coast should be treated not as ordinary real estate but as a unique place, where conservation and special kinds of development should have priority. Coastal resources are limited; meeting human needs while safeguarding the coast will require special measures.

The Plan's 162 policy recommendations form the framework of a management program concerned with both natural and manmade coastal resources.

- The Plan actively *promotes:* productive agriculture, viable communities and neighborhoods, expansion of commercial fishing activity and fisheries research, acquisition of additional parklands, restoration of degraded coastal environments, and continued development of existing ports and marinas.
- The Plan seeks to *achieve balance* where there is a competition among goals, such as where increasing coastal access competes with resource protection, where economic development conflicts with conservation, where urban expansion competes with the retention of natural areas, or where short-run gains result in the forfeiture of long-run economic benefits.
- The Plan is *highly restrictive* in its control over the dredging and filling of coastal wetlands, its protection of areas of unusual natural or historic value, and in its regulation of activities that involve substantial environmental risk or the loss of productive agricultural or forest lands.

The major findings and policy recommendations of the Plan are:

Coastal Waters

Improve the Productivity of the Marine Environment. California's coastal waters are among the world's most productive marine environments. Since the turn of the century, however, there has been an ominous decline in the quality of food fish caught in the State's coastal waters, especially near intensively developed urban areas. The reasons for this are threefold: overharvesting of some popular fish, shellfish, and marine mammals has depleted their numbers; until recently, the ocean has been viewed as a convenient dumping ground for all sorts of waste products, including materials poisonous to marine life; and coastal wetlands, which serve as "nursery grounds" for many species of fish and wildlife, have been dredged and filled for development.

Protect Against Overharvesting. The Coastal Plan calls for a coordinated program of marine resources management to combat overharvesting and to maintain high yields of fish, both for food supply and for sportsmen. High priority is given to meeting the needs of commercial fishermen and to the expansion of "aquaculture" (growing marine organisms under controlled conditions).

Protect Coastal Water Quality. The Coastal Plan specifies that all wastes released into the ocean should receive adequate treatment and that wastewater discharges into enclosed bays and estuaries be phased out when necessary for estuarine protection. The Plan supports (and proposes some expansion of) the current programs of the State's Water Quality Control Boards and the Department of Fish and Game. Power plants, or other industries that use ocean water for cooling, would be required to have special design measures to help protect marine life from being drawn into the cooling system, and from the effects of the discharge of heated water back into the ocean.

To insure careful handling of petroleum, cleanup of accidental spills, and prompt payback of damages and cleanup costs, the Plan calls for a $100 million oil spill liability fund, to be financed by a two-cent per barrel tax on oil entering California.

Control Diking, Filling, and Dredging of Wetlands. Nearshore waters, estuaries, marshes, and wetlands are the most productive part of the sea—and the most vulnerable to damage. The Plan proposes strong measures to protect the State's remaining wetlands. Restoration of wetland areas of comparable productivity would be required as a condition of many dredging or fill approvals. The Plan recognizes that expansion of some developments, such as ports and energy installations, may be necessary in wetlands, but establishes stringent provisions to minimize any harmful effects of such expansion.

Protect Against Harmful Effects of Seawalls, Breakwaters, and Other Shoreline Structures. Seawalls, breakwaters, groins, and other structures near the shoreline can detract from the scenic appearance of the oceanfront and can affect the supply of beach sand. The Plan limits the construction of shoreline structures to those necessary to protect existing buildings and public facilities, and for beach protection and restoration. Special design consideration is proposed to insure continued sand supply to beaches, to provide for public access, and to minimize the visual impact of the structures.

Coastal Land

Protect Coastal Streams and Plan Carefully for Coastal Watersheds. Coastal streams collect and channel waters draining from the land to the ocean, and thus form a fundamental linkage between shore and sea. Sediments and pollutants deposited in these streams can affect coastal wetlands as much as dredging and filling. The Plan recommends that comprehensive coastal watershed management plans be drafted to protect streamside vegetation, to maintain salt-water-freshwater balance, to protect the quality of water feeding coastal wetlands, to control sand supply (and thus protect ocean beaches from erosion), and to protect streams important as spawning areas for steelhead and salmon.

Retain Natural Habitat Areas. The richness of the nearshore ocean habitat is matched by the richness of the nearshore coastal land habitat. Many plants, animals, birds, and marine creatures are completely dependent upon the unique environment of the coast and can only survive in this setting. The Plan provides for careful protection of habitats of particular importance or rarity through acquisition, by controls on recreational uses, and through regulation of adjacent development.

Encourage Coastal Agriculture. The presence of the sea moderates the coastal climate, helping to create an extended growing season and to protect coastal crops from frost damage. The rich alluvial soils in coastal valleys, combined with temperate climatic conditions, create some of the finest and most productive agricultural land in the nation. Plan policies seek to support agriculture and to discourage conversion of these highly productive agricultural lands to other uses. The Plan proposes to alleviate the pressures of high property taxes and urban utility assessments that can force conversion of farm land to urban development. Also proposed are direct economic support and technological assistance. Controls are recommended to limit urban encroachment into agricultural areas and to regulate rural subdivision of land and lot splitting. The Plan recognizes, however, that some conversion of lower quality agricultural lands to other uses may be unavoidable in places where it has become uneconomical to continue farming. The Plan thus recommends standards to govern the conversion of farmlands surrounded by urban development and the partial conversion of larger parcels of less productive rural lands in ways that would allow some residual agriculture.

Encourage Continued Timber Production. The coastal forests in northern California are a valuable, renewable economic resource. The Plan seeks to maintain forests in long-term production with controls necessary to protect streams from erosion, to protect against damage to fish-spawning areas, and to protect the scenic beauty of forested areas. The Plan recommends that present tax laws be amended to encourage sustained forest yield by taxing timber only as it is cut, rather than taxing the value of all standing trees, as under the present system.

Conserve Soil and Mineral Resources. The soils and minerals of the coastal zone are irreplaceable resources of California. The Plan requires that local building and grading ordinances include effective measures to control erosion. Sand and gravel extraction would be barred in environmentally sensitive or highly scenic areas, and site restoration would be required where mining is permitted.

Protect Coastal Air Quality. In many urban areas, increasing numbers of people want to live and work along the coast because of its relatively clean air. Coastal Plan policies would exclude major new pollution-generating developments (refineries, fossil-fuel power plants, freeways) from portions of the coastal zone now designated as problem "air quality maintenance areas" unless there is no less environmentally damaging alternative. Where permitted, such developments would have to be designed and sited to minimize adverse effects on coastal air quality. The Plan would require the cumulative impact of development on coastal air quality to be considered in land use and transportation plans.

Coastal Appearance and Design

Protect the Scenic Beauty of the Coast. The California coastline is a visual resource of great variety, grandeur, contrast, and beauty. In many areas coastal development has respected the special scenic quality of the shoreline, but in others, incompatible development has degraded and altered the attractiveness of the coast. Plan policies provide guidelines for various types of development in highly scenic areas and in areas affording the public prominent coastal views.

The overriding design goal is that in scenic areas new development should be visually unobtrusive and subordinate to its setting. Development should be sited to protect coastal views and be landscaped to soften its visual impact. Construction materials should blend either with the natural setting or with adjacent structures. Massive structures such as major industrial plants and shopping centers should be built back from the shoreline. The Plan bans unsightly billboards along the coastline and requires the removal of existing billboards from such areas within 10 years. The specific design objectives for various coastal areas would be established through local design review programs developed by local governments. To help combat litter, the Plan recommends that the Legislature consider enacting a law forbidding the sale of non-returnable or non-biodegradable containers.

The Plan policies contain detailed guidelines for development in different coastal settings including standards for construction affecting wetlands, sand dunes, bluffs, headlands, islands, canyons, riverways, and uplands.

Coastal Development

Encourage Orderly, Balanced Development. Recognizing the need for continued development in appropriate areas, Plan policies propose that new development be concentrated in places able to accommodate it (i.e., areas with adequate water supply, sewer service, road and public transportation capacity, etc.).

New development would not be allowed to continue to leapfrog and sprawl over open lands but would, instead, be directed to already-developed areas. Along the immediate shoreline, priority would be given to "coastal-dependent" developments such as ports that by their very nature require coastal sites.

In rural areas not identified as containing significant natural resources, as highly scenic areas, or as viable agricultural lands, first preference in determining permitted uses would go to development that would preserve the open character of sites and serve the needs of coastal visitors (e.g., riding stables, campgrounds, or tourist accommodations). Residential development would be given lower priority but would be permitted where other types of development were infeasible. Plan policies recognize that certain potentially hazardous industrial activities (liquefied natural gas processing works and nuclear power plants) may require remote locations but seek to minimize the proliferation of these through site consolidations.

The Plan also recognizes that some of the unique communities along the coast, such as La Jolla, Venice, and Mendocino, are themselves coastal resources, and recommends special standards for protection of their scenic and community qualities.

Protect Against Natural Hazards. Development along the coast of California is threatened by a number of natural hazards such as floods, earthquakes, landslides, cliff erosion, and tidal waves (tsunami waves). The Plan proposes policies to restrict new development in floodplains, require that a geologic hazards description be made a part of residential sales information, place limitations on uses of land within coastal areas of highest risk, prevent public subsidies for hazardous development, and provide setbacks from erosion-prone bluffs.

Energy

Reduce Energy Consumption. Energy conservation can not only conserve petroleum and other resources, thus strengthening the nation's self-sufficiency, but it can also help to protect coastal air, land, and water from unnecessary oil, gas, and power-generating facilities. Expanding demands for oil and gas will result in increased tanker movements and port development, or in additional offshore oil production, or both, and in refinery expansion. Growing electricity consumption increases pressures for construction of coastal power plants, and some are likely to be fueled by oil. Plan policies recognize that energy conservation programs should be applied statewide, and that the primary responsibility for implementation of such programs rests with the State Energy Commission. The policies recommend to the Energy Commission a detailed program for energy conservation, which could be implemented separately within the coastal zone only if the Energy Commission fails to meet its own legislative deadline for implementing a statewide conservation program by July 1, 1977. Plan policies also advocate that tax incentives be provided to encourage energy self-sufficiency in building design. The Plan urges development and exploratory programs to expand use of alternative energy sources such as solar, wind, and geothermal energy, and energy from solid wastes and methanol.

Siting Energy Facilities. The Plan recommends that the Energy Commission have authority over the siting not only of new power plants but also of all other major energy facilities including those for petroleum production and refining. The coastal agency would, under the Plan, have concurrent jurisdiction in site selection and certification for sites in the coastal zone. The Plan would *not* exclude energy installations from the coast, but rather would require that both inland and coastal sites be fully evaluated so that necessary new energy facilities will be provided in a manner least damaging to all of the State's natural resources.

Power Plants. Power plants would be permitted within the coastal zone at sites jointly certified by the Energy Commission and the coastal agency. The Plan provides that adequate freshwater supplies for agricultural irrigation be reserved before any fresh water is appropriated for evaporative power plant cooling at inland sites, and urges research on the use of agricultural waste water for cooling. Among the most significant considerations would be demonstrations by a utility (1) that the plant is needed despite energy conservation efforts; (2) that alternative coastal and inland sites have been evaluated, and the proposed site is the least environmentally damaging site; (3) that the plant would be compatible with neighboring land uses; (4) that, where feasible, a substantial coastal area would be provided for public use; and (5) that adverse visual impact would be minimized. Plants could not be built in areas identified as highly scenic nor could they increase pollution in problem air quality areas.

Offshore Petroleum Development. Plan policies would allow offshore petroleum development, provided it is part of a clearly defined energy conservation and development program for the country or for the western states, provided stringent environmental safeguards are made part of the entire exploration and production schedule, and provided there is careful planning to minimize onshore impacts.

The policies also recommend revising current federal leasing practices to provide for withholding approval of offshore petroleum development until the offshore exploration has been sufficiently completed to determine the extent of the oil and gas available and the environmental impacts from extracting it.

Tanker Terminals. Tanker terminals would be permitted under criteria including the following: (1) existing facilities should be used to their maximum capacity before new port facilities are developed; (2) oil companies should be encouraged to trade crude oil supplies to minimize the need for petroleum transport and costly new terminal facilities; (3) existing harbor areas should be used to accommodate the tankers that will transport Alaskan oil (tankers with drafts of about 65 feet), but larger tankers to transport oil imports should be restricted to deepwater off-shore terminals away from environmentally sensitive areas; and (4) new terminals should be planned for multicompany use and should have adequate equipment for oil spill containment.

Liquefied Natural Gas (LNG) Terminals. Terminals for importing LNG would be permitted under the following criteria: (1) until concerns about the public safety risks inherent to LNG marine terminal operations have been satisfied, there should be only one LNG terminal for California, at a site remote from heavily populated areas; (2) if the public safety concerns can be satisfied, consideration should be given to building LNG terminals in already-developed port areas to minimize adverse environmental impacts; and (3) LNG terminals should meet rigorous design and operational standards for safety.

Transportation

Limit Adverse Environmental Effects of Coastal Access Roads. Access to much of the State's coastline is over roads that were built to meet the needs of another era. Increasing volumes of coastal visitors sometimes fill the roads to their limits, and there have been growing numbers of second-home owners and long-distance commuters. High-volume freeways, with their graceful curves and generous widths, are ill-suited to the rugged landforms of much of the coastline and would cut massive swaths through coastal neighborhoods.

Plan policies seek to improve the efficiency of existing roads by promoting use of public transit and by mandating transportation plans that pay special attention to weekend congestion problems. Coastal roads should be designed, as many in California have been, to reflect their use as recreational routes and should include such amenities as scenic vista points, rest stops, beach accessways, and picnic grounds. The Plan recommends that local land use proposals be evaluated against road building and transit plans to make sure that land developments do not overrun the capacity of the roads and effectively block access to coastal visitors.

Regulate Parking at the Coast. If everyone insisted on driving his car to the water's edge it wouldn't be long before much of the coastline would be paved for parking. Plan policies would restrict expansions of oceanfront parking lots but would provide for added parking immediately inland, well designed and connected to the shoreline by trails or shuttle buses. New developments would be required to have sufficient onsite parking or, in some cases, to provide payments to local transit systems.

Improve Public Transit. Public transit is little used for recreational travel, so on weekends fleets of transit vehicles used for access to work and school sit idle. There is excellent potential for increasing the use of public transit for recreational trips (experimental programs from San Francisco to beaches in southern Marin County have filled buses to capacity). Because public transit is less polluting than private automobiles and more efficient in its use of road capacity, transit is given strong preference for coastal transportation in many areas, and the Plan supports programs that would increase the attractiveness of transit to coastal visitors.

Provide for Water and Air Transportation. Port and airport facilities are vital to the State's economy, but expansion of either can have serious environmental consequences. Plan policies provide for increases in both air and water transportation, within a system of environmental safeguards. Except for ports handling hazardous materials, all port expansion would be channeled to existing port areas, and these would be used to their maximum potential before new diking or filling of water areas would be allowed. The potential for airport expansion within the coastal zone is limited, and the Plan recommends avoiding expansion of coastal sites, especially where this would require filling wetlands or losing recreational potential.

Public Access to the Coast

Guarantee Rights to Public Access to the Coast. Public access to the ocean is a right specifically set forth in the California Constitution. But it has not always been enforced, and many parts of the coast are now fenced off from the public or are otherwise inaccessible. The Plan proposes that existing legal rights of public access to the coast be enforced, and that reasonable requirements for public access be established in new developments along the coast. Recognizing that additional public access will require additional policing, litter control, and other such measures, the Plan provides that public accessways in new developments be set aside but not opened for public use until a public agency accepts responsibility for maintenance and liability. Where a new oceanfront development could not reasonably provide public access within its boundaries, appropriate in-lieu payments to an acquisition fund may be required to help buy nearby property for public access.

Create Opportunities for Persons of All Income Levels to Live Near the Coast. In recent years much coastal property has increased rapidly in value so that people of limited means, including many elderly people, can no longer afford to live in some coastal neighborhoods. Older residences that could be renovated are torn down, generally to be replaced by larger and more expensive buildings. Policies give preference to coastal developments that would be accessible to people of diverse incomes, also stressing shared ownerships, rentals, and a retention of existing moderate-income housing.

Encourage Multiple Use of Coastal Lands. Part of the beachfront at the Marine Corps' Camp Pendleton in San Diego County has been opened to the public, with management of the beach by the State Department of Parks and Recreation. The Plan proposes that on other military lands, consistent with security and safety, oceanfront areas be opened for public use. And the Plan recommends similar public access to the oceanfront, where appropriate, in major installations such as port facilities, power plants, etc.

Recreation

Increase Coastal Recreation But Protect Coastal Resources. The California coast provides recreation for millions of people every year—many from within the State, but many from other parts of the country and the world. Serving their needs provides California with jobs and income constituting a valuable part of the State's economy. Visitor surveys, filled campgrounds, and jammed parking lots make clear that even more visitors would be at the coast if there were more room for them.

The Coastal Plan proposes to expand recreational opportunities, by purchasing not only oceanfront beach and park land but also land just inland from the coast for parking and other support facilities, so the oceanfront can be reserved for recreation. Priority would be given to coastal areas close to major metropolitan centers. Where coastal communities are unduly burdened with the costs of maintaining recreational facilities enjoyed by inland residents, Plan policies recommend that State funds be made available to the extent they are needed to offset local costs of serving visitors. Where public purchase is not proposed, the Plan gives priority to private developments serving recreational and visitor needs over other types of development on the coast and encourages recreational facilities serving all income ranges, i.e., campgrounds, rental housing, or resort hotels.

But the Plan also recognizes that many coastal areas cannot accommodate unlimited crowds without environmental damage; indeed, too many people in an area can destroy the very features that attracted the visitors to the coast in the first place. Recreational areas would be managed to respect the natural capacity of park lands. (The State Parks and Recreation Department now allows only a certain number of people at a time into Point Lobos State Reserve south of Carmel, to protect a spectacular coastal promontory.) The Plan provides that limits be placed on public access and recreational use as necessary to protect coastal tidepools, bluffs, dune vegetation, and other such fragile areas; but also that additional sites be acquired as recreational demand increases so that facilities are not overburdened.

The Plan encourages construction of a coastal trail system, but with adequate policing and maintenance to protect adjacent agricultural lands from vandalism or other damage. Off-road recreational vehicles would be prohibited on the immediate beachfront, except at Pismo Beach in San Luis Obispo County and in a limited number of other places where stringent environmental standards could be met.

Encourage Recreational Boating, But Protect Wetlands. The demand for recreational boating has grown sharply in recent years, and in many coastal marinas there is a shortage of berths. In the past, small-boat marinas were often created by dredging and filling valuable marshlands or other wetlands, thus destroying fish and wildfowl habitat. Because such areas are essential to protect the State's fish and wildlife, and because boating can be accommodated elsewhere without habitat destruction, the Plan provides that new or expanded small-boat marinas be built in natural harbors, in deep water (that is, deeper than marshes and wetlands), and in areas dredged out from dry land. In addition, dry storage, rental programs, multiple ownership, and other means are proposed to provide for more boating while protecting wetland values.

Scientific and Educational Resources

Protect Sites of Scientific, Historic, or Educational Value. The Plan builds upon existing programs to protect sites of historic, archaeological, or scientific importance from being put to incompatible use. The policies advocate an intensified effort to identify and provide protection for the coast's historic and archaeological resources.

Restoration

Restore Degraded Coastal Areas. New recreational opportunities can be provided, new habitat areas created, and blighted coastal neighborhoods renovated through a coastal restoration program.

Because of the profusion of coastal subdivision and lot splitting and the extreme costs of providing urban services and access to remote developments, a restoration program is recommended to reduce the numbers of undeveloped coastal lots. Purchases are recommended to protect areas usable by the public and in areas where costs of extending urban services would exceed the costs of buying lots. In some cases, lots in common ownership would be consolidated. Owners of individual buildable lots would be guaranteed construction rights or, alternatively, public purchase at full market value in locations where plans call for acquisition.

Carrying Out the Plan

No plan dealing with controversial matters is likely to be self-enforcing. The Coastal plan thus recommends that the following implementation program be established:

Local Government Responsibilities for the Coast. Because city and county government is accessible and accountable to its constituents, because statewide coastal concerns should be reflected in local planning and regulation, and because Plan implementation should be streamlined to reduce costs and delays, primary responsibilities for carrying out the Coastal Plan should rest with local governments. Within three years of the effective date of state legislation to carry out the Plan, local governments along the coast should be required to bring their General Plans into conformity with the Coastal Plan. Local governments would submit their plans to the Regional and State Coastal Commissioners for certification as to conformity with the Coastal Plan. After all the local plans in a region had been certified, the Regional Commission would go out of existence. Local governments would then control coastal conservation and development, subject to a system of limited appeals to the State Commission to insure that approved local plans and thus the Coastal Plan were being followed in day-to-day decisions.

Coastal Resource Management Area. Because the Coastal Plan seeks to provide for the wise use and protection of coastal resources, local plans would be required to conform to the Coastal Plan in an area designated as the coastal resource management area. This area, shown in detail on the Plan Maps in Part IV, is the area of varying width along the coast containing the coastal waters, wetlands, beaches, bluffs, agricultural lands, and coastal communities and neighborhoods that are the subject of Plan policies. In some cities, the coastal resource management area is *less* wide than the 1,000-yard permit area established in the 1974 Coastal Act (Proposition 20). In rural areas and other areas of undeveloped land, the resource management area may extend to the inland boundary of the coastal zone to include coastal agricultural lands and streams and areas where the cumulative impact of development would limit public access to the coast (e.g., Malibu, Big Sur). As provided by the 1972 Coastal Act, the California coastal zone is the water areas under state jurisdiction, the offshore islands, and land areas inland to the highest elevation of the nearest coastal mountain range, except that in Los Angeles, Orange, and San Diego Counties, the boundary does not extend more than five miles from the mean high tide line.

Permit and Appeals System. To insure that unwise development decisions do not occur while local plans are being brought into conformity with the Coastal Plan, the permit and appeals system specified in the 1972 Coastal Act would remain in effect except that (1) the standards for issuing and denying permits would be compliance with the Coastal Plan, not the 1972 Coastal Act; (2) permits would also be required within the coastal resource management area for the conversion of any prime agricultural land to other uses and the conversion of other agricultural land in parcels of 20 acres or more; (3) anywhere within the coastal zone, a Commission permit would be required for major water, sewer, transportation, or energy developments that could adversely affect coastal resources; and (4) permits would *not* be required where a Regional Commission (or the State Commission, on appeal) determined after public hearing that development of a particular type or in a particular area would not adversely affect coastal resources.

Permits and Appeals After Certification. After a local plan has been certified by the Coastal Commissions as being in conformity with the Coastal Plan, local governments would have primary implementation responsibility, subject to a system of limited appeals to the State Coastal Commission to insure that the approved local plan and the Coastal Plan were being followed in day-to-day conservation and development decisions.

State Coastal Agency. After the Regional Commissions have gone out of existence, a State Coastal Commission with 12 members—one-third appointed by the Governor, one-third by the Speaker of the Assembly, and one-third by the Senate Rules Committee—would have the following responsibilities: (1) carry out the planning and research necessary to keep the Coastal Plan up to date in light of changing conditions; (2) assist local governments in Plan implementation; and (3) through the appeals process, monitor the decisions on proposed coastal conservation and development.

State and Federal Agency Responsibilities. The Plan provides that all state agencies, and all federal agencies to the extent applicable under federal law, be required to conduct their activities in full compliance with Coastal Plan policies. The Coastal Commission would seek to insure that California maintains a Coastal Plan complying with the standards of the Federal Coastal Zone Management Act of 1972, thus qualifying the State for federal funds to help carry out the Plan, and also insuring that federal agencies would be required to follow the Plan unless an overriding national interest compelled other actions.

Proposed Bond Issue. The Plan proposes that a limited number of key coastal properties be bought by the public, primarily for oceanfront recreation and for the protection of wildlife habitat. Based on assessments by county assessors, the parcels *tentatively* proposed for acquisition have a total market value of about $180 million. Because of inflation, and because some assessments have not been updated recently, estimates may be low with regard to some parcels. On the other hand, the total cost may be reduced by eliminating some parcels from the list (the Commissions are continuing to review the acquisition proposals) and by purchasing easements rather than full title in some cases. The Plan proposes that, after further review of the proposed acquisitions, a bond issue be submitted to the voters of California in 1976 to pay for prompt purchase of coastal properties.

Costs of Carrying Out the Plan and Possible Sources of Funds. Costs of carrying out the Coastal Plan are (1) the cost of land acquisition, not expected to exceed $180 million to $200 million together with some additional operating and maintenance costs to park agencies as new beaches and parks are open; (2) the cost of Coastal Commission permit and appeals administration, estimated at $1 million to $1.5 million per year; (3) the cost of further Coastal Commission planning to keep the Coastal Plan up to date and to assist local governments in Plan implementation, estimated at $1 million to $1.5 million per year; and (4) the cost to local governments of bringing their plans into conformity with the Coastal Plan, estimated at $600,000 to $800,000 per year for three years.

The Plan proposes that these costs be paid from several possible sources:

- The bond issue cited above;
- Federal acquisition grants from the U.S. Land and Water Conservation Fund;
- Federal planning grants (once California's Coastal Plan has been certified as in compliance with the Federal Coastal Zone Management Act of 1972, California will be eligible for two-thirds of the planning and administrative costs of carrying out the Plan);
- Taxes on the production and transport of petroleum on and across California coastal waters, because a principal purpose of coastal planning is to provide adequately for needed energy production consistent with environmental protection; and
- Perhaps from added fees on pleasure boats or added taxes on visitor accommodations in coastal areas, in both cases requiring those who benefit most from coastal recreation and amenities to help pay the costs of protecting the coast.

Rights of Property Owners

The Coastal Plan recognizes fully that the ownership and use of private property are fundamental concepts in the law and traditions of the United States. This nation's long history of personal liberty, as well as its material prosperity, have resulted in large part from the freedom and private enterprise encouraged by the private ownership and use of resources. The Consititutions of both the

United States and the State of California protect property owners against the taking of their property without just compensation. The Coastal Plan cannot violate these Constitutional mandates, and it does not.

Landowners' Rights Protected. The Coastal Plan protects the rights of landowners. The Plan proposes that some key coastal properties be bought by the public for public use or environmental protection; the owners of such property would be paid fair market value for their holdings. If such property is not in fact bought by the public, the property may be put to other uses by its owner consistent with Coastal Plan policies. The Coastal Plan proposes development standards, similar to those in long-established city and county laws, under which new buildings would be designed to minimize interference with ocean views from public roads, and to provide public access to the oceanfront where appropriate.

The property rights of a landowner are not absolute. Rights can and do change over time, and the rapid urbanization of the United States during the 20th century has led increasingly to restrictions on the use of private property—restrictions held by the courts to be consitutional. For example, the U.S. Supreme Court held 25 years ago that property owners could not create an enforceable agreement requiring racial discrimination in the future sale of their land. For many years, laws have prohibited the use of property in a way that would result in health hazards or noxious effects on the public at large. And local zoning laws have been upheld by the courts since 1926.

Rights and Expectations. The issue is not whether property owners *rights* could be violated; under Federal and State Constitutions they could not be. The issue, at least in many places, is that property owners' *expectations* may be affected. When people buy land, they often expect a certainty of financial return greater than when they buy securities or make other investments. Because they may live on the land and farm it, because they pay property taxes on it, and because of the recent rapid rise in land values in many areas, many people expect to make money by holding or using land, and they believe they deserve to be compensated if their expectations are not realized. Under the Coastal Plan, as under many Constitutional land use laws, people can use their land in a variety of ways, but in some cases not as fully or intensively as they might like.

Development in Both Public and Private Interest. The Coastal Plan recognizes that in many coastal areas open lands now providing spectacular ocean views are in fact lands that have been divided into small lots generally intended for single-family homes. If all the owners build single-family houses, as presumably they eventually expect to do, and if all the homes are screened and landscaped, motorists on the publicly financed scenic State Highway 1 will not see the ocean but the backs of a nearly solid wall of houses. The Coastal Plan recommends policies to deal with this situation. In appropriate areas, lots not yet built upon could be bought back from their owners—at fair market value—so that the land could be preserved as open space or, alternatively, replanned, redivided, and resold for a clustered form of development that would preserve substantial open areas. If the property is not covered by a public program of this or similar type, then the Plan recognizes that the owner of an individual lot, having no legal or physical impediments to restrict development and having no reasonable use other than a single-family home, will be able to build such a home on it.

But the Plan would require that such houses be designed, built, and landscaped to minimize interference with public views from Highway 1, and to safeguard wherever feasible public access to the publicly owned tidelands. Thus, with no taking whatever of an owner's property, the owner of coastal land might be required to build in a slightly different manner from what he might otherwise like to do. This is no different from the existing city and county ordinances, accepted by landowners and public alike, that require, for example, street dedications or front and side yard setbacks from a property line. In other words, established law already requires that an owner of land take public needs into account in his private development.

Public Access to the Ocean. The Plan would not take any private property for public use, but rather seeks to protect existing public rights of access to the ocean and other navigable waters. Just as the California Constitution protects private property rights, so it also protects rights of public access. The State Constitution, adopted in 1879, provides in Article XV, Section 2, that "The People Shall Always Have Access to Navigable Waters, No individual, partnership, or corporation, claiming or possessing the frontage or tidal lands of a harbor, bay, inlet, estuary, or other navigable water in this State, shall be permitted to exclude the right of way to such water whenever it is required for any public purpose, nor to destroy or obstruct the free navigation of such water; and the Legislature shall enact such laws as will give the most liberal construction to this provision, so that access to the navigable waters of this State shall be always attainable for the people thereof."

Summary. In summary, the Coastal Plan, if carried out as presented in this report, would not take any landowners' rights. In some cases, it might change his expectations, but there are many factors other than the Coastal Plan that can influence future land values—for example, the value of land for second-home subdivisions depends, in part at least, on the price and availability of gasoline for driving to distant areas. Thus, there can be many reasons for financial reverses in the ownership of land, as in the ownership of securities or any other investment. Although no compensation for loss of expectations is legally required, perhaps there should be a public policy debate as to its desirability. At the very least, however, it could be difficult indeed to correctly measure declines in value, and to fairly assess the many factors that might be responsible. And there is yet no tradition of public responsibility for guaranteeing the success of private investments in land or in anything else.

Economic Impact of the Plan

Protecting California's coast is essential for the State's long-term economic well-being. The Coastal Plan calls for economically sound measures: well-planned, orderly development to curb the wasteful use of land; vigorous protection of the coastal resources that are the basis of the multi-million dollar coastal tourist industry and the thousands of jobs it provides; and similar protection for coastal farmlands, timberlands, and ocean fisheries—all of which provide jobs and income for Californians.

Factors in Economic Analysis. Economic activity along the coast is affected by many factors of which the Coastal Plan is only one. Interest rates, population growth, unsold or under-used buildings, and the availability of energy are all factors that will affect building activity along the coast. The coastal economy, and indeed the State's economy, may also be affected in less obvious ways. For example, there is an economic loss when low-quality, sprawling development is allowed to overrun land suitable for much better development. There is an effect on the consumer's food bill when prime agricultural land is converted to other uses—followed by efforts to achieve comparable production on less valuable land through energy-intensive applications of irrigation water and fertilizer. The past misuse of California's coastal resources has caused unmeasured but real economic losses.

Short-Term Vs. Long-Term Economics. The gradual, piecemeal degradation of natural resources has not usually been recognized as a major economic loss. Rather, attention has been concentrated on short-term economic benefits: when a marsh was filled, attention was given to the jobs created by new construction, and a resulting increase in the local tax base. Similarly, building houses on prime farmland has usually been seen as economically beneficial. But there is increasing evidence of long-term losses that may not be so visible. Filling marshes, bays, and estuaries, which are essential nursery grounds for many species of fish and wildfowl, can gradually decrease the ocean fisheries—and the jobs and income, together with food supply, that ocean fishing provides. There may well be serious long-term consequences from the increasing loss of prime agricultural land—effects not only on food prices but on the ability of this nation to help feed the world's growing population, and to export food in return for petroleum, metal ores, and other products from abroad.

The Coastal Plan recognizes, in short, that protection of coastal resources is essential to a sound economic future for California. Specifically:

• *The Coastal Plan Seeks to Protect the Economic Value of Public Enjoyment of the Oceanfront.* While it may not be possible to determine precisely the dollar value of a day of recreation or inspiration provided by ocean beaches, parks, bluffs, and trails, there are clear dollar values attributable to the coastal visitor economy. And the Coastal Plan seeks to increase public access to the oceanfront in appropriate areas; to provide tourist accommodations from campgrounds to hotels, resorts, and meeting centers; and to give preference to these public activities over private housing in suitable coastal areas. If Californians were to allow the coast to be further degraded, ocean views to be blocked by poorly-designed buildings, and access to beaches restricted, they would be risking the future of one of the most important economic assets of the State—coastal visitors.

Security Pacific Bank, in its 1975 Coastal Zone Economic Study, wrote that "tourism is a vital economic base industry, i.e., its income accrues from sales to people from outside the state, and it brings in 'new dollars.' Some of its benefits include the direct and indirect support of a multi-industry infrastructure, the employment of many relatively unskilled workers, and the taxes paid by the tourist . . . Tourists make relatively small demands on a region's public services (police and fire protection, street maintenance, etc.) and yet they contribute heavily toward providing employment and income and in reducing the tax burden of local residents."

• *The Coastal Plan Seeks Orderly, Balanced Development, Reducing the Excess Costs of Urban Sprawl.* "The Costs of Sprawl," a study made in 1974 by Real Estate

Research Corporation for the Federal government, showed that well-planned, concentrated development means savings to the public of between 5 and 33 percent when compared with wasteful, land-consuming development. The savings are in the costs of roads, sewer and water lines, etc., and also in travel time for residents, the need for services such as schools and fire stations, etc. And, of increasing importance, well-planned developments can save greatly on energy. The Coastal Plan seeks *not* to stop growth and development, but to direct new construction primarily into the rebuilding and upgrading of already-developed areas where additional development can be accommodated. The issue is not *whether* there should be new development, but *where.*

• *The Coastal Plan Seeks to Protect the Harvesting of Renewable Resources—Agriculture, Forestry, and Ocean Fisheries.* Thousands of jobs and millions of dollars in annual crop production depend on the unique combination of California's coastal soils and climate. Protecting California's agricultural lands is not only a coastal issue; it is obviously a problem of statewide concern. But the Coastal Plan seeks to maintain the long-term productivity of coastal farmlands, grazing alnds, and timberlands for their long-term economic value. Similarly, the Plan seeks to protect ocean fishing, both commercial fishing and sport fishing. The Plan therefore seeks to protect the coastal estuaries and wetlands essential to California's ocean fishery, and to protect coastal water quality. The economic values are clear: the Security Pacific study noted that in 1972, the most recent year for which detailed figures are available, California landings and shipments of commercial fish were valued at $162.5 million. The study added that "the real value of commercial fishing to the State and regional economies of California in terms of primary, secondary, and tertiary income and employment is difficult to assess. In most cases, these values are probably understated. California fishermen range many miles from their home ports in search of their catch—from Alaska on the north to South America on the south—and in many instances, they market their catch at the nearest suitable port in order to shorten their turn-around time. Consequently, California's official published valuation figures are understated in that they include neither the value of the fishing catches, the profits, nor the wages, resulting from deliveries to non-California ports. There is a positive effect, however, in that these monies are brought back to California and introduced into the state and regional economies as export or 'new' dollars."

• *The Coastal Plan Recognizes the Possible Need for Energy Installations and Production.* The Coastal Plan recognizes that some future coastal sites may be needed for new or expanded power plants, that new port terminals may be needed for larger petroleum tankers, and that offshore petroleum production may be required as part of a national energy conservation and development program. The Plan provides standards by which necessary energy installations may be accommodated, consistent with the protection of coastal economic and environmental resources.

• *The Coastal Plan seeks to provide Other Economic Benefits.* The Coastal Plan seeks to protect the coastal streams that deliver sand to ocean beaches; beach erosion costs property owners and governmental bodies several million dollars every year for building groins, jetties, and other erosion-combating structures, and for importing sand. And the Coastal Plan also seeks to maintain and enhance coastal air quality; air pollution causes millions of dollars annually in crop damage, and inestimable damage to human health.

The Future Envisioned by the Plan

The Coastal Plan envisions a future for California's coast that includes:

- An orderly transition between fully developed communities and productive farm and grazing land.
- Recreational boating increased, consistent with wetland protection.
- New residential development concentrated and served by public transit, so that roads to the coast are kept uncongested.
- Downtowns and neighborhood commercial areas renewed and refurbished, with no further construction of sprawling shopping centers that destroy valuable farmland on the fringes of the cities.
- Traffic flowing smoothly through cities to the shore, with many vehicles being shuttle buses from nearshore parking lots where motorists have left cars.
- Well-maintained, older, less-expensive housing that provides opportunities for people of all incomes to live near the ocean, and clearly blighted areas replaced by new residential construction.
- Many more people enjoying beaches, coastal resorts, hotels, and waterfront restaurants.
- Power plants as needed to serve an economy that employs effective energy conservation, and every power plant sited and designed to minimize environmental damage and hazards.
- Expanded and more efficient facilities at existing ports, to take advantage of the great energy and cost savings of ocean transportation, and port developments planned to minimize environmental degradation.
- Beyond the urban areas, a largely undistributed coastline that can be enjoyed from comfortable tour buses, cars, motorcycles, and from miles of foot, bike, and horse trails, with many more carefully planned beach access areas, and campgrounds.
- Agricultural lands kept in agricultural production with taxation based not on potential subdivision but on farmland needed to feed a growing population; and with incentives for Californians to work in productive agriculture.
- In the North Coast Region, a more vigorous visitor industry, an enhanced agriculture, and a timber industry made stronger by more widespread use of sustained yield practices and by an increased demand for wood products to replace increasingly expensive and dwindling manufacturing and construction materials such as plastics and steel.
- And overall, continued growth channeled both to achieve greater savings in public costs by concentrating development, roads, utilities, and to protect coastal wetlands, farmlands, views, and other natural resources.

Discussion

MR. BEN ESCHEM [Northfield, Wisconsin]: At what stage of the planning are you in in California? What has been approved by the Commission? And my second question—if this plan is already adopted, what kind of legal policies have you to enforce it?

MR. BODOVITZ: The Plan has been adopted by the Coastal Commission, who prepared it, submitted to the Legislature and the governor. The Coastal Commissions are temporary under the California initiative, and so they will expire at the end of the year if no legislation is passed.

The answer to the second question depends on what kind of legislation is passed this year as to what kind of legal powers will be available to enforce the Plan.

I should point out that during the three years in which the Plan was being prepared, the Commission had very strong legal power. Those who wanted to develop in the area up to 1,000 yards from the high tide line had to get a permit from the Commission.

People who wish to have little or no restraints on Coastal development are vigorously opposing the plan, and I suppose there is no issue in the legislature this year that is more controversial.

MISS POLLY DYER [University of Washington]: In the development of your plan, have you taken time to look at the situation in the hinterlands and what is happening up there, on the coast, both on the land or in the tidal zone, in thinking possibly of chemical application to farmlands and forest lands?

MR. BODOVITZ: Yes. Let me go on and say that the concerns are not just for the immediate shoreline. If the question is: "Are we concerned with pesticides that run into a body of water, or the things that are happening immediately adjacent to the shore?" The answer is absolutely yes. One of the concerns in coastal planning is that although the coastal zones of the country are special areas and deserve some special treatment, they are connected to the rest of the states. We tried to make clear in our plan that the coast should not be accorded special treatment at the expense of other areas.

I will give you an example. One of the controversies in California has been over the siting of power plants. The inland people believe the plants should be on the coast, and some of the coastal people want them inland. Everyone wants power plants, but not in their neighborhood.

One of the strong provisions in our plan is that new power plants, if needed, should be built so that, environmentally, they do the least damage. One of the concerns, however, in inland California, is that the power plants not be built in areas where they would take cooling water away from agriculture. Therefore, we have suggested that other ways should be explored for power plant cooling. But we would not propose taking fresh water from irrigation to do that.

MR. GEORGE BENTLEY [Upper Basin River Commission]: Would you explain the federal role in coastal zone planning and management planning? What federal agencies play a prime role, and what authorities do you have over them, or what contacts you have with inter-agency councils etc.?

MR. BODOVITZ: I answer that in two parts.

In 1972 Congress passed and President Nixon signed the United States Coastal Zone Management Act of 1972. It provides, essentially, that coastal states may receive grants of federal funds to assist in the preparation of coastal zone plans. A state may receive grants up to three years for this purpose. Our program has benefitted greatly from this.

It is my understanding that all the coastal states, including the Great Lakes States, now receive some funding under this program for preparation of their coastal plans.

Congress also provided that once the Secretary of Commerce has certified a state program as being in accord with federal law, a state may then benefit in two ways. It may receive additional money to assist in carrying out that plan. There is also a provision of the federal law that says all federal agencies shall conduct their activities consistent with the approved state program, at least as much as possible. Those of you who believe in fairy tales believe that this means the Interior Department will thereupon abide by prudent state programs, and the Navy will do likewise, as will the Federal Energy Administration. Those who do not believe in fairy tales will suspect, as I do, that we have no idea how that is going to work out.

The Federal program is in the Federal Office of Coastal Management in the Department of Commerce, and I would like to take this opportunity to say that it is a very well-run program, under the direction of Bob Knecht.

MS. LOUISA BATEMAN [Fish and Wildlife Commission, Oregon]: I believe you said you are going to work on plans for prime farmlands. We are involved in that. Could you enlarge on the subject?

MR. BODOVITZ: There is a bill now in the California Legislature. It has passed the Assembly and is now pending in the Senate, and it would require all cities and counties to map their prime agricultural land.

"Prime" is a term in California that is under much attack. It has to do with soil quality, productivity, and so on. I think, however, it is clear that it is the most productive agricultural land in the state.

The bill would require the local governments to map and designate this land and not allow it to be used for any other purpose. Then property taxes will be on the basis of permanent agricultural use, not as land potentially available for residential or other kinds of development.

It is very controversial as you might imagine. People who own this land do not like the restriction. One of the arguments against it is it would put greater pressures on the next-best land.

It seems to me this is an example, however, of the kinds of hard decisions that lie ahead with regard to land use planning. There is only so much prime agricultural land. As I said earlier, you can take less productive land, and if you could get the water and the fertilizer, you could do things with it. With the cost of water and fertilizer perhaps going to be higher than they have ever been, however you have to consider this in relation to the cost of the food being produced. The great problem in dealing with this kind of issue is the suddenness of the change.

Let me dwell on that for a moment. One of the great concerns of these issues—and I admit to having no great answers, although I wish I did, is that it is important to find ways to preserve agricultural lands in ways that are fair to the landowner.

People from the farms, when they attend the hearings on this, and see what the conservationists want to do, claim it will make serfs of the farmers. Those of you from rapidly urbanizing areas well know that many farmers see themselves as people who are going to work the land. When their children do not want to work the land, they sell it to the subdivider. At the end of all that hard work, the farmer is selling his farm land outright, and you have a whole economy based on this kind of expectation.

When you say to people "we are going to let you continue to work your land and have the hard life of the farmer, but we are going to remove from you the expectation that you will be able to sell it for condominiums," it seems to me you should not be surprised and cannot be surprised at the eruption you get from the people who own that land. It does not always soften the blow to say that we are going to lower their property taxes.

I do not minimize the difficulty of these pressing problems.

CHAIRMAN HELLER: I would like to urge you not only to pick up copies of the summary. The total Plan, for anyone who is used to reading planning prose, is a remarkable document. Because of the way in which it was developed, it holds promise of being put into effect in substantial form.

I mentioned earlier that the base plan was a prime example of a successful plan in action, and I must say that I feel Joe is the best example I know of, of a successful planner, and certainly he belies the current vogue of belittling the planning profession.

Energy, Land and Equity

Bruce Hannon
Energy Research Group
Center for Advanced Computation
University of Illinois at Urbana-Champaign

When economists first began to describe production, land and labor were the only primary factors considered necessary. As the industrial revolution unfolded, it became increasingly clear that the output of labor could be multiplied many fold through the use of tools, machines, and buildings. These elements were introduced as a capital factor in production theory. Multiple-story buildings and complex transportation networks allowed capital to multiply the productivity and allowed the specialized use of land so much that the relative importance of land as a cost of production declined.

Recently, energy has been introduced as an element of production. Energy has augmented the productivity of capital, labor and land. Energy is used to heat and cool and to construct buildings; also to build and run machines. The centralization of industry allows capital to be used efficiently, but at the cost of increased transportation energy use. Energy-intensive machines have augmented labor productivity, but have produced the potential for great unemployment too. The job loss would have been higher than any recorded unemployment had not the absolute level of economic activity increased enough to absorb many of the extra workers. Since energy was inexpensive relative to wages, the substitution of energy for labor caused consumer prices to decline in real terms. This general price decline stimulated consumption, causing economic growth which, in turn, required further employment, although at declining labor intensity. The productivity of land as measured in output per acre per year was increased by using energy-intensive fertilizers and chemicals and by energy-intensive mechanization replacing the power provided by draft animals. Also, energy-intensive transport systems allowed the connection of disparate pieces of land so as to increase their real and potential productivity.

Each factor has its own special nature. Capital is produced by manufacture. The earth's mineral resources are used to produce capital goods, which can be completely recycled when their structural utility is lost. Labor will also age or become outmoded, but it can be renewed. Energy derives from mineral stores in the earth and from the sun, yet energy cannot be recycled.

Energy from the earth's mineral resources is available at a rate limited only by our technology, but is in finite supply. Energy from the sun is available at a finite rate because of the fixed surface area of the earth, but the supply of the sun's energy is unlimited. The United States may now be at the point of turning from an economy based on stored energy toward one based on energy flow. If we do proceed, land will become increasingly more important as an energy collector, as will the lakes and oceans, and land will return toward its former level of relative importance as a factor of production.

Land use in the U.S. is currently about 21 percent crops, 27 percent rangeland, 32 percent forests, 8 percent urban, industrial and recreation land, and 12 percent undeveloped (Frey 1973). Of the total 2.3 billion acres (93.15 million ha), 40 percent is publicly owned. To capture the sun's energy for use in homes and industry could produce substantive conflicts in land use with the current production of food and fiber.

For example, I have calculated that to provide for the U.S. residential, commercial, and industrial energy used in 1970 by growing especially suited vegetation would require nearly all of the U.S. crop and forest land[1].

In contrast, if the entire 1970 energy demand were to be supplied by strip-mined coal, about a million acres would be required (Averitt 1970)[2]. In about 50 years[3] of strip mining at this rate, we would have cleared an area roughly equal to the size of Pennsylvania and West Virginia, and would have exhausted our presently known reserves of strip-mineable coal. There could also be a decline in soil fertility in the strip-mined areas. This comparison of surface coal mining and vegetative energy production sharply points up the difference between land impacts of finite and infinite energy supplies.

The emphasis in this paper is on the impact of energy-demand reduction on land-use patterns. Changes are suggested in these patterns in order to facilitate the change to a lower energy use by our society as a whole. These changes are based on the results of recent research on energy and employment demands coupled with a series of personal speculations regarding the extremely complex effects on the economy wrought by the changes. As such, this paper is intended to challenge the conventional wisdom of unlimited growth in the face of limited energy resources and also to challenge those who do not understand the systemic effects of the changes they propose.

Reducing Energy Use

The transition of the U.S. from an economy based on energy supply to one based on energy flow is perceived as an inescapable eventuality, as well as a means of reducing dependence on foreign energy supplies and as a way of diminishing environmental damage. Certainly, the long lead time and massive capital allocations required to increase energy supplies are good short-term rea-

[1]Throughout this paper, I calculate the bounding condition (upper or lower) in order to illustrate the effects of the logical extremes. For a breakdown of 1970 U.S. energy use see, Cook (1971). I assume that the solar capture efficiency would be 0.4 percent (Kemp and Szego 1975), that transport fuels would be provided in the form of industrial alcohol and that one half of all residential and commercial space and water heating could be provided by the sun directly (about 5 percent of the total U.S. energy use). The efficiency of land use might be improved by providing the alcohol by fermentation, by short term storage of the sun's energy, in molten salts for example, and by direct generation of electricity. The latter is useful for peak demands primarily. In the latter two cases, the energy cost of distribution may be substantial and the net energy produced may not exceed the system's capital, operating and maintenance energies. Energy intensive manufacturing facilities could also be relocated to desert areas where solar energy is more intensive and less interrupted than elsewhere.

[2]According to Averitt (1970) there are an estimated 128 billion tons of strip mineable coal remaining in the U.S. (4.4 billion tons have been removed), with an overburden of from zero to 150 feet. The remaining reserves cover an area of 71,000 square miles, approximately the combined area of Pennsylvania and West Virginia.

[3]Long before this time, the costs of strip-mined coal would be likely to rise so high that solar energy would have become a greater reality and overall energy demand would have dropped.

sons for lowering energy use now, mainly through changes in the energy efficiency of production and consumption efficiency. The conflict between energy production and food and fiber production also means that we will probably reduce our use of energy in the long term. To extend that time of reckoning and to smooth the economic transition, we should begin now to reduce the use of the fossil and uranium energy. This is my definition of energy conservation, and I justify my position with the following argument.

Assume an objective of survival. Of a set of equally free energy-endowed consumers, the one who uses the least amount of free energy per unit of time on the average will survive the longest. Such a consumption scheme is possible as long as consumer competition for wealth does not exist. With such competition, however, the consumer who produces the least waste energy per unit of free energy used will last the longest.

The difference is that without competition a consumer can, and I claim will, concentrate on the *absolute level* of resource use. With no competition, it seems unlikely that many individuals would then accelerate their own consumption. With interconsumer competition, the consumer is limited to the *efficiency* of resource use.

This dichtomy lies at the source of confusion over the definition of energy conservation. Environmentalists usually align themselves with a reduction in the absolute level of energy use, hypothesizing that energy production and use are the causes of environmental damage. Students of the problem with backgrounds in engineering and economics usually align themselves with the efficiency criterion, believing first of all that consumer wants are sovereign, that is, people must be thought of as having infinite material desire, and second that technological substitutions will solve all problems of resource shortages. From the engineering-economic viewpoint just given, growth of material consumption becomes a positive attribute of a successful society.

There are two problems with this latter view, however. First, do we actually possess infinite material wants? Perhaps what appears to be an insatiable desire for material goods may actually be a desire for equity, in terms of the distribution and amount of energy. The relative question concerns equity of distribution; the absolute question, amount. If we perceive of the available energy as being distributed equitably, then perhaps the preoccupation with efficiency could change to a consumption pattern based on reducing the absolute level of energy use.

If a social system never modifies itself in order to reduce consumer competition, its members would always appear to have infinite wants. Shortages of resources would be accompanied by accelerated competition and aggression. To overcome such circumstances, we could redefine the society's goal definitions for the individual so as to raise the status of the indicators of nonmaterial wealth to a level above those of material wealth. We could also strongly associate individual behavior with systemic effects in the hope of reducing our discounting of the future. Finally, a guarantee of energy equity could be given to all consumers.

On the other hand, assume that people may indeed recognize infinite material wants. Since energy exists either in finite supply (fossil and nuclear fuels) or is available at a finite rate (solar), these infinite wants cannot be fed forever. Even-

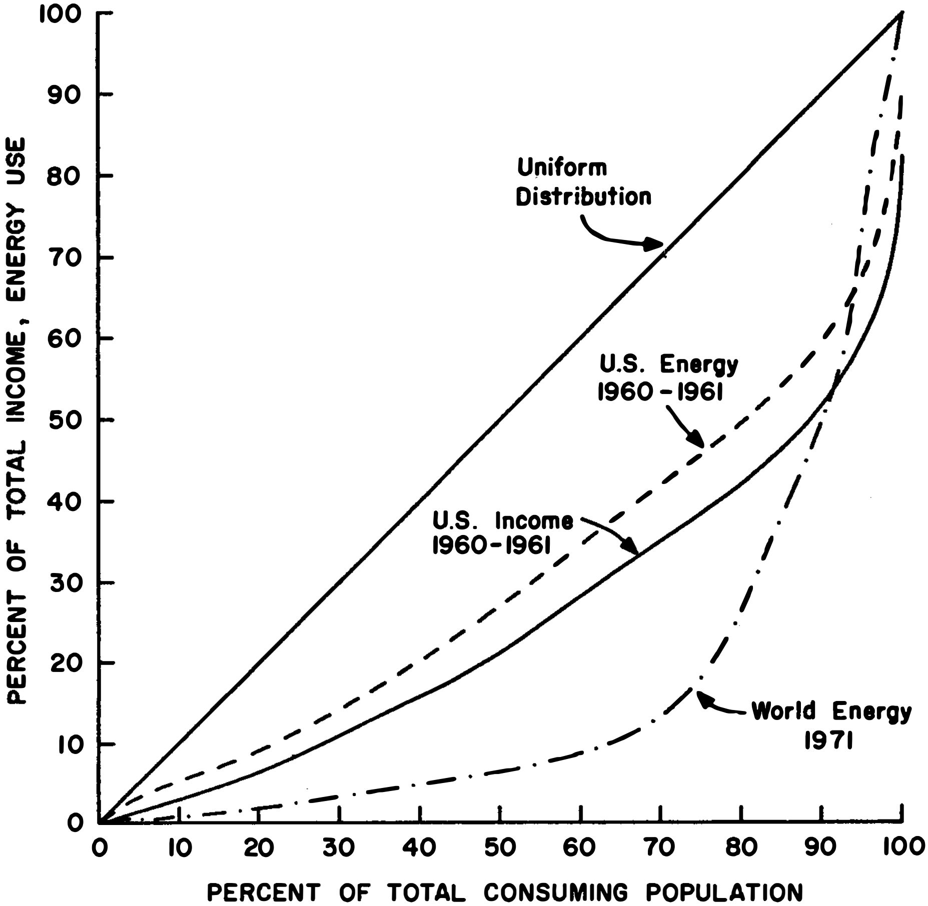

Figure 1. Distribution of U.S. consumer income after taxes and energy use (Herendeen 1974) and world energy use (Schipper 1975).

tually, the wants must reach equilibrium, and then we must face the equity problem.

The data in Figure 1 show the relative distribution of after-tax income and energy use in the U.S. in 1960 and 1961. A comparison is made with world energy distribution in 1971. In such figures, the closer a line of distribution lies to the straight line, the more nearly perfect is the equity of distribution. U.S. energy use was distributed better than income in 1960-61, probably because it was so inexpensive. Since income distribution has improved in the 10 years after 1960-61 (Radner and Hinrichs 1974), energy distribution has likely also improved.

As seen in Figure 1, the U.S. system clearly distributed energy far more equitably among its own members than energy was distributed (10 years later) among the nations of the world. In the world energy use curve the U.S. is represented by the last 6 percent (94 to 100 percent) of the world consuming population and about 38 percent of world energy consumption. It is unclear how long this inequity will exist and how long fossil and nuclear fuels would last if the world distribution of energy became equivalent to that of the U.S. This is the most compelling of all reasons for energy conservation in the high-energy-using countries.

A democratic society would approach a transition from a high level of energy use to a low one with Jeffersonian sureness. The arbiter of equity would be a system of decisions reached by the public through those elected to serve them and based on widespread, accurate information plus an ability and willingness of the people to participate.

A socialist society would reckon that people's behavioral patterns are products of their perceptions and of governmental mechanisms. Thus, a technology of energy-saving behavior would emerge and would be implemented (Skinner 1972).

However, we must realize that whatever our form of government, that government will concentrate more on interpersonal equity (distribution of goods among those currently in the adult population) than on intertemporal equity (forestalling consumption). Corporate forms, particularly monopolies, seem to inadvertently provide intertemporal equity by reflecting resource scarcity in the costs of their products. Autocratic governmental forms also possess the capacity for intertemporal equity. Autocracy and monopoly are in some sense analogous to the climax ecosystem wherein a few dominant members of even fewer species control the available energy flow. An ecosystem in this condition seems to be indicating that survivial (intertemporal equity) takes precedence over symbiosis (interpersonal equity).

The Dilemmas of Energy Conservation

The patterns which will be adopted in the United States are certainly not clear. However, there are three dilemmas which confound a rapid and easy transition to a lifestyle based on lower total energy use than at present (Hannon 1975)[4].

First, labor, capital, and land have been replaced historically by energy[5]. To save energy, the cost of labor, capital, and land must be reduced relative to the cost of energy.[6] This substitution means real wages and real returns to capital

[4]See also B. Hannon, "Energy Growth and Altruism," Mitchell First Prize Paper, Limits to Growth, Thayer School of Engineering, Dartmouth University, New Hampshire (Oct. 21, 1975).

[5]Our research clearly shows that the products of the U.S. economy in the 1960's are either energy intensive or labor intensive but not both. A redistribution of demands for these products could therefore produce an overall increase in the demand for labor and a decrease in the demand for energy.

[6]If e is the unit cost of energy, ℓ is the unit cost of labor, C the unit cost of capital and ℓ the unit cost of land and we order the factors, energy, land, capital, and labor in order of decreasing scarcity, then the inequality; $\frac{e}{L} > \frac{e}{C} > \frac{e}{\ell} >$ sets a constraining condition for proper factor substitution. Thus, governmentally induced increases in the unit cost of energy must be coupled to rise with the unit costs of labor, capital, and land.

and land holders must decline on the average, relative to energy cost. Only energy-resource owners would derive economic benefits from such a change. Thus, labor and capital and land holders plus all of the associated institutions would be likely to resist a rise in the relative value of energy. Effective resistance would block a more equitable income distribution. (The resistance also produces the solutions of increasing unemployment payments and increasing cost of living which outpace increasing wages.)

Second, total energy demand and income appear to be almost linearly connected (Fig. 3); therefore, if energy use is to be reduced, wage and income reduction cannot be compensated for by longer work weeks, improved returns on investments or increased land productivity. But the principle of rising expectations, so ingrained in each of us, provides a basis for considerable social unrest if real income must be reduced.

Third, most energy-reducing plans would free dollar flows which, in turn could be used for other purchases, thereby also demanding energy. The net reduction in energy demand may be small or nonexistent. Thus rearranging the pattern of expenditures is marginally effective but can even lead to a net increase in energy consumption.

Aside from population reductions, decreasing real per capita income is the principal long-range means of reducing energy use. An energy tax and rationing have been proposed as the most equitable solutions (Hannon 1975). These solutions would improve the efficiency of direct and indirect energy use; and if extensively applied would reduce real income by causing a technological shift to a more labor-intensive, less energy intensive society. The problem then becomes one of reducing the cost of living and income equitably.

Means of Conserving Energy

In general, there are three basic categories in which energy conservation practices can be placed: the efficiency of direct energy use, product use (indirect energy) efficiency, and the limitation of total economic activity. The three procedures can be viewed respectively as having an increasing impact on the lifestyles of the three main energy-consuming groups: individuals, industries, and government. Individual consumers are the main subject of this paper, since their decisions presently control about two-thirds of all U.S. energy use (Herendeen 1974).

Direct energy use efficiency can be improved, for example, by using more efficient systems for space heating and cooling, designing automobiles with greater fuel efficiency, and employing better insulation. The focus in this part of the paper is on the connection between urban living space, population density, and direct energy use.

Product use efficiency requires a more sophisticated view of energy use. Since all things that are made and delivered require energy, the judicious substitution of one product for another can reduce energy use. For example, travelling by buses or trains instead of by cars and planes will reduce energy use; so will the substitution of labor for mechanized manufacturing processes. Refillable bottle beverage systems use a third of the energy and demand more labor than the throwaway container systems. Also considered here is the impact on income, energy, employment, and agricultural land use of substituting vegetable for animal protein.

If these efficiency changes cannot meet the societal need for a significant reduction in energy use, control of the total economic activity represents the last resort. In general, total spending would need to be reduced and measures that equitably permitted lower-cost living would need to be sought. One of the most sensible choices would appear to be a carefully planned fragmentation of the large urban areas.

Direct Energy Use Efficiency

In 1970, all residences directly consumed about 20 percent of all the energy used in the United States for space temperature control, cooking lighting, water heating, and appliance and machine operations (Hise 1975). In addition, the fuel used by personal autos in urban areas accounted for 2.9 percent of all U.S. energy use, excluding trips to work (Hannon et al. 1975). Thus, the noncommercial urban-area activity directly accounted for about 23 percent of the total energy used.

Two basic changes with a direct impact on energy and land use would be to decrease urban sprawl and to provide more efficient transportation systems. A recent study by the Real Estate Research Corporation showed that the direct use of energy could be reduced by 44 percent if the urban residential fringe area were a planned high-density one, as opposed to the present low-density sprawl condition. (Conversely, an increase in the dollar cost of energy would tend to reduce sprawl.) This figure represents the maximum energy savings rate. To estimate the average potential savings, I assumed that all present residential use is made up of "mixed sprawl" (Real Estate Research Corp 1974), a combination of single-family homes, standard apartments, and high-rise buildings. Accordingly, direct energy use could be reduced by about 31 percent if present conditions were converted to high-density planned communities (Real Estate Research Corp. 1974). This would reduce total annual U.S. energy use by about 13 percent, excluding the energy investment required to rebuild the urban area. These savings are produced by consolidating the external surfaces in the design of homes and commercial businesses, thereby reducing the area exposed to large temperature differences,[7] and reducing the average trip length for autos when not used for travel to work.

The noncommercial urban area comprises about 4.5 percent of all U.S. land (Frey 1973). Assuming, as we do here, that the average present development can be represented by a "mixed sprawl" condition, then the switch from the current urban land use to one of a high-density planned nature would free about 50 million acres (20.25 million ha) of urban land. This land could be used to slowly decentralize and relocate some of the nation's industrial facilities, thus allowing for shorter trips to work. Such land could also be used to develop community recreation areas, thereby reducing recreational travel needs while focusing individual concern on local environmental quality.[8]

[7]Such density also reduces the potential for employing solar heating and cooling.
[8]It is also possible that the population density and socio-economic condition of urban areas is responsible in part for a declining birth rate. If so, then reducing sprawl has an especial value over dispersing the population.

Although the high cost of capital and historically low cost of energy have fostered centralized industrial production (Hannon 1975), certain changes in the cost structure could help realize a general decentralization. First, raise the cost of energy relative to capital through an energy tax or energy rationing, which would effectively limit the return to capital holders. Second, reduce the wage differentials within urban areas by setting minimum and maximum wage levels. Third, have the cost of employee transportation borne explicitly by the employing industry, causing workers to cluster around their workplace or giving the industry an additional reason for decentralization.

If high-density planned development displaced the current patterns of urban residential and commercial development, individual dollar costs for home and community services could be reduced by about 32 percent[9] (Real Estate Research Corp 1974).

These dollar savings along with those achieved by denser housing would likely be respent on the consumption of other things, consequently requiring energy, land, capital, and labor to be consumed in other sectors of the economy. This important respending phenomenon produces a net impact on the factors of production, as is discussed below. The direct effects of reduced sprawl and reduced auto use on energy and land use are so great that any conceivable respending scenario is unlikely to reverse them. The net impact on labor is not clear; but aside from the reconstruction labor, the demand for general labor would be largely unaffected.

Suggesting a change to higher-density communities also calls for an analysis of why sprawl has occurred. Certainly greater per capita affluence, the low cost of land on the fringes of urban areas relative to the cost of land near the center, the desire for neighborhood socio-economic uniformity, and relatively cheap gasoline are parts of the sprawl mechanism. But the driving forces appear to have been a growing population and, in particular, the phenomenon of family unbundling.

Apparently, there is a desire to reduce the population density inside the home as well as in the neighborhood. In earlier times, members of two or three generations often lived under one roof. But gradually, grandparents, parents, and older children sought and found separate housing. Further increases in the demand for separate housing probably stem from changes in rates of divorce and separations.

The unbundling pattern is depicted in Figure 2. The data show a decline of 24 percent in the average number of persons per room on the average, seems to have leveled off. The number of housing units occupied at densities of over 1.5 persons per room has steadily decreased, while the number of those at the lower density has risen dramatically.

The number of persons per housing unit continues to decline, indicating a trend toward housing units with fewer rooms. This phenomenon is somewhat verified by the rate of multiple-unit construction, compared to the construction

[9]About $3,800 per average housing unit per year in 1973. This value includes differences in community and housing capital costs and community but not housing operating and maintenance costs.
See Real Estate Research Corporation 1974, p. 215 and 218. Includes capital operating and maintenance. Present value at 10 percent interest charge.

of single-family homes. In 1964, 38 percent of all housing units were for multiple-family occupancy; by 1972, the figure was 45 percent (HUD 1973).

Regardless of the causes of family unbundling, however, the trend is probably reversible by high energy costs alone. In fact, rebundling in a variety of forms could occur very quickly in response to a severe energy crises. The conflict of the desire for unbundling with land use could also be controlled by well-enforced zoning laws, better coordination between urban and county governments, and a tax on present nonurban land which becomes severe if the land were to be converted to urban use. The transfer of fringe area development rights into the denser parts of the urban area is another well known, but untested solution.

Family unbundling obviously increases material consumption per capita. However the psychological drive behind unbundling may be competition.

Urbanization and unbundling in the U.S. have produced an urban form which uses energy inefficiently. Changes in plans for new urban construction and the planned reconstruction of present urban areas would lead to a lowering of the energy and dollar cost of living. Higher energy dollar costs alone could make these changes to a higher density urban lifestyle but one cannot necessarily count on energy prices rising at a slow enough rate to allow an orderly transition from the presently sprawled urban place.

Product Use Efficiency

Many examples of alternate product uses that would save energy and increase employment have been examined (Hannon 1975). The alternatives include the various items of personal consumption, a variety of personal and freight transportation systems, the use of home appliances, and the effects of a variety of federal programs concerning construction and service activities. Changing from one of these products to another would, however, have a nearly neutral effect on land use, since they all derive from roughly similar industrial processes.

As an example of an energy-saving product substitution consider the aluminum beverage can. This container is considerably more energy-intensive and less labor intensive than the refillable glass container (Hannon 1973). Another example is the use of energy intensive herbicides in row-crop agriculture to displace farm labor. Probably the most important product substitution is the increased use of the urban bus instead of the car (Hannon et al. 1975). The car is 3.5 times as capital-intensive, 1.7 times as energy intensive and only half as labor intensive as the urban bus on a passenger-mile basis. Total passenger-mile cost for the bus, including subsidies, however is 1.5 times that of the car. This dollar cost difference stems from the fact that bus drivers are paid labor while auto drivers are not. Nevertheless, companies which operate largely in dense urban areas are more profitable than those which do not and their passenger-mile costs are lower than that of average urban cars (Hannon et al. 1975).[10] It is also

[10]See the successful experience of the 3M Corp., Minneapolis, Minn., with "van pooling," where the company leases vans to certain workers who are responsible for the work trips of about 8 to 10 fellow employees. The next largest use for the urban auto is recreation which in most instances could be handled by mass transit (Hannon et al. 1975). The use of the car for grocery shopping cannot be replaced by mass transit, however. In this important instance store-home delivery would appear to be a lower cost (energy and dollars) alternative, providing that deliveries could be made along a precalculated route and the demand for this service was great.

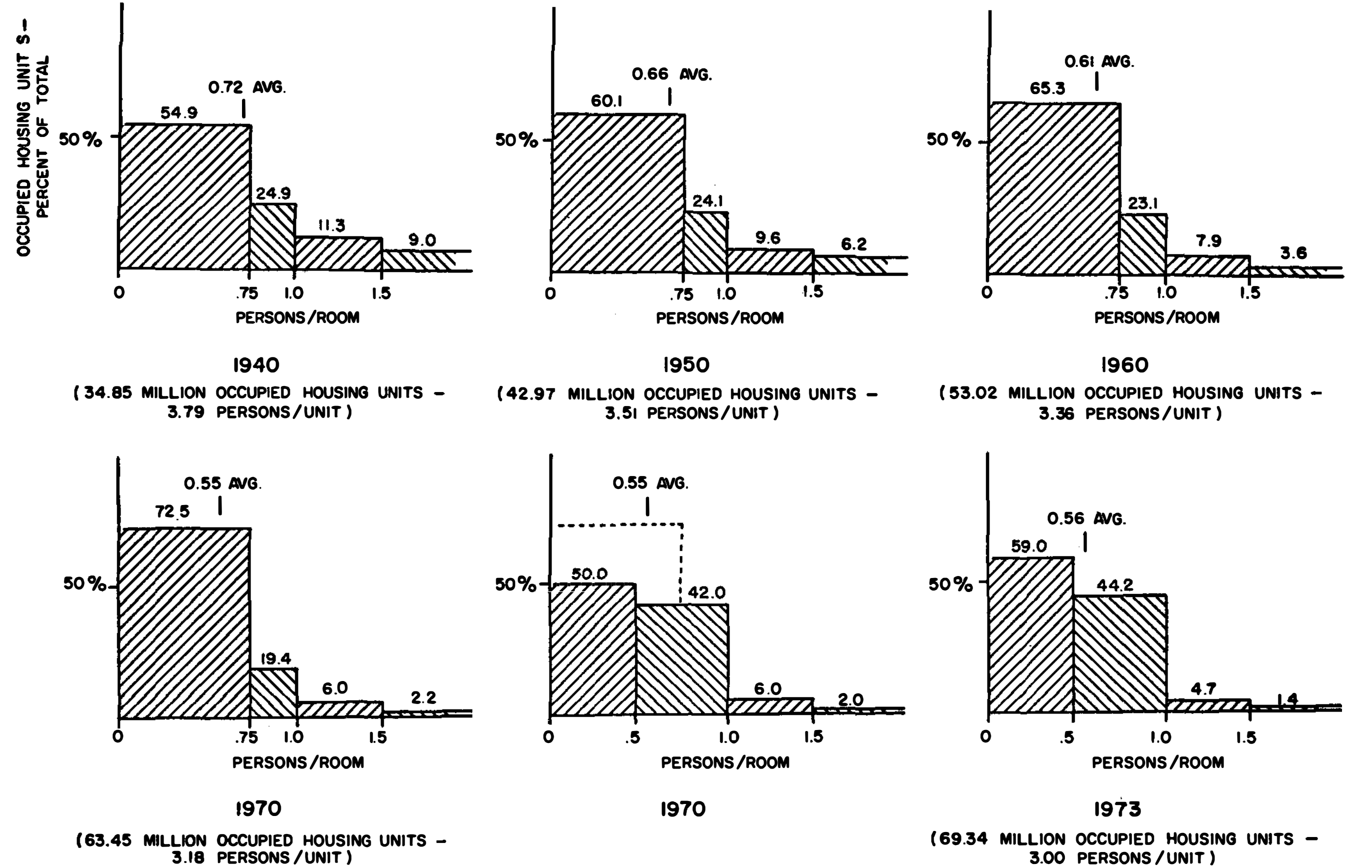

Figure 2. The trend toward lower density housing (U.S. Dept of Commerce 1973).

possible to substitute lower-energy-using video communication systems for a portion of urban travel (Goldsmith 1974).

The product choices that would affect energy and land use are those involving foods and fibers. For example, the sustained yield of the average forest acre (.40 ha) in the U.S. is about 860 pounds (390.1 kg) of paper products per year, at an energy cost of about 19,000 Btu (20.045×10^6J) per pound (Hannon 1973). Thus, every 1,000 pounds of paper products not used spares about 1.2 (.486 ha) forest acres from sustained cutting, and saves the energy equivalent of 152 gallons (575.3 l) of gasoline. As an additional example, in reducing urban sprawl, high-rise apartment buildings, requiring masonry, cement and steel, are substituted for single-family houses, often made of wood. So reducing sprawl would have an indirect impact on forest land use.

The most significant single product choice affecting both energy and land use is the method of protein production and consumption. The chief sources of U.S. protein are animals, principally beef. For most of the rest of the world, the main protein sources are vegetables and fish. The Energy Research Group has determined the total dollar, energy, and employment costs and the agricultural land consumed by three protein delivery systems (Hannon et al. 1976). The results are shown in Table 1.

The three basic systems are beef protein production (in three major areas of the U.S.), processed soybean protein production (as a meat extender and as a complete meat substitute), and the direct home consumption of unprocessed soybeans. The costs are compared on the basis of a unit of net utilizable protein, an empirical standard devised by nutrition experts to allow an equitable comparison of different protein-use efficiencies. The initial results are not surprising: switching from beef protein to a soybean meat substitute saves the consumer money while also reducing energy use, employment, and the demand for agricultural land. In terms of beef raised in the cornbelt, a complete soybean meat substitute is one-sixth as energy-intensive when compared on a unit protein basis; direct soybean consumption is one-eighth as energy-intensive.

But a switch from beef to vegetable protein would also reduce the employment required and the total consumer dollar costs. If total U.S. spending is to be maintained, as is likely in the short run, the consumer will spend these dollar savings on something else, and that consumption will require energy and employment increases which would tend to offset the energy savings and employment losses obtained within the food industry.

If we assume that the consumer spends his dollar savings on general personal consumption[11] (Herendeen et al. 1975), then the *net* impact on the economy of a voluntary shift from beef to vegetable protein is an *increase* in energy consumption and a *decrease* in total employment: approximately 53 million Btu (55.915×109^9J) and one-third of a job per 1,000 pounds (453.6 kg) of net utilizable protein. The reduced demand for agricultural land of 23 acres (9.31 ha) of cropland per 1,000 pounds (453.6 kg) of protein would probably remain un-

[11]Energy Intensity = 63,000 Btu/1973 dollar; (35,500 without energy sectors) Job Intensity = 6.9 Jobs/100,000 1973 dollars (7.1 without energy sectors) Estimated from the inflation and productivity changes calculated from *Handbook of Labor Statistics, 1974*. Energy and Labor intensity of Personal Consumption without direct energy purchases; Herendeen et al. (1975).

Table 1. The dollar, energy, employment, and land costs of protein production in the U.S. (1973), per pound of net utilizable protein.[a] (Costs cover the entire system from seed planting to the table.) (Corrected for caloric content differences using impacts of soybean oil.)[b] (Source: Hannon et al. 1976)

System description		Dollar	Energy 100,000 Btu	Employment Thousandths of a job[c]	Land Hundredths of an acre (% grazing land)		Percent protein (on the table)
Beef (cow-calf and feedlot)	Inter-mountain	10.01	6.65	0.95	431.00	(98.9)	17.7
	Texas	10.52	5.81	0.81	53.80	(96.3)	17.7
	Cornbelt	10.47	6.01	1.03	5.70	(61.4)	17.7
Processed soy bean	T.S.P. (Textured Soybean Protein – an additive)	1.48	0.84	0.080	0.010	(0)	52.0
	Unitex (a complete meat analogue)	1.57	0.93	0.089	0.010	(0)	52.0
Unprocessed bean		1.04	0.55	0.079	0.0190	(0)	38.0

[a]Net utilizable protein is an empirically determined value based on growth of test animals per unit of protein consumed.

[b]To insure that the dollar, energy, labor, and land costs represent only those associated with deriving protein, the effects related to the least-energy-cost method of producing calories (soybean oil) were removed from the costs of each of the types of protein supplies, in proportion to their associated calories.

[c]Does not include household labor.

changed as consumers spend their savings on other forms of personal consumption.

We do not know the direct and indirect demands for land through the various forms of personal consumption. However, under the average respending scenario, it is conceivable that the demand for forest and cotton land would increase slightly as more lumber, paper products, and clothing would be required.

Since the average person in the U.S. directly consumes about 8.75 pounds (3.97 Kg) of net utilizable beef protein each year (Hannon et al. 1976), the total effect of a voluntary switch from beef to the soybean meat substitute would be a decrease of about 597,000 jobs, an increase of some 16 million barrels of oil (energy equivalent) each year, and a decrease in the use of more than 40 million acres (16.2 million ha) of cropland (considerably more grazing land). Food animal grazing may be the only way to utilize grazing lands but generally they are only periodically available for grazing.

We could also assume that the average consumer would focus the dollars saved in the switch to vegetable protein on the nonenergy items of average personal consumption. In this case, about 60 million barrels of oil (energy equivalent) would be *saved* each year and about 564,000 jobs would be lost. The net result on the demand for land would be essentially unchanged from the previous scenario. Capital investment increases would be needed only to supply the increase in general personal consumption.

Changes in consumption from beef to vegetable protein represents a true overall reduction in resource demand. Land, labor, energy, and apparently capital demands would all be reduced as a result of the change.

Of course, the above calculations are based on the average and not on the marginal costs of protein production. Even if average and marginal costs are equal under current production, they would not remain so as beef production declined and vegetable protein production increased. The difference in energy costs, however, would probably increase as the shift occurs, since the former will become less efficient and the latter more efficient. The dollar cost difference is not likely to change appreciably as long as some market competition prevails.

The ratio of the energy cost differences to the difference in dollar costs will increase relative to the energy intensity of personal consumption. Therefore, the probable lower bounds of the effects of the voluntary shift were the ones calculated. By similar reasoning,[12] an energy cost increase should decrease the net energy and increase the net labor required per pound of substituted protein.

This respending effect is a difficult dilemma for a nation bent on reducing energy use, and it appears in all examples of our research. What are the possible solutions? The government could ban meat production and tax vegetable protein, then spend the tax on an activity such as postal services which is sufficiently labor intensive to offset those jobs that would be lost and uses small enough energy amounts so that a net energy savings and an employment increase would result. The average wage would have been lowered under such a change, especially in relation to the cost of a unit of energy. The tax could be used to subsidize the construction of new energy supplies, such as electric power plants. But here

[12]Here I assumed that the most energy- and labor-intensive of the two processes are increased and decreased in intensity the most, respectively, by an energy price increase.

the money would create fewer jobs and use more energy than it would in personal consumption, thus exacerbating the above dilemma.

The government could absorb the tax as a reduction in the money supply, but this would reduce total economic activity and, in the short run, further reduce employment via the multiplier effect. Under this scenario, wages would slowly decrease until full employment is reached. Again, wages would be reduced relative to the cost of energy.

Anything that would raise the cost of energy, such as an energy tax or an energy-rationing program, would speed the process of substituting labor for fossil energy. The resulting increase in the labor intensity of the economy could possibly be structured to completely offset the loss of jobs resulting from the switch in protein sources. The revenue produced by an energy tax should be returned to the consumer as a reduction in the income tax (Hannon 1975). Presumably, the consumer would lower his overall energy demand by redirecting purchases to less energy-intensive goods and services. In the short term, this behavior would be equivalent to an increase in energy efficiency. But in the long term, I suspect that the effect of the tax (and energy rationing) would lower real income because it would make the economy more labor intensive.

It is also conceivable that the urban space which would be freed under a sprawl-reduction plan and not used by relocated decentralized industry and commerce could be used to produce food for the surrounding population, where climate and soil conditions permit. Environmentalists would also argue that human wastes could be more easily applied to these local farm lands rather than released to the nearest river or shipped great distances to sparsely populated areas. Apparently, vegetable protein production would be more practical than meat production on this limited space.

In the high-density urban areas, high-efficiency energy systems are feasible. Small electric generators servicing 5,000 to 10,000 people who waste heat is available for space heating and cooling could be made with thermal efficiencies nearly twice those of the present electric generating systems. However, without high-priced energy relative to capital, without high-density urban areas, and without the appropriate mix of housing and industrial and commercial buildings in these areas, high-efficiency total energy systems are probably not feasible.

Controlling Economic Activity

One principle is now clear. Energy can be substituted to an extent for capital, labor, and land. Stored fossil and nuclear energy is the only nonrecycleable primary factor of production and, therefore, it is in finite supply.

As long as energy is plentiful and inexpensive relative to land, labor, and capital, it will be substituted for them. As the supply of energy becomes short, its dollar cost will rise and the factors just listed will be substituted for energy. When labor is substituted for energy, we as workers will of necessity share less in the fruits of production per unit of our effort. So, too, will the land and capital holders share less per unit of investment. To the worker and to the shareholder, this means a decline in real wages—getting poorer in a material sense. The core problem becomes: How do we become poorer without sacrificing present equity in material well-being?

Convincing people that they need to reduce energy use in order to save money does not guarantee the preservation of equity. Individuals with higher incomes have more options than those with lower incomes.

On the other hand, it is conceivable that until the advent of higher-priced energy, energy was used by the poor as a surrogate for income in order to establish status. If so, this pattern will not be given up easily. Guarantees of equity, if such exist, must come from the government. Therefore, solutions to the question of reducing net energy consumption must at the very least possess the capacity for equity.

Under the suggestions for improvements in the efficiency with which energy is used, I have pointed to the examples of reducing urban sprawl and meat consumption. Both of these scenarios reduce demands for energy and land directly; but together with the income-preserving effects, could reduce the net energy saved and possibly net decline in the demand for labor, under the current technology of production. A declining demand for labor implies a lowering of real wages, if full employment is maintained. It is possible to reduce wages sufficiently to induce full employment through a technological change to an economy that is more labor-intensive and less energy-intensive. But, theoretically, individual income could be preserved by longer work weeks.

Figure 3 shows the connection between energy and income during the 1960-1961 period, the latest available complete data set on personal consumption in the U.S. (Herendeen 1974). Direct energy use tends to saturate with rising income, but on the average total energy use is nearly linear. From this, I infer that if income were lowered, total energy demand would be lowered almost proportionately. The total energy curve in Figure 3 is nearly linear because consumption patterns change as incomes rise. For example, as income goes up, so does the consumption of beef and, consequently, energy and land.

To blunt the hardships of accepting reductions in income, we should seek general ways of reducing the cost of living as in the examples given earlier of substituting a high-density pattern for urban sprawl and vegetable protein for red meat. Figure 4 shows an intriguing connection between the cost-of-living and the population size of the consuming community (Hoch 1973). The cost-of-living rises as the urban population goes up. Some of the cost of living differential noted for the Southern region reflects differences in heating and clothing costs. (The significantly lower cost of living in the Southern region suggests the strategy of geographic relocation in addition to city size reduction, as a means of lowering energy demands equitably.)

Income per person is also higher in larger cities (Richardson 1973). In fact, wages appear to increase faster than the cost of living (except in the small- and moderate-sized Northeastern cities and the small Southern cities) as city population increases (Hoch 1973). This phenomenon may have provided an economic basis for urbanization. But smaller population centers somehow, either through greater economic efficiency or because of a less-frenetic lifestyle, allow for people with lower average incomes, compared to larger population centers.

Exactly what population level would be desired for a minimum cost of living is open to question. There has been considerable debate about optimal city size and the basis for determining it (Hoch 1973; Richardson 1973; Karvel and Petry 1972; Bradley 1973). Nearly three-quarters of the U.S. population was ur-

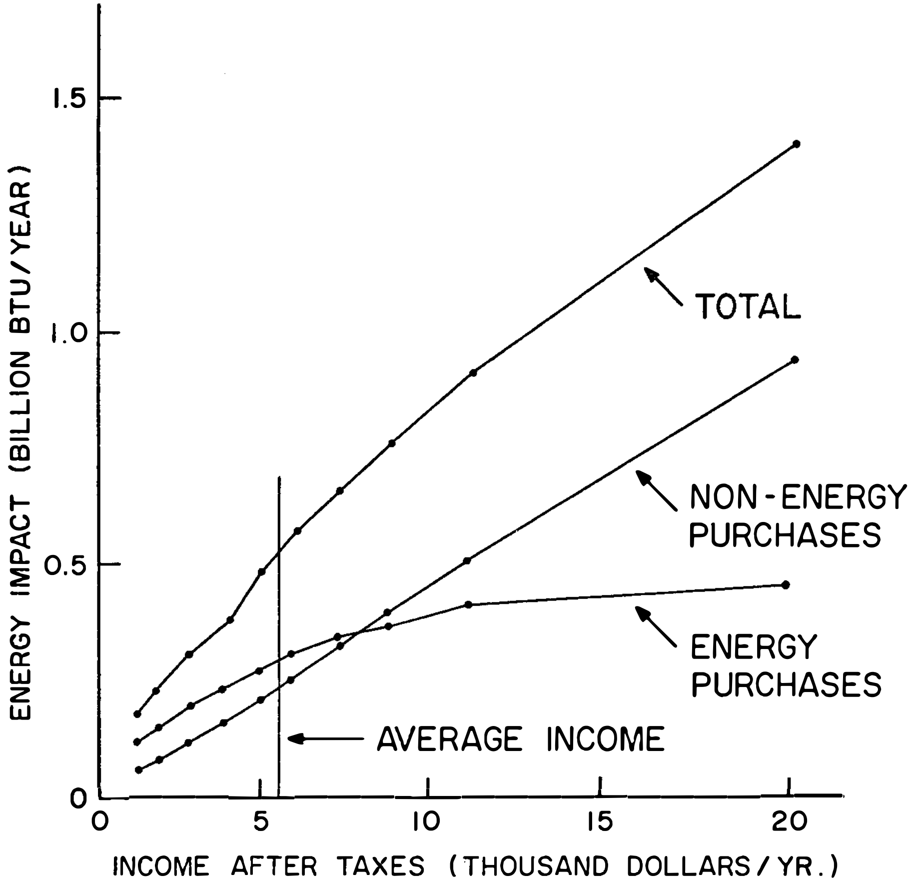

Figure 3. Direct, indirect, and total consumer energy impact plotted against consumer income, 1960 and 1961 (Herendeen 1974).

banized in 1970, 10 percent more than in 1950. In both 1960 and 1970, the "average" urban area had about 20,000 people. Compared to 1950, the most rapidly growing urban areas in 1960 were those with 10,000 to 25,000 population. But in 1970, the most rapidly growing incorporated urban areas were cities of 5,000 to 10,000 population (Richardson 1973). These smaller communities may well be subsidiaries of larger cities, and the residents may not be paying for all the costs which they incur (for example, commuter-generated air pollution). Residents of smaller communities working (and possibly incurring some unpaid costs) in larger communities are likely to at least pay for their own community's cost, plus the extra cost of long-distance transportation. Therefore, their total costs could be reduced, along with the intrusion costs to the larger city, by working near their residence.

Historically, large cities are thought of as possessing an organizational structure that provides more benefits than costs to the average participant. The

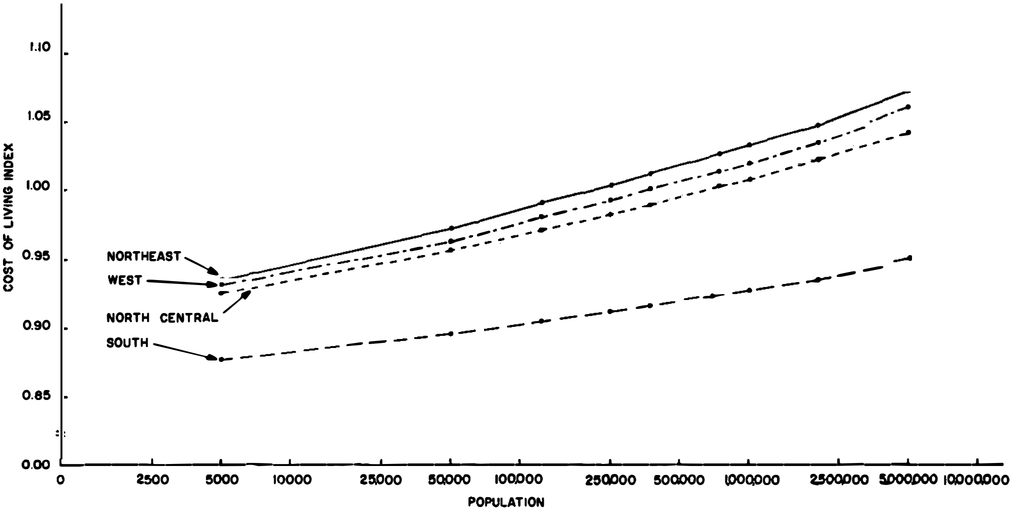

Figure 4. Cost of living index, by population size and region (Hoch 1973).

question is: Who should and who actually does financially support this structure? If all beneficiaries—rather than simply the residents—can be made to support it, then the structure can remain viable. The viability of large cities would be assured if these beneficiaries were also making the necessary long-term commitment to continue their appropriate support. It is unclear whether current users of the large cities in the U.S. possess either the willingness or the commitment to pay their share of the costs (U.S. Census Bureau 1970).

Local governmental expenditures per capita seem to be positively correlated with urban size (Karvel and Petry 1972; Bradley 1973). Municipal expenditures per person more than quadrupled for a three order of magnitude change in population level in 1967. Municipal plus county per capita expenditures were the lowest at a population of about 10,000. For county expenditures alone, the lowest per capita figure occurred when the population was about 100,000 people (Bradley 1973).

Local expenditures per capita for police and recreation rose with city size, but highway expenditures and the costs of sewage-treatment facilities per capita declined with rising city size (Karvel and Petry 1972). The optimal city size based on public costs seems to be about 100,000 people (Karvel and Petry 1972; Bradley 1973), however, the data in Figure 4 show no such optimum because the curves are only indicative of the cost of living (Sherwood 1975) and do not include all taxes.

With rising rates of urban growth per capita, local governmental expentitures went up but increases in personal income declined (Bradley 1973), indicating that zero urban population growth is also required to hold down the cost of living.

Federal expenditures at the city level like revenue-sharing would appear to be a subsidy for smaller cities, since the funds are generated from income taxes and distributed on the basis of population. Unfortunately, the spending of revenue-sharing funds is not constrained to activities which would aid in controlling city size.

Reducing the dollar cost of living also implies the need to reduce intercity transportation, particularly by people. The need for the interstate and urban freeway system would diminish, and it is doubtful if such a system could survive on the rather highly subsidized large truck traffic alone (Intercity truck transport is far more energy-intensive than railroad carriers.)(Bezdek and Hannon 1974).

A decline in land used for intercity transportation is probably the largest change in land use that would result from reducing the size of the typical urban place. The entire 43,000-mile (69,187 km) interstate highway system alone occupies slightly more than a million acres (405,000 ha) (U.S. Dept. of Transportation 1975). This land is more economically productive in a transport mode than as farm or timber land, as long as energy and food remain inexpensive.

If large urban areas could governmentally and productively fragment to mimic the function of smaller cities, the total cost of living (private plus public) for their inhabitants should decline, as would individual income. The cost could be further reduced if each subcity would also retract its sprawl, thereby traveling less and by more efficient means. In fact, the fragmentation of political control in large urban areas is a necessary condition for changing to a high-density pattern. The high-density pattern is, in turn, required for a more efficient transportation system. As cost is reduced, then income and, consequently, total energy and land use can also be reduced. Also, production and service technologies must become more labor-intensive in order to create full employment.

But there is surely a limit to increasing urban population density. This limit must be based on the economic and social condition of the residents and such things as the quality of the surrounding environment, the amount and quality of the nearby open space and the general sense of community.

Summary

As the cost of energy increases relative to the cost of labor, capital, and land, work trips will become shorter as will family business and recreation trips, and they will occur more by public mass-transit modes than by the use of personal cars. Per capita housing space and sprawl should also decrease. Vegetable proteins will be substituted for animal proteins. If an accompanying high level of unemployment is to be avoided, average wages along with average incomes and average total energy would decrease. Land use would probably also decrease as a result. To allow the smallest decline in the quality of life under a condition of decreasing income, the absolute size of all urban places should drop to about 100,000 people, and a near zero rate of growth would be required.

Reducing urban sprawl improves the direct energy use efficiency, frees urban land to allow employment locations (including food production) to be near residences, and reduces the dollar cost of living. Changing protein consumption from beef to a processed soybean protein is an example of improving process energy efficiency. This change in protein source reduces the demand for energy, land, and employment. The change would also free consumer dollars, which if spent in an average way would increase energy use but would not restore the lost employment, unless the technology of food production were to become more labor-intensive.

Switching from a sprawled urban area to a denser one and changing from beef to vegetable protein would free relatively large quantities of urban and crop land, about 50 million acres (20.25 million ha) each. This change could mean a reduction in the dollar value of urban and certain rural land.

If total dollar income is maintained, direct and process energy efficiency improvements are not likely to lower overall U.S. energy use significantly. Then the absolute level of personal spending and taxes must decline. Because the cost of living and general level of personal income are lower for smaller cities versus larger ones, the political and productive reorganization of large cities into smaller ones (100,000 people or less) is recommended.

The relative independence of these smaller communities can theoretically be established by a judicious organization of the community boundary to maximally include the services and jobs demanded by those who presently live there. Accepting a job in another community, for example, would then require a move to that place. Only under such requirements can a large urban area be fragmented so as to accurately mimic the lower per capita costs of the small community. Sprawl reduction could then be slowly accomplished within each "new" community, further reducing the cost of living. Physical capital increases would be needed to decentralize present industry but capital demand would decrease in the areas of personal transportation and housing.

I believe this scenario is needed to protect and to insure equity as energy becomes more and more scarce. Planning for an energy shortage or even setting the controls on city growth and development makes the transition to a lower energy lifestyle less of a traumatic one. It seems to me an experiment is in order. It may be possible to subsidize a change in a small urban area to generally conform with the above requirements; sprawl reduction, mass transit use and all jobs held within the community. Careful measurements of the change in cost for the residents and their products should be made to check the argument.

On the other hand, a federal energy tax, geared to the unit costs of labor, capital and land, or energy rationing alone should reduce the desired effects, as a surrogate for a host of coercive and more direct plans. The higher the price of energy, the more a labor-intensive economy would be induced, meaning fuller employment and probably the best that can actually be done to preserve equity. The tax or outright energy rationing (Hannon 1975) should be considered now at an introductory level, in anticipation of a future for the United States with a declining availability of energy that becomes more and more expensive. Capital tax credits should be allowed only if the change produced would be more labor- and less energy-intensive per unit output. The energy tax could be used to augment the lowering of the energy cost of living. For example, the tax could be used to subsidize moving expenses to those who wish to move closer to their work place or to those who would install home insulation.

Each U.S. citizen makes direct and indirect use of portions of our extremely diverse types of land. The connection for each of us to forest and crop land, to grazing and recreational land, to land used for steel making and for financial transactions, to land of the desert and of personal residence—is unprecedented in the history of man. Such an egalitarian connection is a product of our economic system and the use of tremendous amounts of energy. Given the finite supply of available energy, however, worldwide equality, of the level now present in the U.S., does not seem likely. What does seem likely is the fragmentation of the developed world into roughly independent communities with tight control over their own resources. Whether this reorganization takes place in slow response to the stress of resource shortages or in response to a catastrophic shortage is unclear. The long term result is probably the same.

The new lifestyle in the smaller, denser, more nearly independent community would also tend to simplify what many seem to view now as an already overly complex and perhaps unmanageable society. Such a lifestyle could restore to each person a greater sense of place and perhaps, to labor, a greater chance for dignity. Personal talents could be turned to solving local problems, rather than being diluted in attempts at overall national societal control.

Intelligent energy and land use (Leopold 1949) could become the focus for a convergence to the plethora of conflicting values now so common in this society. The benefits of extensive urbanization have not been without their associated costs. The separation of these benefits and costs by the energy intensive process of geographical discounting (as opposed to temporal discounting) has produced a perception of net benefits in favor of large and sprawled cities. What has been lost is each individual's awareness of his connection to the land and to the frail finiteness of energy.

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Discussion

MR. TOM VALENTINE: The other night the CBS news did a report about Britain that went into all of the economic and political struggles, and it was a sort of run-down to point out the workings of an industrial system. Do you feel from your studies that their troubles are in any way connected with their massive need for oil?

MR. HANNON: I should not venture any opinion because I am uninformed about the subject.

However, I have been there several times and talked with a number of people. There are some things that seem clear to me; that is the strength and tenacity of organized labor and of organized capital. No one gives up anything easily. Take the case of the refillable container versus a throw away container. We feel the former is a much lower energy way to provide the same service. The refillable even creates more jobs in total. But it does this by disemploying people who make cans at $9 an hour, and employs people at $3 an hour working in a grocery store handling refillable containers. I do not know, if I were a steelworker making cans, if I would give that up, my job to a refillable container, unless the whole labor institution was willing to share the purposeful exploitation.

I think England is being victimized by not sharing. They probably are now aware of an energy shortage. Their resources were used to grow rather than to maintain the economy, and now they have to pay the piper.

I really do not know any more than that about England. According to that television documentary, the government takes care of you better than the Union does.

MR. JOHN CARROLL: I question your calculations on the energy cost of existing meat. I think people in Colorado City have shown that if ruminant meat is produced almost entirely on forage, that the energy cost is about equal to the energy cost of producing corn or soybeans.

True, we can produce better beef if we feed grain to beef cattle. But particularly with sheep, lamb is more efficient in the production of meat on forage alone, and largely on natural forages. I think it will be possible to hold our meat production and make the soybeans and grain available for direct human consumption.

MR. HANNON: That is right.

These are beef processes in our study. Remember, my figures deal with total energy from the ground to the consumer's mouth. It is dealing with a system different from the one you spoke of. We are dealing with a feedlot system which is, at least until recently, the typical way of producing beef.

Of course, I understand forage land is not available except for a fraction of the year, and I do not really know how you handle that.

MR. CARROLL: There is a great deal of waste material that we can use in lieu of forage, but some countries produce meat entirely on forage. Iceland, for example, cannot grow grain. They produce meat entirely on forage. Their meat consumption is not as high as ours, but it is quite adequate.

MR. HANNON: I understand from the nutritionists that we consume three or four times the protein per capita than we need. If you rearrange the production system to vegetable protein production, I do not know what the new numbers would be. Certainly the input of grain would drop.

CHAIRMAN HELLER: Are there others?

MR. PAUL HAYES: When you suggest rationing energy as a means of clarifying per capita use, do you refer to that only as a rationing of direct uses of energy, such as electricity or gasoline? Or, do you propose to include indirect uses, such as in materials use? And if the later is the case, how do you go about identifying and clarifying it?

MR. HANNON: I do propose the latter. We have identified to some extent the process by which one would evaluate the indirect energy cost of goods and services. That is, how much energy does it take to make this desk or make a car? It seems to me that is the only real way that we can ration energy. About two-thirds of all energy used in the country can be allocated to personal consumption. Approximately one half of this energy allocation is direct and half is indirect. So, if we could save 50 percent of the energy that consumers are responsible for, this would be appreciable. But such a change cannot be accomplished only by direct energy rise reduction. Indirect energy use would have to be reduced also. I suggest an energy currency much like today's monetary currency.

MR. HAYES: There is one clause, however, that indicates that the only goods and the only commodities moving in commerce are energy. That is what we are buying, is the energy in usable goods. While this is distorted by subsidy, profit-taking, and the like. If that is true, then by rationing energy use, perhaps you are really suggesting that your institutional system whereby control is imposed on how to dispose of income is the answer.

MR. HANNON: Well my control would be not on how to dispose of income, but how much income is available for disposal. This is the real question. We are dealing with a finite supply of energy currency and it becomes a question of how well do you treat the future.

You are right in your thought, whether it is economic or not, that everything is energy. Marx said that everything is labor, but people are labor, and everything else is energy. The whole Industrial Revolution is based on the substitution of energy for labor.

This substitution worked as long as there was a seemingly infinite energy supply. But we no longer think of it as such. I would say that not limiting how energy is spent but rather limiting the total dispensed by each person, would mean that one still is free to choose what they do with their energy coupons.

MR. A. KESSLER: One of the problems that has bothered me concerning your discussion is the changing of personal habits of people.

As you recognized, more than 40 percent of our energy consumption is in the production and manufacturing of natural goods. I do not know what percentage of that is in the utilization of junk energy, and I am talking about the production of goods that have no real, viable place in our society, or that really contribute to the quality of our society.

I am talking about going into any department store today where you will find every shelf is littered with junk items that we really do not need. I do not know whether men need eight different choices of hair dryers. You go around at Christmas time and you will see a million different types of plastic Santa Clauses. These all take a great deal of priceless chemicals, and a great deal of precious energy to produce. You do not see these items much in Scandanavian countries, or in Europe; but American stores are littered with this junk.

I wonder how we are going to change the purchasing habits of the American people to bring more quality into their purchasing.

MR. HANNON: That is a great question. The big question is how to live with a shortage of energy and maintain equity?

There are two general ways, as I see it. One is that you somehow raise the price of energy, as I have already suggested, either by rationing it or by taxing it.

Or, we simply ignore the energy problem and say the cost of a solution is too great and we let inflation take over. Prices go up because energy is getting scarce and energy-induced inflation, not wage-induced inflation results; so the real compensation per man hour drops.

No one recognizes this rather slow process. It had started in 1972 even before the oil boycott and the reduction in real compensation has been going on ever since. This is the way inflation corrects for the price of energy. Somehow, energy costs must rise relative to labor costs if energy use is to be reduced. The problem with the inflation solution is that it is not necessarily equitable.

When people's real income starts dropping, those who are hardest hit will start paying attention to lower energy using alternatives. Then we begin to answer the question of what is the alternative to "junk".

Then they will listen; but I think you have to get their attention first.

CHAIRMAN HELLER: May we make this the last question?

MS. NANCY SHIRK [National Recreation and Parks Association]: If you ration energy by allotment, that holds a certain amount of dollars out of the spending stream which, as I understood what you said previously, would be saved and would be invested in energy in different areas. In the assumption of rationing, with purchasing going down, the production of energy, too, has to fall. How would the capital realities be realized? Would people simply put money in sugar pots?

MR. HANNON: I think they would tend to do that.

First of all, they would have their chance to horde energy under a rationing system. They would have this alternative available to them which today is not. Today, you look at your light bulb and say, "If I shut that off I will save energy." But for whom? Certainly not for me. It is really being saved for the individual who does not care. If I drive 55 miles an hour, and others drive 75 miles an hour, it is clear where my energy savings go. And so I do not save for want of a personal incentive.

But with individually guaranteed energy supplies, with energy coupons, we have the ability to spread energy shortages more equitably. The big problem, as I see it, is not whether or not rationing is possible, but when we will accept it.

CHAIRMAN HELLER: I want to say that I find it distinctly refreshing to hear a speaker on this 200th year of the birth of the United States talking about altruism as a public policy.

I also feel it is somewhat heartening to know that in the time of difficulty in this country there are thinkers and knowledgeable technicians such as Bruce Hannon who are at work on our problems.

Incorporating Fish and Wildlife Values in Land Use Planning

Robert L. Hoover
Colorado Division of Wildlife, Denver

The amount of wildlife habitat lost or seriously degraded from all types of changes in land use probably exceeds 2 million acres (.81 million ha) annually, representing an area larger than that of Rhode Island and Delaware combined. Looking back in this Bicentennial Year, no one knows how much habitat was lost in our first 200 years but, if the present rate of loss and degradation continues, our nation stands to lose 625,000 square miles (1,618,750 km^2) of habitat in the next 200 years, which is an area approximately the combined area of California, Oregon, Washington, Montana, Idaho and Utah.

"Each year in the U.S., over one million acres of habitat is either buried under buildings and pavement or drowned by reservoirs," (Strohm 1974). Two thousand acres of rural land are urbanized each day (Strohm 1976). Rural subdivisions in Colorado alone have impacted nearly one-half of the 8.5 million acres (3.44 million ha) of land administered by the Bureau of Land Management (U.S. Department of Interior 1972), much of which is winter range for mule deer.

No one seems to have compiled any national statistics on miles of fishing streams lost or damaged, or the acres of terrestrial wildlife habitat inundated by construction of dams. Figures from Colorado show 243 miles (391 km) of trout streams were lost prior to 1970 from dam construction and the loss of 216 additional miles (347.54 km) is predicted by 1990 (Prouty 1970).

Channelization of streams has also taken its toll of wildlife habitat. Figures on Soil Conservation Service channel improvement projects, reported by Madson (1972), reveal 3,000 miles (4,827 km) of streams were treated prior to 1970, 8,000 miles (12,872 km) of new projects were underway, and an additional 12,000 miles (19,308 km) were included in future plans.

Drainage of wetlands represents another great loss of wildlife habitat. Here, figures are even more shocking. Of an estimated 127 million acres (51.44 million ha) of wetlands in the contiguous 48 states at the turn of the century, we only have 82 million acres remaining, representing a loss of 36 percent.

Surface mining is another activity severely impacting wildlife and one that is becoming increasingly significant. About 208,000 acres (84,240 ha) are despoiled annually from strip mining (Hill 1973). Even more alarming is the fact that only about one-sixth of the land disturbed by surface mining has been reclaimed (Strohm 1974). Furthermore, much of the surface mining slated for the arid western states is on land where scanty rainfall may preclude any significant reclamation.

Vegetative manipulation projects on both public and private lands represent still another loss of wildlife habitat. In a five-year period, 1963 to 1967, the U.S. Forest Service and the Bureau of Land Management manipulated the forage on 2,150,000 acres (870,750 ha) of public lands (U.S. Department of Agriculture

1963-67). Only a small fraction of this acreage was treated to benefit wildlife. An inventory of projects in Colorado (Kufeld 1970), showed one-third of those lands treated were for removal of sagebrush, which is essential to the survival of deer, antelope and sage grouse.

The results of this erosion of wildlife habitat can be measured in the number of endangered species. Last year, six species of wildlife were added to the Federal endangered species list, and 65 mammals, 44 birds and 2 fish are currently under study for possible inclusion on the list (Strohm 1976). Of course the answer to this erosion of wildlife habitat is to achieve full recognition for wildlife values and have these values play a major role in the land use planning process. In addressing the situation, this paper will identify the problem, discuss responsibilities of government, briefly describe federal and state efforts in wildlife value systems, summarize different wildlife values and value systems, explain the Bayesian approach to wildlife values, and explain the new Colorado system for analyzing wildlife values to be used in land use planning.

Problem

At the heart of the problem of using wildlife values in land use planning is the lack of a good system for establishing such values. "Wildlife managers and resource agencies have been unable or unwilling to place monetary values on wildlife," according to Norman et al. (1975).

Nobe and Steinhoff (1973), in their appraisal of the wildlife value systems, said, " . . . values of wildlife are consistently underestimated in public decisions that involve choices among alternative uses of natural resources." They blamed this situation on the failure to develop acceptable ways to place unit values on wildlife, expressed in dollars. Additionally, they criticized the failure to recognize all the different kinds of wildlife values.

After reviewing all the known methods for evaluating recreational benefits from wildlife resources, Ashton, Wykstra and Nobe (1974) concluded, " . . . no one technique has become universally accepted as unquestionably superior to all others." These workers further concluded " . . . the problem of recreation valuation remains unsolved . . . despite extensive research efforts over the last 25 years."

Responsibilities of Government

Federal and state governments have a two-fold responsibility in terms of using wildlife values in land use planning. First of all, those federal and state agencies concerned with wildlife management have a responsibility to separately or collectively come up with a wildlife value system that is acceptable at all levels of government. Secondly, those federal and state agencies with land use planning authority have a responsibility for incorporating wildlife values in the planning process.

It is becoming increasingly apparent, that we as wildlife managers must become deeply involved in land use planning at all levels of government and with private industry. We must participate in public meetings and respond to environmental statements on planning efforts of state and federal land management and construction agencies. We must also be prepared to work with other political entities, public and private utilities, and private developers.

Federal and State Efforts in Wildlife Value Systems

Both federal and state wildlife agencies have long realized the need to express wildlife values in terms of dollars and have been struggling with the problem for many years.

Efforts by Federal Government

The U.S. Fish and Wildlife Service, using the expertise of the Bureau of Census, has conducted national surveys of fishing and hunting at five-year intervals starting in 1955 (U.S. Department of Interior 1956, 1961, 1966 and 1972). Sportsman participation in various hunting and fishing activities and their expenditures for each are reported nationally and regionally in these surveys.

Results of these surveys fill important needs on the national and regional levels for which they were developed, and offer some hopes for influencing land use decisions on the national level (Farley 1956, and Patton 1956). However, the data contained in these reports are too gross for use in land use planning at the state level or for smaller geographical units. The national and regional findings do, nevertheless, provide a basis for comparing similar types of data collected for smaller geographical areas.

An important federal contribution to solving wildlife values problems was passage of Public Law 91–503 in 1970, which amended the Federal Aid in Wildlife Restoration Act to permit financial assistance to states for conducting economic and planning studies.

Efforts by State Governments

Nearly every state wildlife agency has conducted economic research projects to determine the value of hunting and fishing.

These are too numerous to mention individually.

Economic investigations by state wildlife agencies have followed a trend. In the beginning, most economic studies were conducted within these agencies using direct expenditure type surveys. In the next phase, the agencies continued to conduct the surveys but with assistance from professionally trained economists. The final phase and present situation in this trend involves economic studies done in cooperation or under contract with institutions. A cursory review of literature seems to indicate the western states have taken the lead in depending upon institutions to do their economic research work. Economic investigations of which the writer is aware include those in Arizona (Davis 1962), New Mexico (Kirkpatrick 1965), Oregon (Bellaine and Fiekowsky 1953; Brown, Singh and Castle 1964), Utah (University of Utah 1961), Washington (Wallace 1952, 1956), and Wyoming (Doll and Phillips 1972). Colorado has relied heavily on the Economics Department at Colorado State University for its economic investigations, which will be discussed later.

There are several advantages to be derived by having institutions assume the responsibility of conducting economic studies. First of all, these institutions have the expertise and facilities necessary to plan and carry out sophisticated economic studies. Secondly, these institutions, because of their expertise and insulation from the bias of wildlife agencies, have the credibility that is so necessary if economic data on wildlife values are to be utilized in land use planning. When it comes to a real battle over the economics of a controversial land use decision, it is far better to have a professor of economics than a wildlife manager or biologist sitting in the witness chair.

Efforts by Colorado Division of Wildlife

After plugging away on its own for 15 years, doing direct expenditure studies, the Colorado Division of Wildlife entered into a continuing agreement with the Department of Economics at Colorado State University. A comprehensive sportman expenditure study conducted in 1968 by the University (Nobe and Gilbert 1970) revealed some gross discrepancies in a similar study conducted independently by the wildlife division.

Other studies performed by Colorado State University include the following: An input-output analysis of sportsman expenditures in a mountainous county (Rohdy and Lovegrove 1970); an economic evaluation of the division's land acquisition program (Schaefer and Nobe 1969); a study to determine optimum supplies of recreation days under conditions of uncertainty (Ashton et al. op. cit.); and an update of sportsman expenditures for the year 1973 (Ross, Blood and Nobe 1975).

All this research has lead to the development of two new systems, one for determining wildlife values and another for evaluating wildlife habitats, both of which will be briefly discussed later.

Wildlife Value Systems

The first question to be answered in any evaluation of wildlife values is: What kind of values are you going to measure? The second question then becomes: How are they to be measured? Both of these subjects are addressed below.

Types of Wildlife Values

A scholarly analysis of types of wildlife values was presented at the Colorado Governor's Conference on Wildlife and the Environment by Nobe and Steinhoff (op. cit.). They divided wildlife values into two systems, one based on the socioeconomic benefit of the user and the other on the role of the resource user.

Socioeconomic objectives of the user were the same as those proposed by King (1947), including recreational, esthetic, educational, biological, social and commercial values. Obviously, some of these values are extremely difficult, if not impossible, to measure accurately in terms of dollars.

The second system, based on the role of the user, is a modification of a system devised at a workshop on fishery economics sponsored by the National Marine Fisheries Service (Chapman 1973). Elements of this system include the following:

Direct user - a consumptive or nonconsumptive user of a wildlife resource.

Primary beneficiary - a business benefiting directly from the direct user's expenditures.

Secondary beneficiary - a business benefiting from expenditures of a primary beneficiary.

Option holder - one who is willing to pay a premium for some future use of a wildlife commodity.

Vicarious user - one who benefits indirectly just by knowing wildlife is present in an area.

Altruistic user - one who sees value in wildlife for the enjoyment of present and future generations.

Environmentalist - one who considers wildlife an intergral part of his overall concern for the environment.

Alternative resource user - one who sees wildlife as negative values in terms of wildlife incompatibility with other resources.

Of these resource user values, the first three, direct user, primary beneficiary and secondary beneficiary, and the last, alternative resource user, lend themselves to quantitative evaluation. The other three categories, including the vicarious, altruistic and environmentalist, almost defy measurement.

It becomes apparent from the foregoing analysis of wildlife values that some can be quantified in terms of dollars and others are so nebulous that their dollar value can't be accurately determined. Therefore, any dollar evaluation on wildlife based upon those elements which can be measured must be recognized as representing less than the total value for wildlife.

Methods for Measuring Wildlife Values

Wildlife values, having no free market, are difficult to measure by methodologies developed for other commodities. A brief account of the different methods which have been utilized to determine wildlife and recreation values is presented below.

For those interested in a general treatise of wildlife value methodology, the reader is referred to Nobe and Steinhoff (op. cit.). A much more detailed analyses of methods is presented by Ashton et al. (op. cit.). Information from both of these sources is summarized here along with some examples from other sources.

Expenditure Method.—Surveys in the form of interviews or mailed questionnaires to determine what people spent on wildlife resources are used in the expenditure method. These methods are commonly used by wildlife agencies and provide good information. However, these surveys are costly to conduct and don't tell the complete story. They have been criticized for not including nonconsumptive wildlife values, for omitting consumer surplus and for overlooking the dollar multiplier factor. These will be discussed later.

Input-Output Method.—The input-output method approaches wildlife values from the standpoint of what contribution they make to the national, state or local economy. Values generated from this method can be utilized to compute recreation day values. Like direct expenditure surveys, input-output analyses are expensive to conduct. An advantage of this method is that it gives a measure of how many times a wildlife dollar turns over, called the multiplier factor, before leaving the geographical unit.

An input-output analysis study conducted in Grand County, Colorado (Rohdy and Lovegrove op. cit.), showed dollars spent there by hunters and fishermen had a multiplier of 1.99. Therefore, $3 million in expenditures by sportsmen actually generated $6 million in the county's economy. It is interesting to note that agricultural expenditures, usually considered one of the highest contributors to local economy, had only a slightly higher economic multiplier of 2.2;

and timbering and mining had much lower multipliers of 1.71 and 1.10, respectively (Gessel 1971).

The input-output method used in combination with the expenditure method, provides one of the better evaluations of wildlife values generated by the sportsmen. Still missing, however, are nonconsumptive values and consumer surplus.

Consumer Surplus Method.—In the consumer surplus method the difference between what is actually spent and what the wildlife user would be willing to pay is identified as consumer surplus, or unused value, and is added to amounts actually expended. A travel-cost market simulation is usually used to measure this willingness to pay.

Another approach that can be used in the consumer surplus method is to conduct surveys where people are asked the maximum amount they would be willing to pay for a day of hunting or fishing; or, looking at it in a different light, how much would they have to be paid to forego the hunting or fishing experience?

A Colorado study (Gilbert 1971), using the consumer surplus method, showed the total value of hunting and fishing in Colorado was $483,845,000 in 1971. Of this amount, 58 percent represented direct expenditures and 42 percent was consumer surplus.

Not well understood and often criticized, the consumer surplus system is still thought to have some merits in determining total wildlife values. The authors of a recent Sports Fisheries Economics report (Chapman op. cit.) criticized this method but suggested it be used in benefit/cost analyses when evaluating wildlife values associated with major water resource development projects.

Cost Method.—The cost method relates cost of development of recreation to benefits. This method was used and subsequently rejected by the National Park Service on Federal water projects since such a method automatically generates benefits on a one-to-one basis.

Another approach using the cost method is one in which the maximum cost the public is willing to pay is equal to the cost of producing a commodity. For example, the public might go along with a wildlife agency that stocks hatchery trout for $1.00 a pound but would reject costs of $2.00 a pound if the resulting price of its fishing license would also double.

Market Value Method.—Known costs of supplying alternative values by the private or public sector are used in the market value method to estimate value of a recreation day or unit value of game or fish harvested. This method was used by the National Park Service in the late 50's and early 60's to evaluate recreation at federal projects. A big problem with the market value method is that comparable values are not always available and the use of national averages is seldom applicable in local situations.

Monopoly Revenue Method.—The monopoly revenue method is based on distance traveled to participate in an activity presumably controlled by a monopolist. This method assumes that, with a fixed cost, user participation is directly related to distance traveled. The Oregon study on the value of salmon and steelhead resources by Brown et al. (op. cit.) is considered a classic example of the monopoly revenue method.

Bayesian Approach to Determine Wildlife Values

In the process of developing their optimal supply approach to determine how many recreation days of each kind of hunting and fishing a wildlife agency could economically produce, Ashton et al. (op. cit.) developed a new methodology for determining the value of a recreation day. It represents a pioneering effort by applying the Bayesian decision theory to determine the value of recreation days for different types of hunting and fishing.

The Bayesian decision theory is based upon probability analysis. Essentially, this is how the system works. Lists of ranges of possible values for a recreation day for each species or group of species are prepared. These lists are then submitted to a group of wildlife experts, who are asked to assign percentages of probability for each range of values, based upon what they think the average participant would be willing to pay for a recreation day. Through a probability analyses of these results, the researchers then determine the value of a recreation day. Information obtained by this method was used in combination with data normally collected by the Division of Wildlife on numbers of days people hunted or fished to compute total values. Ashton et al. modestly concluded that "experience and supporting evidence from more costly techniques, at least for Colorado, do suggest that the Bayesian approach may be worthy of attention, particularly since it may be applied rapidly with minimal expenditures."

Colorado Approach to Compensation For Wildlife Values Destroyed

Threatened with drastic losses and degradation of wildlife habitats from surface mining of oil shale and coal, the Colorado Division of Wildlife organized a task force to develop methodology for measuring these impacts on wildlife habitats in terms of dollars and to determine the manner in which these losses should be compensated. Basically, the system developed by this task force (Norman et al. op cit.) requires that every net loss in wildlife value caused by a change in land use shall be replaced by an equal net gain in wildlife value on the same site or elsewhere.

The system has several applications in land use planning. First of all, it can be used to appraise wildlife values which might be lost if a proposed project is developed. This provides land use planners and administrators a basis upon which to make decisions. If the decision is to proceed with the development, the amount of compensation required is known. The system has further benefits in that it can be used in benefit/cost analyses to evaluate proposed land acquisitions, land exchanges, and wildlife enhancement projects.

The Division of Wildlife has officially adopted this system and is currently using it to the maximum extent possible. Of course, such a system is of little value in land use planning outside the division if others don't recognize and accept the system. Accordingly, the division was highly encouraged recently when the Bureau of Land Management agreed to support the system in securing compensation for wildlife habitat losses resulting from oil shale extraction on public lands.

Realizing the need for securing broader acceptance for the division's system, a three stage plan is being developed. The first stage would involve a contract with the Economics Department of Colorado State University to refine the system. In the next stage, legal assistance would be acquired to place the system in a legal framework and to draft legislation that would make use of the system mandatory. Of course, the final stage would be an attempt at legislative enactment.

The Colorado system makes several basic assumptions, namely, (1) wildlife values lost can be replaced, (2) wildlife values are separate and distinct from land values, (3) resident wildlife are the property of the State, (4) wildlife populations decline in direct proportion to losses of habitat, (5) wildlife populations are evenly distributed throughout their seasonal ranges, and (6) the real value of wildlife lost is equal to the value of land required to totally replace the wildlife lost.

Briefly, the system involves an inventory of the wildlife resources on affected property and the conversion of these resources to a dollar amount that includes both the consumptive and nonconsumptive values of wildlife. Consumptive values are based on a modification of those values determined by the Bayesian analysis, while those for nonconsumptive use are after Horvath (1974).

An important element of this system and one which can't be ignored is that of wildlife habitat values which, if destroyed or damaged, can't be fully compensated. This may well be the case with the habitats of some threatened and endangered species. In such instances, the wildlife agency and any federal agency involved should oppose use of the proposed site and recommend an acceptable alternative site.

Conclusions

It is apparent that some great strides have been made in quantification of wildlife values. It is equally apparent that much more effort is going to be required to develop more sophisticated methodology for measuring wildlife values. This is particularly true in determining values for nonconsumptive uses of wildlife and endangered species. Once wildlife agencies are armed with realistic wildlife values, the problem becomes getting these values recognized in the land use planning process. This will require the maximum amount of persuasion a wildlife agency can muster. In many instances, further legislation, requiring recognition of wildlife values and making compensation for their loss mandatory, may be the only solution.

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Discussion

MR. TONY MAZZACCARO: If there is a flaw in the direct expenditure method, except for inefficiency and difficulty in gathering data, I am not aware of it. And it seems to me asking participants what they are spending to capture a unit of recreation would determine the cost better than asking wildlife managers or park managers what they think their participants would think it is worth. The latter seems a bit suspicious to me.

What I do not understand is why you are advocating a substitution of a rather simple, forthright and, I think, accurate assessment of economic value.

MR. HOOVER: To answer your question, I do not think there is anything wrong with the direct expenditure method. One of the basic problems is it is expensive to conduct; and one of the other problems is some economists will tell you that this is a very minimal figure because it does not take care of dollar turnovers or economic multipliers in a community.

I was quite interested in finding out how wildlife dollars turn over in the community. A study conducted by Colorado State University for us in one mountainous county showed that a sportsman's dollar turned over 1.99 times before it left the community. This means that the dollar that you determine from a direct expenditure survey in that county is really $2.

MR. MAZZACCARO: Just one more comment. If we are going to compete, we know what a bushel of soybeans is worth. If I am a wildlife manager, and I say, "Look, this Elk Range is worth X number of dollars and those soy beans are worth X number of dollars;" and if the farmer says, "I figure I can raise X number of bushels," I think we can compete rather well with that comparison.

MR. HOOVER: The reference I checked showed an economic multiplier of 2.2 for agriculture. With the wildlife multiplier at 1.99, I think we are pretty competitive. In contrast, the multiplier for timbering is 1.7, and mining is 1.1. If we can use these figures to our advantage, I think we should do so.

CHAIRMAN HELLER: Are there other questions or comments?

MR. PAUL LATTERMAN: You mentioned the need for measuring the value of wildlife, and you speak of it principally in economic terms. I am wondering, getting a little bit more to the roots of it, about the psychological value that goes into the aesthetic appreciation of wildlife. What are those psychological values?

For instance, Leopold and Dooty have developed a means for characterizing and even quantifying the values of landscape, and I am wondering what your reaction would be if an attempt were made to develop a similar system for the aesthetic amentities of wildlife.

MR. HOOVER: Several people have addressed themselves to the various types of wildlife values to be measured, and most of them will admit that the most difficult to measure are the aesthetic values of wildlife.

For years, those of us in the wildlife profession who were asked to put a dollar value on this said, "What value can you place on a kid going out and catching a fish?"

This was a copout. We finally learned we were going to have to place some dollar values there, right or wrong, and admittedly it is going to be difficult to get these aesthetic values, and put them in perspective with the rest of wildlife values.

As I said, we must consider all these types of values if we are going to come up with anything approaching the total value of wildlife.

CHAIRMAN HELLER: Are there any other questions or comments?

MR. FRED JOHNSON: [Pennsylvania Fish Commission] In 1970, the value given in the National Hunting and Fishing Survey for a day in the field was approximately $6 or $7.

Dr. Horvath of Georgia State University, in a Southeastern Economic Survey, came up with a figure for fresh water fishing, hunting, and salt water fishing, which ranged from the category between $30 and $45 per day, approximately five times as high as the figure that has been used previously.

These figures have stood up in court cases against the Corps of Engineers, which I believe attributed a value of approximately $1 per day.

And since that has stood up, why have you gone off in a different direction? Do you feel that your figure will stand up as well? Is your figure higher than this figure that Dr. Horvath came up with?

MR. HOOVER: I was impressed in reviewing the literature for this talk to see the great variety of values for a recreation day. Those in the national surveys were lower than almost any other sources I consulted. I think these figures are ultraconservative.

Many times they are talking about the local person participating rather than the person taking long trips to participate in these various activities.

The fact that Horvath's figures have held up in court I think is good. However, with the Bayesian approach, the fact that it is supported by other studies we have done in the state and can be done much more reasonably, has a great deal of appeal to us. Whether it will withstand a court test is something that we will have to determine.

MR. JOHNSON: How do your figures compare?

MR. HOOVER: Our figures under this theory are probably higher for the recreation day but if you consider the various parts of the country and the level of income being different in different parts of the country, you will find people have a more expendable income in some areas and, consequently, spend more pursuing wildlife.

CHAIRMAN HELLER: Are there other questions or comments?

MS. POLLY DYER [University of Washington]: My question is related to my being a member of the Washington Board. We are giving wildlife short shrift.

When you talk about compensation for habitat losses, are you speaking only of public lands, or also of private lands?

MR. HOOVER: I am speaking of both public and private lands. In Colorado we are starting to address ourselves to this situation now.

MS. DYER: And you have a program where one can take a look at the private lands, and the private land can be acquired to replace habitat that is lost.

MR. HOOVER: We are doing this. We are starting to do it in the case of some of our base facilities for ski areas. The base land will be on private land and the ski trails will be on national forest land. We just obtained a large area dedicated for wintering elk adjacent to a ski area. This is for compensation of some losses on the private and public lands as a result of the ski area development. It is going to be extremely difficult with the private sector. This is probably where we are going to need legislative help.

MS. DYER: I have a second question and perhaps an observation.

The young man referred to the psychological advantages in wildlife. I think my concern is about non-consumptive forms of wildlife.

I am thinking of the reaction that we will get, such as "why preserve some wild area for the pack rat?"

I would like to know if there are any studies on how to evaluate those kinds of wildlife over all?

MR. HOOVER: Most certainly! One of the needs is to come up with nonconsumptive values for the wildlife, endangered species, and nongame species. We are getting into it in Colorado. We used to be a game and fish department. Now we are a state wildlife agency that is responsible for some 727 species, even mollusks.

This is a new ball game for us. We are having a lot of trouble. When you start telling some rancher in the sheep country that the coyote has a dollar value, his comment is, "The only value of a coyote is that it be dead and not running around."

CHAIRMAN HELLER: Thank you very much.

I would like to shift gears now from the general picture to the specifics of a magnificent state, Alaska, and I will turn the program over to Bob LeResche.

Land Allocations in Alaska

Cochairman's Remarks

Robert E. LeResche

The discussion of "Land Allocations in Alaska" could, with only a little facetiousness, be termed the vivisection of a subcontinent.

The area of Alaska is 586,000 square miles or 373 million acres.

If you want any reference for comparison, Massachusetts is 5 million acres, Connecticut is 3 million acres; New Jersey is 5 million acres; Maryland is a little less than 7 million acres. We are talking about a state that has 373 million acres.

We are talking about a state that has two-thirds of America's shoreline, and along with it, whether we like it or not, two-thirds of her outer-continental shelf. We are talking about a state that many will agree is the most beautiful state of all. We are talking about a state that many people describe as the last place in North America that we can still save. And we are talking about a state that many other's describe as the last place in North America where one can still go out and tame the wilderness.

We are also talking about something that many non-Alaskans forget when they discuss Alaska: We are talking about 400,000 people, 390,000 plus or minus eccentrics, probably; and we are talking about cultures that range from just post-stone age to Houston eclectic.

We are talking about lifestyles in this one state that vary from that found in the Petroleum Club to that found by the true subsistance hunter a hundred miles from the nearest settlement.

The allocation of resources in this last great storehouse of American resources has begun. The basic rules have already been laid down. These rules were set not by the old laws that govern the rest of America, but primarily by an Act passed in December of 1971 called the Alaska Native Claims Settlement Act.

The Alaska Statehood Act guaranteed that the State of Alaska could select 100 million acres of the 370 million acres. The Alaska Native Claims Settlement Act created new private corporations—corporations composed of Alaskan Natives, and gave these corporations the right to select 44 million acres of Alaskan land.

At the time of the Act, a little more than 90 percent of Alaska was in federal land. There was very little private land. This Act immediately made it inevitable that private land holdings would eventually total something over 40 million acres, and that this would happen very fast.

It also made it inevitable that this would happen in a checkerboard fashion, and it created a new social entity, the private corporation, limited to certain shareholders: some of which are already in the Fortune 500, and one of which is currently the largest private landowner in the world.

In addition, the Alaska Native Claims Settlement Act created what many people see as a new opportunity, perhaps the last opportunity, to set aside lands in the traditional four systems of management—national parks, wildlife refuges, wild and scenic rivers, and national forests.

It is inevitable that by 1980 or 1985, Alaska will not consist of a single large block of federal land, but will consist of approximately 160 million acres of state and private land, and 210 million acres of federal land.

On top of all of this, I have hardly mentioned that Alaska has energy, being fondly known as the "oil barrel of America." Alaska stands ready to have things extracted from her one last time.

The questions that we will be discussing revolve around these questions: Will the allocation of Alaska's land and resources involve planning? Will it involve creativity and new ways of allocating things? And will it leave a niche for that diversity of lifestyle that some continue to think healthy, but that our society seems to inevitably wish to crush? Or, will the allocation occur as it has in the past? Will it occur in Alaska through the tug of war of special interests that characterized the first 200 years of this country's western expansion? The opportunities are here, but the outcome is far from certain. These are the questions that these four speakers will address.

Before I introduce the first speaker, I would like to put things in another perspective by pointing out that the four individuals that you see on this platform are approximately 25 percent of all of the State of Alaska's planners. That is where we are.

The first speaker will be the Honorable Guy R. Martin, Commissioner of the Alaskan Department of Natural Resources. Guy has an exceptional overview of the issues involved here. He was intimately involved in the drafting of the Alaska Native Claims Settlement Act as a Congressional Aide in 1971. Today he holds the most responsible position in the State of Alaska regarding her land and her resources.

During the past year he has been the architect of Alaska's attempt to alter the federal Outer Continental Shelf Program to a semblance of rationality. Under him the Cook Inlet Land Trade was consummated. This is really one of the most progressive, creative very practical planning Acts that has yet occurred in Alaska.

As Commissioner of Natural Resources, he is forging for the state a policy to regulate our energy-related actions in the future. Given the past performance by Commissioners of Natural Resources, this is a pretty outrageous thing to do in Alaska.

Alaska's Land—The Crucial Years

Guy R. Martin
Commissioner of Natural Resources
State of Alaska
Juneau

"Would you tell me, please, which way I ought to go from here," asked Alice.
"That depends a good deal on where you want to go," said the cat.
"I don't care much where," said Alice.
"Then it doesn't matter which way you go," said the cat.

Lewis Carroll
Alice in Wonderland

Alaska: Statehood was attained in 1958; Prudhoe Bay came in during 1968; the Native land claims were settled in 1971; the "national public interest lands" concept was created within the Claims Settlement Act in 1971; the "energy crisis" was kicked off in 1973; the Trans-Alaska Pipeline was authorized in 1973; the federal OCS program was imposed on Alaska in 1974; Pet. 4 was rediscovered as an issue in 1975; and the list continues to grow. To say Alaska is in a difficult transition period is like claiming that New York City could use some spare change.

Although the list began with statehood, the critical era for Alaska lands began in December of 1971 with the enactment of the Alaska Native Claims Settlement Act (88 Stat. 688). During the decade which began then, the factors which were listed, plus innumerable others at the state and local level, will converge, intersect and interact with one another to create powerful forces acting on the land and resources of Alaska. It is already happening, of course, and the early returns are inconclusive, in the view of the author, from the standpoint of assessing the chances for a rational land and resource pattern to ultimately emerge.

In some respects, there is little reason for hope. The land and resource allocation systems created over the years for Alaska are diverse, largely uncoordinated, and dedicated in many instances to sharply conflicting objectives when applied to specific land decisions.

Can the TAPS haul road be opened to the Winnebago crowd or to mineral explorers without the loss of vast Arctic habitat or the culture of the people of the Arctic Slope? Can the leasing and production objectives of the Federal OCS program be met without the loss of the coastal wilderness or the Alaska fishing industry? Can the massive (80 million acres [32.4 million ha]) plans for national public interest designation survive the land allocations for Alaska energy programs (gasline, Pet. 4, utility and transportation corridor withdrawals)?

This paper does not conclude that such conflicts are irreconcilable, yet there is ample basis for despair. History may very well judge, for instance, that we have committed more errors respecting land and resources under the false assumptions of the "energy crisis" than under any similar policy base in recent times.

Going still further in a negative vein, it should also be noted that, in the face of the many existing and potential conflicts between Alaska land allocation systems, there are few institutional structures having the apparent capability or strength to deal effectively with individual conflicts. There are no such institutions with the ongoing ability to deal with the "crisis of the whole" or comprehensive situation.

Native organizations are diversified, largely profit-motivated and high demand has spread available human resources very thin. Federal agencies, such as the Department of Interior, continue the pattern of narrow-use management bureaus (with constituencies) which create internal conflicts rivaling the external. The recent leaderless period at Interior is virtually inexcusable from the Alaska perspective for allowing such conflict to fester. At the same time, the State is entering a period when the debate between state, regional and local institutions will be intense and possibly debilitating.

In short, existing institutions and systems regarding Alaska land allocations have marked deficiencies, and their strength, competence and flexibility to resolve conflicts is being severely tested. In many cases, individuals of good will and vision fill some of the gaps, and temporarily mitigate the situation, but this is neither lasting nor wise.

Where the level of conflict is high; where fear of the complex or comprehensive solution exists; where there seems to be no handle on the inevitability of events or means of control on uncoordinated decision-making, the line of retreat is to the comfort of clear self-interest.

This is as true of the BLM as of the State of Alaska; as true of Native corporations as of the Park Service; as true of the oil industry as of the local Alaska communities. At the present time, most of the key Alaska land allocation decisions are functions of self-interest clashes, with most of the conflict resolution occurring in the political arena. This is no wiser nor more precise now than it was when the Native Claims Settlement was hammered out in equitable but uneven fashion five years ago.

The State versus the Federal Government on the O.C.S.; the Natives versus the State, the Federal Government and the Alaska recreationists on easements and corridors; the oil industry versus environmentalists and government agencies for every permit and approval needed for new development projects; the Park Service versus the Forest Service for the prime area in the Wrangells—all of these and many more are being determined now in the self-interest crunch.

This portrayal is not intended to reject the political process as the ultimate vehicle for land allocation decisions in Alaska. This process, well used, is the highest refinement of decision-making—the art and science of the public good. Under present circumstances, however, this process has little upon which to base decisions but the conflicting allocation systems, the relative strengths of the self-interests, and the perils of dealing with difficult resource issues at three government levels. There is also a disturbing and self-defeating trend toward a belief that certain decisions are inevitable and Alaska is helpless before them.

If some of the foregoing appears to be an argument to simply join up with the best or strongest interest, it is not intended to be. Rather, the conclusion of the author and of the present state administration, is that with a strong commitment from the various Alaska land-owners, and the adoption of a higher, and common policy base, there is substantial reason to be optimistic that the land patterns of Alaska can be successfully shaped and balanced even during the pressured decade which has been described.

First, let us acknowledge something about the way we ought to deal with the future:

> The future is not a result of choices among alternative paths offered, but a place that is created—created first in mind and will, and later in activity. The future is not some place we are going to, but one we are creating. The paths to it are not found but made, and the activity of making them changes both the maker and the destination.
>
> John Schaar

In Alaska, there is no inevitability except as we submit to it. The future of Alaska lands is one and the same with each action we take to decide how to use them, or the day-to-day management decisions being made right now.

How should a common policy base be developed—a concept for Alaska lands? As a beginning, we must think of the whole system and reject the continuing efforts to segregate and simplify specific issues. The fact is that the overall problem *is* complex and will call for our best and most progressive thought. To simplify the complex is to distort it, and it is crucial that in the beginning we do not alter the reality of the overall situation facing Alaska's lands. If we are successful, we can identify the common objective—the broad policy base—that will be the vehicle to begin transcending the unhappy results of special-interest conflicts.

The experience of the author is that the common objective can be well and easily identified by asking the question—what is the Alaska we would like to see? While it is by no means certain to result in the same answer from all, it is the further experience of the author that a clear consensus can be formed.

Whether expressed as cultural preservation, environmental purity, the Alaska which is fondly remembered from the past, or the desire to see that nonrenewable resource extraction not be accomplished at the expense of renewables, it is the "natural model" which is being chosen as the ideal we should pursue. Without belaboring the point, it must be recognized that this is our only successful model, and that there is a natural plan for Alaska as well as elsewhere. It requires not so much our intervention with governmental allocation systems as our recognition that it exists as something we should enhance.

Accepting it as the model upon which to base land allocations in Alaska will compel land and resource decisions, even those associated with extractive or industrial development, to be conditioned on the central theme of protection/enhancement of the natural environment of the State. It will create the necessity of really learning how that environmental system works, and of designing land allocation decisions which fit it in terms of cultural values, level and type of economic activity, land patterns, population level and distribution, and technological modes. Shape, rather than be shaped will be the rule as in Jean Baittaillon's—"We create nothing, we merely plagiarize nature."

To carry a plan for Alaska's lands beyond a broad policy base into action, all those having major land allocation roles must not only find and recognize the necessary central principles, but also devise practical systems to apply them to the numerous specific problems arising during the crucial decade.

These systems must include: new and creative structures for *cooperative* land allocation and management which reach across federal, state, private and agency lines; new-land classification and management systems which are specifically appropriate to Alaska; systems having great flexibility which permit, with adequate procedural safeguards, innovative management agreements or large-scale land trades; an *Alaskan* energy policy which will fix expectations and permit better planning to promote stability for resource development; and a federal, state and private system to maximize *day to day* coordination of resource management decisions.

There is reason to conclude, even before such systems are created, and before the broad policy base is a common resolve, that success is possible, and much of the hope can be found in state activities and policies regarding all Alaskan lands.

From the beginning of the tenure of the Hammond administration the State has made it clear that it will not hesitate to use its power, either direct or persuasive, to influence and effect major land decisions and activities in Alaska. Many of the actions taken pursuant to this commitment have been controversial and have involved not only the initiative of the State but the cooperation and creativity of other major Alaska land managers. In sum, they indicate the direction and nature of state land allocation plans.

Admiralty Island has for years been agreed to represent one of the prime natural areas in Alaska, and has been the site of continuous struggles to protect it from segmented and inconsistent management. The most recent difficulty arose when urban native corporations geographically removed from Admiralty proposed selections, largely for economic development purposes, in the heart of the Island's most valuable natural areas. The small native village of Angoon, on Admiralty Island, protested the selections, with their likelihood of timber development, as inconsistent with their own community's existence, and the State coalesced with the village and environmentalists to resist the selections and suggest alternatives for the urban corporations.

The Department of Interior, having the decisive role, made a difficult and important decision to locate the selections elsewhere. If the Department holds firm, the result will be a substantially improved chance for Admiralty Island to be better managed under federal and resident Native systems.

Relating to the coordination of day to day management, one of the most successful ventures attempted in Alaska thus far has been the joint state-federal fish and wildlife team conducting surveillance during construction of the trans-Alaska Pipeline. This venture spans state and federal jurisdictional lines on the pipline route, and has succeeded in its own area of expertise, even when state and federal relations have been strained regarding other TAPS surveillance responsibilities. A plan similar to the fish and wildlife effort is now being proposed to carry out surveillance for the federal offshore oil and gas programs being initiated in Alaska.

Perhaps the most challenging and successful of the new land allocation efforts in Alaska has been the Cook Inlet land exchange, which not only set a new pattern but demonstrated that even existing institutions and systems have adequate competence and flexibility to resolve massive and complex Alaska land problems.

The Cook Inlet land selection issue is a classic post-settlement problem resulting from the inability of the Native Regional corporation in Alaska's most populous area to find adequate land to meet their Settlement Act entitlement. Virtually every remedial effort attempted suggested results which were worse than the original selection problem. Federal-Native bilateral efforts at resolution failed, and a Native lawsuit ended up in the Circuit Court before the State saw the necessity and wisdom of participation in the solution rather than accepting the role of third party victim.

What was at stake was the ultimate land pattern in the entire Cook Inlet region as well as in the Lake Clark and Illiamna areas. In a remarkable nine-month negotiation involving the Federal and State Governments and the Cook Inlet Native corporation, a massive and complex agreement was hammered out without courts or legislation.

The final agreement, involving movement of several million acres of land between the parties, and hundreds of millions of dollars in economic values alone, was ultimately approved by all parties, by the Alaska Congressional delegation, by the Federal-State Land Use Planning Commission, by Congress, and by the Alaska Legislature. Second only to the fact that our institutions were effective was the point that more than economic land and resource values were acknowledged in the exchange, with value clearly being recognized and negotiated regarding improved land patterns and management, and regarding aesthetic and recreational elements. The process used was highly public, unquestionably controversial and unguided by the standards for such major exchanges we should now move to establish for the future.

The results of the final agreement will develop over the years, but the author believes they will include better land management, private economic development in appropriate areas, protection for national interest reasons consolidated in key areas, less future costs for state and local governments in support of improperly located settlement and development, and the avoidance of years of acrimony and litigation among interests which should be planning rather than disputing.

At the top of the agenda for the immediate future is final action on the Sec. 17(d)(2) "national public interest" land proposals to place large areas of federal land into the established "four systems" (parks, refuges, forests, wild rivers). Many of the proposals, particularly that by the federal administration, have elements which are antithetical to what will likely work best in Alaska.

The four systems themselves have inadequate flexibility; they have no special applicability to Alaska; and the proportionate share assigned to each system in some proposals reflects a political rather than planning orientation. Overall, the existing proposals superimpose a federal system somewhat insensitively on the people, cultures and communities of Alaska which will actually have to live with the result. Although it is commonplace to assume that only the national will has the capability of enforcing a proper regime in Alaska, this judgment sells short the sense of community Alaskans feel for the land they share, regardless of the boundary lines. It also sells short the superior capability of the state and local governments of Alaska, and the Native corporations, to manage lands and resources based on the sensitivities and competence which come from living in the neighborhood.

The Hammond proposal for the 17(d)(2) lands reflects many of the judgments inherent in the preceding remarks, and offers the only comprehensive alternative to the generally traditional legislation proposed by others. Among its integral parts are:

- the use of the traditional four systems as core areas only where the best future uses are clearly identifiable and fit the existing statutory formulas (i.e. "pure" park quality).
- the use of designated buffer areas around the cores, where uses are not so restrictive, yet Congressional designations of "prime use" will still determine the best federal management agency, and the priorities for management.
- the establishment of a new federal management category for Alaska (Alaska Resource Lands) where later inclusion in an existing system is possible, but should await further scrutiny while experiencing interim management under the "prime use" theme.
- creation of vast new areas called COMANS (cooperative management systems) which include federal and state lands in a structure which can incorporate private and municipal lands where desired by the owners. Such a category springs from the sound theory that the best land management systems are not based on political boundaries, and establishes a structure for essential cooperation between Alaska landowners on a long-range *and* day-to-day basis.
- creation of a state-federal Alaska Land Commission as a continuing entity for cooperative land allocation and management. Intended as a real power rather than a purely advisory one, the commission contemplated by the State would have the ability to make land classifications, affect management schemes outside the four systems and do so from a base in Alaska where one must live with the results of one's actions.

This unique approach to 17(d)(2) offers an alternative on this issue which incorporates most of the necessary elements for rational land allocation in Alaska, and expresses the desire that cooperation rather than competition will be the theme for the future. Now laid before the public for comment, the proposal has been both controversial and ignored.

Perhaps most disappointing is the attitude of those parties to land allocation in Alaska who wait patiently for the state proposal to simply "go away," so that the political struggle over the four systems can proceed.

In view of the fact that numerous enlightened interests are involved (the various federal establishments, environmentalists, Native corporations) and the fact that some of them will "lose" in the struggle, this is a surprising result. This attitude has resulted in efforts to consider specific 17(d)(2) proposals in Congress well in advance of any general discussion of the possibility that new alternative structures will offer more for the future for all Alaska lands.

So far as the author can ascertain, such proposals will not go away, for they incorporate too many of the principals and practices that Alaska land allocators and day to day land managers recognize as correct. What is left is to recognize and adopt the central policy theme discussed, and to use it as the basis for trying new ideas in Alaska. Ultimately, having achieved the most difficult of tasks—giving up old ideas and structures for new ones—we may acknowledge, as Velikovsky did:

> "Is it the case that at first a new idea is regarded as not being true, and later, when accepted, as not being new?"

Perhaps it is too much to seek, although it does not seem so, for there appears no disagreement regarding Alaska's lands that the stakes are high enough to try.

Discussion

COCHAIRMAN LeRESCHE: Thank you.

The next speaker was to be Gary Everhardt, Director of the National Park Service. Unfortunately, however, Director Everhardt is in the Everglades with the Secretary of the Interior.

His able replacement will be Bill Reffalt, whose talk will be on, "Federal Plans for Land In Alaska".

As Guy's remarks pointed out, this is a brand new opportunity for the federal agency.

As Director of the Alaskan State Park System, Bill has likened the federal bureaus to a bunch of kids given carte blanche at the candy store being forced to justify which pieces they are going to take before they can take anything. Others feel differently. They feel that national parks and wildlife refuges, as constituted in the past and as presently made up, do not, frankly, do justice to the Alaskan lands.

Whatever happens ultimately is probably going to happen big. Were all of the Secretary's proposals to pass Congress, the entire United States National Park System would more than double in size. There would be two new parks, each of which would be almost five times the size of Yellowstone, presently the largest park. Were all of these proposals to pass, the National Wildlife Refuge System, would more than double in size, given the Alaskan Refuges.

And yet, as Mr. Martin said, and I concur, were these new parks, refuges, and perhaps forests, to breed traditional hide-bound parks and forests, it would be a tragedy of a high order.

Many of us in fact hope that Alaska will have a profound effect upon the federal land management agencies, Fish and Wildlife Service, the Park Service, the Forest Service, and the B.O.R.

Many of us hope that Alaska itself, acting on these agencies, will act to humanize them, and will act to stretch the boundaries of their bureaucratic thought.

With that, I introduce Bill Reffalt.

Land Allocations in Alaska: Federal Plans

William C. Reffalt
Staff Director, Alaska Planning Group,
U.S. Department of the Interior,
Washington, D.C.

"North to the Future" is the motto of the State of Alaska. No doubt, the motto's author never guessed that the forces of the future would converge on Alaska with the speed of recent years. And yet, that author was right that the future would be found in Alaska; it is already clear that many of Alaska's natural resources will have a major role in shaping the future of the United States.

Oil, of course, is today's major propellant of the forces of Alaskan change. Oil has drawn men and material with such haste and impact that the experience of the gold rush days fades by comparison. When the proposed development of the vast oil reserves was delayed by conflicting claims to Alaska's land, the demand for oil became a foci for national recognition of the need for a prompt land claims settlement.

However, oil is only one of Alaska's many nationally significant resources. Fish, wildlife, and other natural values have long been her major attractions. Originally supporting an estimated 75,000 Eskimos, Aleuts, and Indians, these resources became the initial target of Russian fur traders and those who followed seeking sea otter, fur seal, whale, mainland furbearers, salmon, and crabs. Nonetheless, Alaska's resources have been treasured by many for more than exploitation.

This huge area—larger than Texas plus the original 13 States—also contains widely diverse features such as many of America's tallest mountains, millions of lakes, beautiful forests, giant glaciers, and over one-half of the U.S. coastline. Within Alaska's many unique ecosystems can be found America's cleanest rivers; hundreds of millions of internationally significant marine, shore, and water birds, nearly 40 percent of this Nation's waterfowl nesting habitat, unique or critically important populations of mammals such as brown/grizzly bears, polar bears, caribou, wolves, muskox, and the breeding grounds of huge populations of marine mammals. Here, too, are the artifacts and sites of early Asian visitors to North America.

Alaska is America's last land frontier. Since its acquisition from Czarist Russia, it has been a symbol to many Americans of vast unpeopled wilderness, of fresh unencumbered frontier. A few generations ago Americans could feel this way about other places in the country as well. Yellowstone National Park, for example, was one of those places. Wild and pristine, protected by its remoteness and mostly inaccessible, it was a place to dream about, a once-in-a-lifetime experience. Alaska remains such a place still.

The attraction of the Alaskan wilds is already a major economic asset of the State. As the world develops and its wildlands shrink, the worldwide appreciation of the Alaskan wilds will certainly grow.

For a long time, decisions on the ownership and use of the great acreages of federal land in Alaska were slow in coming. As late as 1970, 97 percent of Alaska's 375 million acres (151.88 million ha) were still under federal jurisdiction. This despite the fact that the 1958 Statehood Act granted the State of Alaska the right to choose over 104 million acres (42.12 million ha) as an economic base, for the support of services to all Alaskans in the years to come.

The State land selections were slowed because no complete settlement had been made with the Alaskan Natives for their aboriginal land claims, a settlement promised as early as 1884 by the Congress. The discovery of huge reserves of oil in 1968 prompted rapid settlement. In 1971, Congress passed the Alaska Native Claims Settlement Act. This Act recognized the needs of Alaska's Natives—Eskimos, Aleuts, Athabascan Indians, and Haida-Tlingit Indians—through the award of $962 million and over 40 million acres (16.2 million ha) of land. In so doing, the Settlement Act permits the fulfillment of the Statehood Act by enabling the State to move forward in its land selection.

The Settlement Act did more than provide for state and Native needs. Recognizing the significant impact of massive state and Native land selections, Congress also addressed the national interest in the Alaskan lands. The full significance of the Settlement Act becomes clear when its various provisions are evaluated in light of the authority of the Secretary of the Interior over public lands. In its total context, the Settlement Act provides the opportunity to conduct the most comprehensive land use planning in our history.

Other major provisions of the Settlement Act include:

(1) Establishment of twelve Native Regional Corporations and over 200 other Native Corporations to act as economic and land managers for the Native stockholders.

(2) Authority for the Secretary of the Interior to reserve necessary easements on lands to be conveyed to Natives, to protect the public's interest for access and transportation.

(3) Establishment of a 10-member Joint Federal-State Land Use Planning Commission to help plan Alaska land use and to advise the President, the Congress, the Governor, and the Secretary of the Interior on the various actions relative to implementation of the Act.

(4) Authority for the Secretary to withdraw from all forms of appropriation under the public land laws up to 80 million acres (32.4 million ha) of federal lands for study as possible additions to the "four systems"—the National Park, National Wildlife Refuge, National Forest, and the National Wild and Scenic Rivers Systems. Legislative proposals for the areas found suitable for addition to the Four Systems were to be submitted to Congress by December 18, 1973. The lands under this provision have become known as "d-2" or "national interest" lands.

(5) Authority for the Secretary to withdraw other Alaskan public lands from all forms of appropriation under the public land laws, except location of metalliferous minerals, in order to protect the public interest and to classify or re-classify these lands for future management. These lands are known as "d-1" or "public interest" lands. Since the passage of the Settlement Act, the Secretary has withdrawn all otherwise unreserved public lands in Alaska, placing them in this "d-1" category. These "d-1" lands are

an important factor to any comprehensive land plan, because of the Secretary's land classification authorities. Ultimately, as much as 100 million acres (40.5 million ha) of land could remain in this public interest category after the Natives and the State make their selection and after final decisions are made by Congress on the Four Systems proposals.

In essence, the Alaska Native Claims Settlement Act gives America the opportunity to "do it right the first time", based on experience gained over the years in other parts of our country, as well as in Alaska. This is our last chance as well. Never again will we have an opportunity on such a scale. The national interest should always be a major consideration in the allocation of Federal lands. Yet the satisfaction of the national interest need not jeopardize the State interest and, in this instance, a solid economic land base will be available for the citizens of Alaska. When the State and the Natives complete their various selections, they will own vast tracts of Alaska's most valuable lands, including highly mineralized areas and nearly all of the areas most suitable for human settlement.

Obviously, the responsibility for balanced land use and planning in Alaska is not a federal challenge alone, for resources of vital importance to the citizens of Alaska are at stake. A good land plan for Alaska will, in fact, require the concerted, creative energies of all affected parties. Furthermore, this broad commitment to Alaska must be a continuing one, since a land use plan is not a static thing, but instead, a process which is refined over time.

The extensive opportunity in Alaska for balanced land use exists because so little of the land has been committed to specific uses. Thus, studies may consider whole river basins, self-sustaining wildlife populations and plant communities, and broad archeological zones. Cooperative land use agreements may be developed between the State, the Natives, the Federal Government, or other landowners to insure careful management in areas of mutual concern. If needed or desirable, lands may be exchanged among the federal agencies, or with the State, or the Natives to properly complete management units.

Though gigantic in proportions, Alaska is a fragile land. Extreme care must be taken by man to protect its delicate ecosystems. Generally, it is a land of severe climate, of thin soil often underlain by permafrost, and of short growing seasons. The web of life is stretched nearly to breaking. For survival, many Alaskan animals require an enormous habitat area. A bear may need 100 square miles (259 km^2) and many caribou range 1,000 miles (1609 km) per year for sustenance. Simple vehicle tracks across the tundra can become ugly gullies, growing worse with time. For example, some vehicle tracks which were made in 1941 and 1942 on Alaska's North Slope exposed the permafrost which eroded so badly that gullies soon became streams. The streams, in turn, have subsequently drained several lakes. Thus, there is little margin for error by land managers; caution is essential. As Secretary of the Interior Kleppe said recently:

> We must strike a delicate balance between resource use and resource protection, and keep in mind that the economic penalty for an error in the direction of overprotection can always be corrected, while the damage from resource abuse may be irreparable.

The importance of careful resource planning was recognized early in the studies for the four systems proposals authorized by Section 17 (d) (2) of the

Settlement Act. Areas included within the National Systems are meant to be protected permanently. Considering Alaska's extreme susceptibility to abuse, an area suitable for inclusion in one of the Four Systems should be a self-contained resource area, capable of being managed wisely and efficiently as a unit.

The four systems or "d-2" proposals resulted from ongoing Alaskan studies by the National Park Service, the Fish and Wildlife Service, and the Forest Service. Each of these agencies had been identifying and evaluating critical Alaskan resource areas for many years. Each agency has had long-term management experience in Alaska as well. The Bureau of Outdoor Recreation, which conducted the wild river studies, was a relative newcomer, having been created in 1962. With the Settlement Act, all agencies intensified their resource studies and because of tight deadlines, areas of mutual interest and other factors inherent to the implementation process, they were encouraged to develop a system of interrelated proposals.

This intense phase of work culminated in December, 1973 when the Secretary forwarded his recommendations to the Congress for establishment of 28 Alaskan additions to the Four National Systems. These proposals are now contained in pending legislation (S. 1687 and H.R. 6089 in the 94th Congress) entitled: *The Alaska Conservation Act of 1975*. These proposals (see Figure 1) include 11 new areas or additions to the National Park System, 13 new areas or additions to the National Wildlife Refuge System, 4 new areas or additions to the National Forest System, and 20 new additions to the National Wild and Scenic Rivers System, 16 of which are contained within proposed units of the other three Systems.

In total, the proposals span the breadth, character and diversity of Alaska. Individually, they comprise unique and singular assemblages of habitats, fauna and flora, cultural, historic and recreational values, yet they do not duplicate one another.

Obviously, there needed to be much give and take in designing the proposals. During the process, the Secretary considered the views of many individuals and organizations, representing a wide spectrum of interest, knowledge and opinion. The product represents a comprehensive and complimentary system of proposals that, in turn, contribute importantly to the individual system for which they offer resources of particular pertinence.

Several important guidelines were developed during the study process:

First, apply what had been learned from the experiences and errors of the past. For example, the inherent limitations of considering lands within specific jurisdictions individually were avoided in favor of a broader conceptual framework which allowed fully integrated regional land use planning. In one way or another, this guideline is woven throughout the others.

Second, propose complete management units, considering basic ecosystems to the extent possible. This guideline has been learned the hard way with a good example being the Everglades National Park which, when created, did not include the watershed which nourishes the Glades. Now the protection of that watershed is costing the American public $150 million.

Third, plan for the existing subsistence needs in Alaska. This represents a uniquely Alaskan circumstance in that most Alaskan Natives still depend upon and practice a way of life based upon gathering and fishing and hunting. America's cultural diversity has always been one of her unique strengths. We have learned that the different viewpoints and different contributions of our varied cultures have been an enrichment to all. The Congressional Conference Committee that designed the final Settlement Act recognized the unique Alaskan circumstance and in their report the Committee stated that: "the Conference Committee expects both the Secretary and the State to take any action necessary to protect the subsistence needs of the Natives."

Already the agencies are working to be better prepared to meet this responsibility. The Fish and Wildlife Service is working to develop cooperative management agreements with Native corporations, has hired native liaison officers at the field level and is cooperating in making subsistence surveys. As another example, the National Park Service has funded a major subsistence study with the Northwest Alaska Native Association. All agencies will work closely with the Alaska Department of Fish and Game, the Native organizations and other local interests to insure careful and proper management of subsistence resources in Alaska.

The Fourth planning guideline was: utilize federal inter-agency cooperation and joint management as warranted to achieve special purposes or goals. Such cooperative ventures and relationships may contribute to the successful management of complex ecosystems in the "d-2" proposals. The "d-2" study process exemplifies the needs and benefits of this guideline. In the effort, the Fish and Wildlife Service and the National Park Service both studied 12 million acres (4.86 million ha) of lands having resources of mutual interest. The Fish and Wildlife Service was also conducting studies of an additional 37 million acres (14.98 million ha) and the Park Service studied another 30 million acres (12.15 million ha). The Bureau of Outdoor Recreation ultimately concentrated its studies on 31 rivers totalling 5 million acres (2.02 million ha), with 3.5 million acres (1.42 million ha) contained within areas being studied by the other agencies. The Forest Service studied 41 million acres (16.6 million ha) with 31 million acres (12.56 million ha) of that overlapping areas being studied by the Fish and Wildlife Service and the Park Service. Such a large amount of mutual interest lands supports the conclusion that "nationally significant" resources were clearly present. The overlaps also contributed to the unprecedented level of inter-agency coordination that occurred in the final development of the "d-2" proposals and led to the recommendations for joint management, advisory boards, etc., that are contained in the Secretary's proposals.

Fifth, involve and relate to state, Native and other local interests. As an extension of the preceding guideline, this one recognizes the importance of including the several other interests required to complete the integration of the planning process with actual land use. The concept of "Areas of Ecological Concern" is an expression of such recognition. Within these areas which surround the refuge and park proposals, critically interrelated resources would be the objects around which cooperative management agreements will be formulated for the mutual protection and careful de-

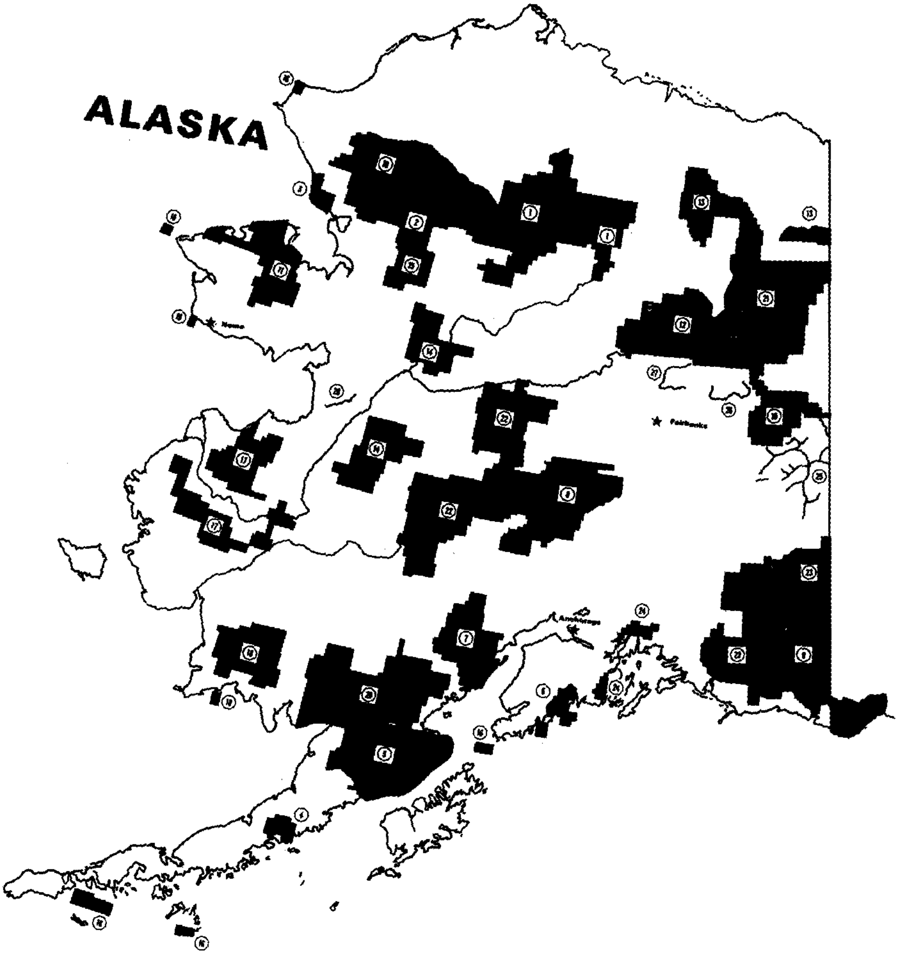


Figure 1.

PROPOSALS

AUTHORIZED BY
ALASKA NATIVE CLAIMS SETTLEMENT ACT
P.L. 92-203

December 18,1973

PROPOSAL NAME		MILLIONS OF ACRES
National Park System		
(1) Gates of the Arctic National Park		8.36
(2) Kobuk Valley National Monument		1.85
(3) Cape Krusenstern National Monument		0.35
(4) Aniakchak Caldera National Monument		0.44
(5) Katmai National Park [1]		1.87
(6) Harding Icefield - Kenai Fjords National Monument [2]		0.30
(7) Lake Clark National Park		2.61
(8) Mt. McKinley National Park Additions		3.18
(9) Wrangell - St. Elias National Park		8.64
Yukon-Charley National Rivers		1.97
Chukchi Imuruk National Reserve [2]		2.69
	Sub Total	32.26
National Wildlife Refuge System		
Yukon Flats National Wildlife Refuge		3.59
Arctic National Wildlife Refuge Additions		3.76
Koyukuk National Wildlife Refuge		4.43
Selawik National Wildlife Refuge		1.40
Coastal National Wildlife Refuge		0.07
Yukon Delta National Wildlife Refuge		5.16
Togiak National Wildlife Refuge		2.74
Noatak National Arctic Range [3]		7.59
Iliamna National Resource Range [3]		2.85
	Sub Total	31.59
National Forest Syste		
Porcupine National For		5.50
Yukon - Kuskokwim National Forest		7.30
Wrangell Mountain National Forest		5.50
Chugach National Forest Additions		0.50
	Sub Total	18.80

NATIONAL WILD AND SCENIC RIVER SYSTEM [4]		
Fortymile National Wild and Scenic River		0.32
Birch Creek National Wild River		0.20
Beaver Creek National Wild River		0.20
Unalakleet National Wild River		0.10
	Sub Total	0.82
	Total	83.47

1 includes existing Katmai National Monument

2 Joint Administration by National Park Service and Fish and Wildlife Service

3 Joint Administration by Fish and Wildlife Service and Bureau of Land Management

4 In addition, 16 Wild and Scenic Rivers also proposed within Parks, Refuges,and Forests.

velopment of the land resources and their values. Several cooperative land planning projects are currently underway such as the Wrangell-St. Elias project, the Mount McKinley Cooperative Planning and Management Zone and the proposed Forty-mile planning effort. The Joint Federal-State Land Use Planning Commission and the State are taking strong roles in these projects with input coming from a broad group of other interests.

Sixth, provide for the availability of major mineral resources. In many instances, the final boundaries of the proposals were set in a manner that placed known mineral belts of high potential outside units having restrictive management mandates and over 60 percent of the proposals provide some allowance for controlled development of mineral resources. In this way the Secretary accommodated the mineral needs of the nation while allowing future generations the options that will become available once more specific mineral data are known in Alaska.

Of course, it was anticipated that the land selections by the Natives and the State will include large areas of high mineral potential. As a result, a considerable portion of the State will be available for mineral development.

Seventh, and last of the major guidelines, develop a system of interrelated proposals which broadly represent the total Alaskan environment and experience. Thus, the Secretary intended that the 28 proposals should span Alaska's nationally significant resources and that they should be designed on a scale appropriate for such an expanse and diversity.

As mentioned earlier, the proposals are not duplicative, but they clearly work to reinforce each other. The relationship between the Lake Clark National Park, Iliamna National Resource Range and the Katmai National Park proposals are a characteristic example. The Lake Clark proposal affords protection of an important portion of the watershed which contributes to Iliamna's internationally significant red salmon fishery. Iliamna, in turn, shelters the lower reaches of Lake Clark. In the southern portion of Iliamna are important bear habitats which contribute to the objectives of the adjacent Katmai additions. Katmai also contributes watershed protection to the Bristol Bay salmon fishery as does the Alagnak Wild River Proposal contained within the boundaries of the Iliamna Range.

Thus, the Administration's proposals were integrated and linked together in order that the mix of land management systems would provide a wide array of uses balanced with necessary protection and controlled use of critical resources. In some scenic areas, such as the Wrangell Mountain region, relatively intense recreation would be available and provision was made for mineral extraction under the Forest Service multiple-use management system. In some areas sport hunting would be prohibited but that prohibition would occur on only about 8 million acres (3.24 million ha) of the total 83.47 million acres (33.8 million ha) proposed for inclusion in the Four Systems. This recommendation is a departure from management criteria for National Park natural areas and would permit sport hunting in six of the proposed parks or monuments as well as in all units of the other systems, in recognition of the significant importance of this activity and the different conditions found in Alaska.

Yet, even with this flexible response, the spectrum of uses which were included in the Secretary's Four Systems proposals emerged from existing agency missions. No new agencies or new missions were found necessary. The proposals are large, in keeping with the vastness of Alaska's ecosystems and in recognition of their fragile nature which requires inclusion of sufficient lands and water to insure management options for protection of the basic resources.

Fish, wildlife and their respective habitats are features interwoven throughout the 28 proposals and often are the basic resources around which the management plan was developed. In the Yukon Flats National Wildlife Refuge proposal, waterfowl and their ecologically related plant and animal resources formed the foundation of the proposal. The adjacent Porcupine National Forest proposal, since it contains 24 percent of the region's waterfowl habitats and resources will require close cooperative effort with biologists of the Fish and Wildlife Service to insure their long range benefits. This important cooperative effort also includes the Native landowners since close to 45 percent of the over 2,100,000 ducks and 16,500 geese that summer in the Flats utilize areas selected by the Native Corporations.

Native Corporations in the Yukon Delta area have also selected lands having great significance to the Nation's waterfowl resources. As high as 67 percent of the area's waterfowl habitats may fall outside the boundary of the proposed refuge unit and within existing refuge lands that have been selected by villages. Thus, the over 2,000,000 ducks, 720,000 geese and 50,000 swans in the fall flights from the Delta will rely on cooperative efforts of the landowners and land managers to maintain the integrity of the habitats they require.

Also, the State of Alaska must be an active participant in cooperative ventures, on advisory boards and in coordinated regional planning efforts as a means of integrating their regulatory authorities with the needs of the resources and the desires of the land stewards. Balanced land use will be necessary in Alaska, and the setting aside of conservation areas in the national interest is a part of that balance. Among the four systems described in the Alaska Native Claims Legislation is contained a full mix of land management capabilities. The 20 Wild and Scenic Rivers proposals will offer high quality, free flowing waters of excellent recreational potential. These rivers will be managed with recreation as the dominant use but will permit some commercial uses that can be accomplished without detracting from the major objective.

The proposed national forests would supply large blocks of land where multiple use of the resources would prevail. Commercial use and development would be permitted within the guidelines of multiple use management practices while protection of highly significant resources could be maintained.

The national wildlife refuges proposed for Alaska would enable that system to comprehensively manage the Nation's migratory bird resources from their nesting grounds to their wintering areas. For the first time that system would control a good percentage of the Nation's waterfowl nesting habitats as well as the breeding areas for hundreds of millions of other worldwide avian travelers. Uses of the refuges would be designed to achieve maximum fish and wildlife benefits while certain other uses could be allowed so long as they remained compatible with those benefits.

The national park natural areas are managed to insure maximum retention of landscapes and life forms in their natural state. Visitation and other people uses will be allowed in a manner that contributes to human understanding and enjoyment of the ecosystem while maintaining the integrity of its resources.

Broadly viewed, these proposals represent not only the essence of Alaska, but also a heritage important to all Americans—and to many others as we look to the future. Furthermore, the agencies involved are proven vehicles for long-term protection and management continuity which is essential to the retention of that heritage. So long as the American people desire, the protection of these areas, as proposed, would be secure.

These proposals may be useful models for future land use planning and management because of the serious attempt to design self-sustaining areas, based upon watershed, ecosystems or physiographic units. Ideal boundaries were not always possible because of previous commitments to other uses. Cooperation will be essential here and should prove desirable on a statewide basis.

The support for ecosystem or watershed planning in Alaska is growing as evidenced by some of the alternative "d-2" proposals such as the proposal recently announced by the State. If, in Alaska, we can demonstrate that the working cooperation of all parties—i.e., the federal, state and private jurisdictions—leads to the careful use and proper conservation of some of the world's prized natural resources, the Alaska experience will be the land use model for the Nation.

Discussion

CO-CHAIRMAN LeRESCHE: Thank you, Bill. Moving on to another aspect of Alaska and Alaskan planning, over and above her mountains, her wildlife, oil, fish, and gold, we have Alaska's people. We have the people, the cultures, the social and the governmental institutions.

These have been shaped by the land in Alaska perhaps more than they have been shaped by the land anywhere else. But our ultimate stewardship of the land rests upon the goodwill of the people, the interaction of the cultures, and the quality and appropriateness of our institutions.

Kevin Waring, our next speaker is Alaska's Director of the Division of Community Planning. He deals daily with local governments and with people. He has a unique understanding of the pull and tug of present institutions on the future of Alaska.

Social and Economic Considerations in Alaska's Resource Development

Kevin Waring
Director
Department of Community and Regional Affairs
Juneau, Alaska

In my remarks today I will try to place some major resource planning and management issues in Alaska in the context of the basic economic forces unfolding there today and to convey, too, some of the special social flavor of the State. I will speak from my own perspective as a regional development planner.

To begin with, a thumbnail sketch of Alaska in the late 1960's would reveal a state with many of the essential traits of an underdeveloped nation. The State had no stable economic base. Nearly all manufactured goods were imported. Employment patterns were erratic and seasonal unemployment was regularly double to triple national rates. The State's total population was less than 300,000 people. A quarter of these were Alaskan natives, that is, Indians, Eskimos and Aleuts, typically living in poverty in remote rural villages, experiencing severe health, housing and educational deficiencies, with one of the highest birth and death rates in the world, heavily dependent upon subsistence and ill equipped to participate productively in the modern economy. The general quality of public services and facilities throughout Alaska was very low and the transportation system poorly articulated. Living costs were notoriously high. There was little land in private ownership and much of the private basic economy, most notably the fishing industry, was controlled from outside the State. All in all, from the vantage point of development economics, conditions were not very promising for the surprising social and economic development that shortly ensued. Two historic events set the stage for that development.

First, in 1971, for various reasons including an urge to expedite construction of the trans-Alaska oil pipeline, Congress passed the Alaska Native Claims Settlement Act. Under this Act, which resolved the long-standing land claims of Alaskan natives against the Federal Government, title to about 44 million acres (18 million hectares) of land is now being transferred to Alaskan native ownership. When these conveyances are final, Alaskan natives, through over 200 separate regional and village corporations, will own more than 95 percent of Alaska's privately held land. By and large, the Alaskan native corporations aspire to develop their land holdings for the profit of their corporations and stockholders. As they come into control of most of the private land, Alaskan natives have become an authentic economic and political force to a degree that is probably unequaled among American aboriginal groups.

Another section of this same land claims legislation provided for allocation of about 80 million acres (32 million hectares) of public domain into the so-called "four systems." These Section 17 (d) (2) lands have become the focus of lively debate between state and federal governments, conservationists, Alaskan natives, mining, forestry and other economic interests, sportsmen and other interest groups about desirable future land use and development for Alaska.

The second stage-setting event was the "energy crisis," brought to public consciousness by the oil embargo and the subsequent steep rises in oil prices. This energy crisis led to Project Independence and to a headlong federal program to develop domestic energy reserves to reduce national dependency on imported oil. This effort includes a crash program of accelerated exploitation of the outer continental shelf, especially Alaska's suspected offshore energy potential, which the Federal Government views as a major untapped source of domestic oil supply. Renewed attention is also being given to exploration and development of Naval Petroleum Reserve No. 4 on the Arctic Slope, a reserve variously estimated to hold one to four times the proven reserves at Prudhoe Bay.

These two events, passage of the Alaska Native Claims Settlement Act and the energy crisis, have triggered an intense period during which major land allocations and resource development decisions are being irretrievably committed at a forced pace. This is a dramatic contrast to the previous decades of wishful but unrealized fantasies that the door to Alaska's fabled riches opened just around the corner. Suddenly, in the span of a few years, that threshhold is being crossed, for better or for worse, and with vehemence. And the crossing is putting an acute edge on many wildlife management issues.

Long the least populous state, Alaska has recently become one of the fastest growing, with the most vigorous economy among the 50 states, during a period when national economic and population growth rates were stagnating. The primary reason for this sudden shift is, in a word, "oil." The famous Prudhoe Bay discovery on state lands is the largest single oil and gas find in the United States. The storied 1969 North Slope Lease Sale brought the State $900 million in bonus revenues which have since been largely spent to upgrade public services, with strong pump-priming effects on the State's economy. The $7 billion trans-Alaska oil pipeline now being built to transport North Slope crude oil to market is the costliest private construction project ever undertaken. These giant events, dropped into the state with the least developed economy and fewest residents, have sustained Alaska's rapid growth since 1969. To all appearances, this is only the opening round.

The trans-Alaska oil pipeline seems likely to be followed shortly by construction of another pipeline system for transport of North Slope natural gas. This second pipeline is projected to exceed the oil pipeline in cost.

The most important growth stimulus promises to be the Federal Government's accelerated Outer Continental Shelf Lease Sale program which has scheduled nine offshore oil and gas lease sales in Alaskan frontier regions during the next three years. This OCS lease program represents the greatest disposition of public resource values the nation has ever contemplated. Again, because of the technological sophistication and capital intensity of offshore oil development, these federal lease sales will unleash private investment in industrial development on a scale that will dwarf Alaska's existing economy. A critical and pertinent aspect of the OCS lease sale program is that it will bring rapid industrial development and population growth to previously unsettled, undeveloped wilderness regions.

There are numerous other prospective economic ventures in petroleum and mineral extraction, tourism, forestry and hydro power. Some are speculative and some are unwelcome but some are sure to add to the pulse of expansion.

Hand in hand with economic expansion comes population growth. In terms of raw population growth, current projections are that Alaska's present population of about 400,000 people will more than double by 1990 at a minimum, and more than triple if high national priority continues to be placed on extracting Alaska's energy reserves. In absolute terms, this is not a great many people but relative to any stress from human settlement that Alaska's natural systems have had to tolerate to date, this population is unprecedented. To put these numbers in a comparative frame of reference, even the minimum projection represents a sustained rate of growth that no other state or nation is likely to match over the same period. For planners, it is a challenge in growth management.

In terms of environmental stress, even more important than the raw population growth is the power and scale of the technology that accompanies it.

Generally speaking, Alaska is not hospitable to settlement in the life-style of contemporary America. Energy costs for transportation and space heating are exceptionally high. Conventional engineering practices are poorly suited to northern and arctic conditions. For an extreme example, the conventional design solutions for public water supply and water-borne sewage disposal systems simply fail in an arctic desert climate where the average annual temperature is 23°F and the annual precipitation measures four or five inches (10 or 12 cm). Nevertheless, it is discouraging to see the mythic frontier give away as we insist on keeping our temperate zone habits and, with economic and engineering overkill, seem bound to repeat the familiar inappropriate pattern of superhighways, downtown congestion, enclosed and heated shopping malls, etc.

But it is in the industrial sector that the full power of technology to intrude on natural systems becomes visible. In the Alaskan context, economies of scale tend to work heavily against minor resource development projects which cannot absorb the total costs of starting from scratch in an undeveloped economy. Thus, the feasible projects tend to be massive in economic scale, usually involving new transportation systems into remote areas, high energy and materials consumption, new settlements, and major land use changes. The oil pipeline, the proposed natural gasline and the proposed offshore oil developments are good examples. The result is that resource development decisions are typically linked to a series of other events with high potential for disrupting social and natural systems and for degrading the natural environment.

Success or failure at the management of growth and change on this relative scale will have a great deal to do with the character of the Alaska society that evolves and the environment that survives. Some of the large familiar themes of social development are being replayed in Alaska as in other places before: the migration from far places to a new land; the settling of the frontier; the historic migration from rural to urban areas; building the great metropolitan city; the search for a vital tension and balance between natural forces and technology and human lifestyles; the cultural melting pot. The playing out of these themes will shape the character of Alaskan society in the years ahead.

What has been the reaction of the Alaskan public and the State of Alaska to this initial heady taste of prosperity, with the prospect of more to come? Not surprisingly, public attitudes are mixed. The dominant sentiment is hardly anti-development, but generally speaking, the public attitude has been to make haste slowly rather than to embrace enthusiastically development at any cost.

In the gubernatorial election of 1974, which, in simplified terms, pitted an advocate of development against an advocate of controlled growth, the electorate barely opted for the candidate of controlled growth. That is the policy that the state administration has followed since, emphasizing environmental conservation, balanced economic growth and attempting a strict analysis of the hidden costs as well as the touted economic benefits of major resource development proposals. This selective approach has led to some innovative policies and, particularly, to head-on collision with the federal energy juggernaut.

From time to time, the State finds itself at the mercy of unilateral federal decisions on major development issues and the OCS lease program is an outstanding example. For a variety of environmental and social reasons mainly stemming from the timing and pace of the sale, the State has recently filed suit to delay the first proposed OCS lease sale in the northern Gulf of Alaska. The basic issue is whether it is environmentally and economically sound policy for the Federal Government to schedule nine major OCS lease sales in undeveloped frontier regions with no existing infrastructure and little lead time to plan for orderly provision of the onshore services and facilities needed to host offshore development. At the same time, the State has mounted an intensive planning effort within its coastal management program to better manage the onshore impacts that offshore activities will stimulate.

Within the realm of the State's own decision-making about major resource development, uncommon attention is being given to analysis of socio-cultural and economic dimensions of development. A start has been made on approaching development decisions critically and selectively, with an eye to long-run consequences. While this experimental approach has really just begun, its effects can already be seen in the outcome of some resource decisions. Thus the State has begun taking a slow and measured approach to management of its own petroleum resources. Although the State is experiencing a serious revenue pinch, any decision to lease additional state lands for oil development in the Beaufort Sea near-shore area of the Arctic coast has been deferred while other fiscal solutions are sought. Legislation has been introduced to repurchase earlier state oil leases sold in Kachemak Bay, an area with rich shellfish breeding grounds particularly susceptible to damage from oil pollution. After careful consideration of alternative trans-Canadian and trans-Alaska routes, the State has chosen to support the trans-Alaska route for the proposed natural gas pipeline. This route would roughly parallel the oil pipeline and avoid crossing the Arctic National Wildlife Refuge.

In a major policy innovation, legislation has been introduced to authorize a constitutional referendum that would establish a permanent investment fund of 25 percent of petroleum and other mineral resource income that will, for a brief period, flow in great amounts. A major portion of Alaska's state revenues derive from the liquidation of publicly-owned depletable resources. This permanent fund is proposed to provide protection against the inevitable day when state income from non-renewable resources begins to decline. There is strong legislative, executive and popular support for this permanent fund.

These are only a few superficially noted examples of the State's effort to introduce social and economic considerations into the equations of resource management. It will take sometime to see how well the effort fares.

To leap to a parallel conclusion that bears direct relevance to this conference, all of this background has a very direct relationship to management of wildlife resources and habitat. It seems clear that, in Alaska, managing the activities and mischief of human beings, those wildest livers of all, is going to be the key to conserving wildlife and wildlife habitat. The connection between growth and wildlife management problems is perhaps most clearly exposed in the conflicting lifestyles of the traditional subsistence harvester and the urban recreational hunter as both compete for a dwindling resource. Alaska offers a rare opportunity to test how effectively professional wildlife management can insinuate sound management principles into a rapid development process and thereby influence key decisions that influence its responsibilities.

Discussion

CO-CHAIRMAN LeRESCHE: Thank you, Kevin. By now it is evident that next year if we are to make the most of our last chance in Alaska there must be at least a partial breakdown in originally defined and often antagonistic state and federal government roles in Alaska.

We Alaskans are seen variously as a colony or as a sovereign nation, depending upon whose opinion you ask. We sometimes seem to speak, that is, the State Government and the Federal Government only in court or in Congress. There is no doubt that this must change if we are to realize the possibilities of Alaska. The dialogue between state and federal governments must be, realistic, personal, and much more regular than it has been.

Our last speaker, who will address the opportunities for this kind of cooperation and interaction, is Samuel E. Wood.

Federal, State and Local Cooperation

Samuel E. Wood
Planning Consultant,
Sacramento, California

We now have a widespread appreciation of environmental dangers, but there is little understanding of the role of comprehensive planning at all levels of government in meeting these threats. Most professional planners believe that there is a lack of fruitful cooperation between federal, state and local government in land and resource management. But actually there is cooperation among single-purpose agencies at all three levels, the project planners working together so efficiently that they dominate their functional areas and fully frustrate the attempts of the professionals to bring their efforts in line with general planning precepts.

Most of my knowledge and experience relate to California which, aside from Alaska, has undergone the most destructive developmental thrust of all the states. California land has been considered a commodity to be consumed and thrust aside. This not only could happen, but I fear is happening, in Alaska where the process already exceeds the excesses of California and the rest of the states.

Alaska joined forces with federal agencies and the oil lobby to accelerate this process. Together they attempted to check the Congress in its efforts to protect the public interest in the classification of Alaska lands by assuring that lands of national interest not be pre-empted by the State. State ownership means multiple use, disposal and leasing. This same alliance opposed continuation of the land freeze, land-use planning, and delay of the pipeline to permit safeguarding land capacity and land use studies. All the people of Alaska, including the natives, would have benefited from the freeze and the resulting comprehensive planning. Together these would have enabled the State, the natives and the federal agencies to make careful and supportable land selections.

Currently, Alaska is being parcelled out by the greatest subdivision in history. Millions of acres are going into uncontrolled private ownership earmarked for the kind of exploitation that has characterized state and local responsibility for the land in much of the 48 continental states. The subdivision is guided by ordinances passed by the Congress. But the ordinances do not require subdivisions to conform to comprehensive planning at any level of government. They actually impose a corporate profit structure on native regions. Some of the regional corporations have already entered into oil exploration contracts. This apparent contradiction between the natives' philosophical opposition to exploitation of the land could result not only in the destruction of a way of life but of the land and resources, themselves.

The interests of the people of the United States in preserving scenic and wildlife values could be protected if Congress were to insist that maximum lands be designated for public domain, with a carefully determined minimum for "multiple use." This designation would permit, over time, with the help of land capacity studies, amendments to the designations justified by comprehensive planning. Or Alaska, itself, could establish a planning process to develop a comprehensive plan for the conservation and development of the lands of the State and its regions. This process could furnish guidance and technical help to native corporations in their developmental efforts.

The fact is that most of the other states have also abdicated their responsibility for the land, while the Federal Government has never assumed any. Actually, the protection of the land is a responsibility that has to be shared by all three levels of government.

Watertight division of powers between the states and the Federal Government, on the one hand, and the State and local government, on the other, is a myth. Major problems of conservation and development especially require this sharing of functional responsibility. No one of the partners can do the whole job, and no one should, because all are involved. How well are the partners handling their responsibility for the land?

Local governments in the main have full authority over land uses in their jurisdictions and full ability to control the amount, direction and quality of their growth. In most localities leaders usually prefer to sweep the problem of growth under the rug, disdain beauty and play games with effective land use controls.

A vacuum of policy and direction also exists at the federal level. Over 40 different federal agencies join their counter-part agencies in the states in a "hit or miss" uncoordinated program for the management and non-management of our resources and land. On the whole, these agencies have been created to carry out single-purpose programs with their own independent policy-making powers. There is no national policy on how land should be treated and no single national policy to protect the considerable national investment in the beauty and productivity of the individual states.

Federal agencies are known to be involved with state and local agencies in actions that often downgrade the environment. Each regulatory or action agency has its own clientele or support group, its own congressional or legislative committee—also captive of the support group—and its backup state agencies serving the same clientele. When the California timber interests defend clear-cutting endangering the California State Redwood Park they speak for and in the words of the State Division of Forestry; they also speak for the U.S. Forest Service, and more recently for the Park Service, which had to be forced by court action to carry out the law.

The long record of BLM's give-away policy is outdone by the Forest Service's contract to clear-cut 1 million acres (405,000 ha) of Alaska's virgin timber in the Tongass Forest. The action is now being challenged as contrary to the Multiple Use - Sustained Yield Act and an array of other federal statutes that are supposed to control the actions of the Forest Service. If the terms of the contract were carried out, almost no timber would be left standing as wildlife habitat, or for wilderness or recreational uses. The entire million acres is to be cut within 50 years, although it takes 120 years to regenerate. Not only does the contract appear to be patently against the law and contrary to basic conservation principles, it appears to furnish little or no benefit to the people of Alaska or the rest of the United States. It seems that the Forest Service is importing to Alaska's fragile slopes the very practices of clear-cutting that are being successfully challenged and rapidly discarded in other parts of the nation. It is instructive that both the contracting company and the State of Alaska have intervened as co-defendants with the Forest Service.

I think it is sad, indeed, that the public which owns our domain can no longer depend upon the agencies we created and directed, financed and I (for one) have always supported, to protect our interest. Now, instead, we are forced to depend upon foundations and the courts for the protection of our land and resources.

I wish I could blame the administration fully for these attacks upon the environment. But the practitioners, the professionals, in federal agencies have their own stake in perpetrating these policies. Foresters, public and private, go to the same schools and most support clear-cutting as the economical way to harvest—they *are* the stumpage people. The water people are big dam and diversion people—federal, state and local. It is no accident that the pipeline contracts were let before land capacity studies were completed or that Alaska is now being subdivided in a vacuum of state planning to control the conservation and development of the land.

Single-purpose agencies—federal, state and local—plow their own uncoordinated paths across our landscape. The method of bringing these agencies under control at all levels is known as comprehensive planning.

For years, management experts in and out of government have advocated the creation of a single massive land agency to plan and control all of the land of the Federal Government in one monolithic bureaucracy. The Department of Interior appears to be the most probable agency to assume this responsibility because it is most experienced and at present holds the most land. Historically, however, the agencies in this department have been riddled with graft. It is not the purity of the department that has brought what respectability it now has, but congressional philosophy that has been slowly and painfully built into Interior authorizations and controls. The Interior Department, the oil establishment and other department clients bitterly fought efforts of the Congress to protect the public interests in Alaska lands. The numerous clientele of the department, however, do keep each other somewhat honest by watching over each other's shoulders.

When one agency begins a program, the others offset this effort with their own similar programs. This competition may be preferable to specialization by land types. The best recreation lands, for example, could be set aside for recreation and wilderness areas without actually being transferred to a specialized agency. Every bureau could then be in every phase of multi-use management, with a diversity of ownership, but with national needs, best uses and management policies determined by uniform standards and uniform national policies.

A major reason for not giving the Department of Interior full federal planning responsibility is its long subservience to present clientele. A strong, independent, quasi-judicial federal planning and resource conservation commission charged with responsibility for developing public policy and a plan of implementation, both subject to congressional acceptance, would be a more responsible planning agency. Single public policies could then control all independent and line agencies of the Federal Government and the states and their local agencies in areas of federal dominance.

Major responsibility for comprehensive conservation and development planning under the division of powers would rest with the states. Here again the need is for coordination of powerful single-purpose agencies, but there is also need for guidance to regional and local governments where detailed land use planning and development programs must be prepared and administered. Single-purpose agencies desperately need central, clearly stated, duly adopted public policies and a state conservation and development plan, as a shared vision of what a state could become.

We not only require adopted policy to keep our state agencies in line, but we especially need guidance when we battle with powerful federal agencies that function in such heavily financed areas as water development, air and water pollution, transportation, housing, land use and resource development. Of immediate concern in California is a federal court decision that denies the State the right to call on federal storage to maintain water quality in San Francisco Bay. Water users in the Delta could be sacrificed by federal bureaucrats, beyond the reach of the people of California, to meet existing irrigation contracts in the Sacramento and San Joaquin Valleys. Without winter flushing and with resulting salinity intrusion, the Bay could become a stagnant pool with no fish and wildlife, a blight instead of an amenity. The Department of Interior is also proceeding with off-shore drilling leases contrary to state policy and local pleadings. In the absence of solid state policy, backed by a state plan, California has no leverage against such federal threats to its land and resources.

But in Alaska, the State and the development establishment, Interior and its clients, appear to be identical. In fact, however, salvation may rest on "four system" lands being husbanded by the agencies of the department. Congress can ride herd on these agencies to get compliance to national policy when it cannot reach the State. I suspect that the Alaska Land Commission and the "Resource Lands" designation proposals are efforts to counter this possibility—reduce the amount of protected lands, increase the State's allocation and open most areas, federal and state, to multiple use. I see no comprehensive conservation and development planning coming from this proposal.

Most of the states, not quite so anachronistic as Alaska, do not have over-all policy because state planning has not developed a strong constituency in either the public or private sectors. A clientele is emerging, however, as development people need rules of the game, as local government asks for guidance and as state agencies become tired of fighting losing developmental battles.

The proposals surfacing in California and elsewhere contain some and several contain most of the following elements that I believe are necessary to a vital state planning process:

(1) A full-time, well paid state planning council, reporting to both the governor and the legislature, responsible for developing state policy and a state plan, both to be adopted by the legislature.

(2) The plan must be comprehensive, controlling on all state agencies, related directly to budgeting preferably by consolidation of the two functions, and decentralized to regional and local levels for detail and administration.

(3) Regional, fiscally viable general-purpose agencies to prepare regional comprehensive plans of conservation and development, review local plans for conformity to regional and state law, devise and implement regional programs of economic growth and development.

(4) The process to be hierarchical in development, implementation and review.

Efforts toward comprehensive planning in California, and similar work in Florida, Massachusetts, Vermont, Hawaii, Oregon and several other states, demonstrate that many people are no longer content to spend their time endlessly fighting well-publicized but desperate, disconnected battles, when even winning them has no lasting effect on the basic causes which produced them.

Clearly, the time is past when any state or the Federal Government can let the future simply happen. We can no longer afford to let the push of population, the pressure of the market, or the maneuverings of politics-as-usual determine how we live.

Discussion

CO-CHAIRMAN LeRESCHE: Thank you. I will give those of you who have stayed five to ten minutes for questions of these gentlemen, if you have any.

MR. ESCHEM: I am with the Conservation Group in Madison. I have two questions for Mr. Martin.

First: Does a lifestyle as a complement to the Plan apply not only to State land use but also to the native lands? If it does not, what is the status of it?

The second question, is related to the attitude of the native fishermen who suddenly become large landowners, just as with any other real estate selling corporation. In the light of the new and advanced types of communication, have their attitudes toward land use or land disposal changed suddenly?

It was mentioned about underlying land that is going to parks, and everyone seems to think a great deal of money is coming. What is happening? Is it going to be decided by the interests in the native population?

CHAIRMAN LeRESCHE: I will ask Mr. Martin to answer both questions.

COMMISSIONER MARTIN: There is no comprehensive plan on the part of any of the private owners, and I think the tenor of everybody's remarks indicated what was going on in various sectors.

The type of plan that does exist is related to the specific plans for each project that is being undertaken by various landowners. As far as comprehensive and coordinated effort, I think all of us would agree that it is really our highest immediate priority.

With regard to the second question, the attitudes of native corporations have been changed towards land planning. The way the corporations were created under the Land Claims Act was in the profit mode. These are corporations for profit, and they have no choice but to address their shareholders' interests by seeking to maximize profit from resource development rather than offsetting it with other considerations.

MR. ESCHEM: Since the federal law created these corporations and set certain guidelines to provide the profit for these corporations, isn't there any provision they are also advised to have some kind of a comprehensive land-use plan to dispose of those lands so that Alaska does not become similar to Los Angeles as concerns giving consideration to natural resources?

CHAIRMAN LeRESCHE: Mr. Wood.

MR. SAMUEL WOOD: There is no such requirement. The lands are parceled out without any stipulation whatsoever.

Logically that requirement for natives, how they handle their land, should be a derivative from a state comprehensive plan which ought to tell, and which actually would tell, the natives what they have to do in certain areas with regard to their land. In other words, lay down some rules.

I do not see very much difference between the need to control the natives in their communities and in their regions than the problems we have in the United States over regional, city, and county planning efforts.

CHAIRMAN LeRESCHE: Commissioner Martin wants to make one more comment.

COMMISSIONER MARTIN: I do not know if your question reflects an impression that either I, or the panel, might have left with the audience, but I feel compelled to say that I certainly do not feel as strongly as Mr. Wood apparently does about what one of your California residents called "The Los Angeleization of Alaska." I do not think the situation is comparable to that extent. I do not think that we are facing the kind of wasteland situation that you portrayed.

It can be very serious particularly in terms of what is lost, but to state it in those terms overdoes it and mis-characterizes it.

What is really important, I think, is that the natives themselves should not be seen as a destructive or as a necessarily difficult force with which to deal.

There is no doubt that the circumstances will make comprehensive planning difficult, but the point that Mr. Wood is failing to see is that there is a substantial difference between the attitude even under the present circumstances that the natives bring to that problem and the attitude that is brought to it by urban and suburban dwellers in Los Angeles and in other areas.

MR. ESCHEM: I do not wish to monopolize the discussion, but I would like to make a comment on this from what I have learned.

I believe the state has the ability to manage for its own social and economic well-being, utilizing its ecological expertise and combining that with the state and local governments' capabilities for land use.

I believe that land use should be improved rather than to make it like Los Angeles, or Chicago, or other urban areas. It should be described by a specific pattern.

CO-CHAIRMAN LeRESCHE: If I may comment, this has been shown to be the case.

Some of the most sophisticated local and regional aspects in Alaska have been undertaken voluntarily by the Native corporations based upon their basic philosophy about what the land will have to be to them in the future.

I would like to compliment Commissioner Martin on his euphemism. I have always heard it called the "Californication of Alaska."

MR. BUD BODDY [Alaska]: I think all of your panel knows me except the gentleman from California.

I would like to try to clarify a little further the current attitude of the people of Alaska. I have lived there for 36 years. I have had a great deal of association with the Native people particularly during the Native land claims question, and particular now that there is a process of selection.

I think that we have documented evidence that the Native people have a real concern for the land that they are going to own and manage.

I have attended a number of meetings and hearings recently about some of their problems, on their behalf.

We have heard publicly—and this has been stated in the papers of Alaska—that they are going to manage their land with the knowledge that they have under the concepts of state management. In other words, multiple use, or things along that line.

They have also asked and agreed to support legislation which would set forth criteria for management of their lands by the State of Alaska, and this is pretty good evidence that we have some good, hard thinking people up there.

Thank you very much.

Energy Demands, Alternative Sources, and Management Needs

Chairman:
ARNOLD I. JOHNSON
Assistant Chief, Office of Water Data Coordination,
U.S. Geological Survey
Reston, Virginia

Cochairman:
JAMES C. WARMAN
President American Water Resources Association and
Director, Water Resources Research Institute
Auburn University
Auburn, Alabama

Energy and Our National Heritage

Roger W. Sant
Assistant Administrator,
Energy Conservation and Environment
Federal Energy Administration, Washington, D.C.

I would like to begin by quoting from a man to whom much homage is paid, but who is not often remembered as a writer.

Christopher Columbus, in his "Journal of the First Voyage," wrote of the new world that he had discovered that he had "never beheld so fair a thing: trees along the river, beautiful and green, and different from ours, with flowers and fruits each according to their kind, many birds and little birds which sing very sweetly . . . it is certain, Lord Princes, that when there are such lands, there should be profitable things without number . . . "

This sort of description recurs in the journals of the early explorations of America. The sense of wonder and of beauty, of riches beyond imagining lying just around the next headland, or at the far side of the next wood.

Today, we live in a world far distant from that of the explorers, distant in way of life, in outlook, in physical appearance, even though we occupy the very ground on which they walked.

But we live in a world, too, which is shaped by those who have gone before us, and sometimes we are not even aware of the way that they have influenced our present lives.

But they *did* influence us.

The pattern which they set determines the way we live, even today, even in areas as seemingly remote from historical speculation as the current energy crisis.

When we read the words of those who discovered and settled North America; Henry Hudson and John Cabot, Giovanni Da Verrazano and Batholomew Gosnold, John Smith and John Winthrop, one feature shines through their descriptions, no matter how well or how poorly they wrote, no matter in what languages they made their observations. This new land was a land without limitations, a land not merely rich, or fertile, but inexhaustible in its potential. The riches may not have been as manifest as the gold and jewels seized from the Aztec and Inca Empires to the south, but they were no less precious for all of that—space; land; later, as we became able to exploit them, mineral resources; the bases of a national economy.

To the early settlers, the abundance of America was frightening as well as enticing. The new land, by its very wildness, oppressed them. It is no accident that the earliest towns in the English Colonies left no trees growing above their houses for shade. Trees were part of the all-encompassing forest, and only where the forest was pushed back could the land truly be the property of the settlers.

Still, for all of the terror of living on the edge of European civilization, and for all of the evil done in the name of civilization; the enslavement of Africans, the dispossession of the Indians who had owned the land before the Europeans came; the land, and the nation which arose in that land, was a place of opportunity. To the settlers who streamed into the Colonies, and later to the immigrants who came hopefully to the new republic, this place was a second chance, a place to start over again free from the material, cultural, and social circumstances which had seemed to preordain their lives in the "old country."

And the land seemed almost specifically designed to meet their needs. When they depended on seaborne commerce, it provided them with numerous safe harbors. When the railroad made travelling overland more practicable, the interior of the Continent was revealed to contain rich farmlands. As the Industrial Revolution gathered force, mineral riches and streams to provide power for the new mills were seen to be everywhere.

The same was true for energy. At the time of the first colonizations, the seemingly inexhaustible forests provided enough wood to meet all our fuel needs. The Industrial Revolution moved beyond the use of wood and converted to coal, whereupon the United States was found to contain vast reserves of both anthracite and bituminous. Petroleum replaced coal and whale oil, and then found a new use as a power source for motor vehicles. The United States was found to contain this resource too, again in great abundance. It really did seem as though the United States had been uniquely blessed by God with everything necessary for economic growth.

This is not to say that the industriousness of the American people did not play a substantial role in our economic growth, but it was multiplied many times by the favorable material conditions under which the nation had grown. The Swiss and the Dutch, too, were industrious, but their small national population and lack of resources made it impossible for them to assume the world role which the United States had achieved by the beginning of this century.

But if material abundance helped us in our rise to world power, it also had some negative effects on our character as well.

Because of the sheer prodigality of nature here, we became accustomed to thinking that we could run through our resources like a playboy through his inheritance. This was a part of our character as long ago as the beginning of the Republic. When the land lost its fertility, the pioneer packed up and moved on farther west. The pioneer didn't realize that a time would come when there *would not be* a farther west, that he would have to live with the consequences, no matter what. America's resources were inexhaustible, weren't they?

Well, the fact was that they were not. We can no longer afford to squander our resources with the prodigal hand of yesteryear. We are going to have to unlearn the lessons of the past, and learn a lesson that citizens of other, less fortunate lands have learned before us—SAVE.

By the turn of the century it was apparent that we didn't have quite *all* the resources which we needed to exist independent of the rest of the world. Rubber, diamonds, phosphates, and coffee all had to be imported. As the century continued they were joined by bauxite and titanium, molybdenum and uranium, materials whose use had not even been known when the new world was discovered.

They were also joined by materials which *were* produced domestically, but of which the United States had insufficient supplies to meet its domestic need; copper and gold, sugar and petroleum.

Of course it was the last of these, petroleum, which helped to prove to us that our country was at the end of the era of wastefulness. Between the end of World War II and the imposition of the Arab Oil Embargo in 1973, our annual rate of growth in energy consumption was between 4 and 5 percent, but the rate of increase in our domestic energy supplies was far less. As a result we came to import more and more of our energy from foreign nations, mostly in the form of petroleum.

At first this system seemed to work well. Since it was cheaper to produce oil in overseas areas, our energy prices began to decline. Between 1960 and 1965, our real energy prices dropped by 3 percent. From the 1965 to 1970, during the years when the United States for the first time became a net oil importer rather than exporter, the decline in prices was even greater—8 percent. Finally, the three year period from 1970 to 1973, real energy prices dropped by an almost incredible 9 ½ percent.

But we could not live forever in this lotus land of cheap energy, and the Arab Oil Embargo brought home to us just how dangerous reliance on foreign energy sources could be.

For the first time we had to realize that relying on other nations for our energy supplies left us open to their manipulation of our foreign policy.

Following on the heels of the embargo came the decision of the member nations of the Organization of Petroleum Exporting Countries to unilaterally raise the international price of oil to better than three times what it had been before the embargo. This action, and the economic results it produced in the United States and around the world proved to us that foreign policy dangers were not the only ones we faced from energy dependence. In fact, they were not even necessarily the greatest dangers.

So it is obvious that we must break free of our dependence on foreign energy sources. We must develop our domestic resources as much as is feasible, and at the same time we must curb the runaway growth of energy consumption which has characterized the postwar period in America.

Now neither development nor conservation *by itself* can free us from energy dependence. We need a carefully thought out and planned program that combines both approaches to our problem.

But it is obvious that to the extent we can stimulate energy conservation, this will reduce the amount of energy demand which will have to be met from domestic development. Moreover, it will buy us time to decide the best, and least ecologically damaging ways to produce resources, and to develop new and non-polluting domestic energy sources.

But that brings us to a consideration of the dilemma which we in energy conservation face, and which makes it so important for me to enlist your support in the fight for conservation.

At this time, we have passed, or are about to get passed, every major piece of conservation legislation that we or anyone else has been able to devise. Conservation in automobiles and in appliances, in industrial processes and in building construction and maintenance, state and federal programs, incentives to the homeowner to insulate, even direct grants to the poor in order to encourage them to practice energy conservation; all have been, or shortly will be, enacted by the Congress.

And the savings which these programs will produce can be substantial. We estimate that by 1985 they will reduce energy demand by a full 14 percent.

But many have said that the potential energy savings from energy conservation are 50 percent of our current consumption! How much more of this potential saving we achieve in addition to the 14 percent we are projecting will depend on millions of everyday decisions in the lives of all Americans. And that is why you can play such an important role in our efforts.

We have found that a consensus of opinion prefers energy conservation information to come from consumer groups and utilities, well ahead of the government.

If you can get the message across to your members that this commitment to energy conservation is vital, you can help create the climate of opinion that is essential if we care to take advantage of the potential for conservation which exists in this country.

In doing so, you will not only be acting in the foreign policy or economic interest of the country, you will also be acting to preserve the environment in the most direct way possible and saving money for consumers.

What we do with respect to energy conservation is going to set the stage for what we do with *all* of our natural resources. It may well be the most basic decision which we will make in the environmental field.

Energy conservation is the most direct way possible to deal with environmental pollution. It is obviously simpler to deal with pollution by not creating it in the first place than by creating it, then trying to clean it up. The extent to which we conserve rather than consume energy is thus one important measure of the extent to which we will be able to preserve our wild lands.

There is also an important economic consideration. The United States only has a limited amount of capital to invest in all of the worthwhile activities which it should perform. Investments to conserve energy are generally much more attractive than investments to increase supply and they ought to take first priority. I also might add that with the rising price of energy in all forms, it will also provide solid savings of personal income for all of your members who practice it.

Finally, but most important of all, perhaps, there is the psychological effect of energy conservation on those who practice it.

But in all of these ideas, my dilemma is only slightly diminished. The bulk of the potential is still there, and I'm open to ideas as to how to get it.

I think I have made rather clear the effects of the myth of endless abundance as it determined our attitude toward our natural resources and toward our land itself.

If we can break away from the mentality which has afflicted us, if we can learn to consume less and make better use of our resources, then I feel that we can also apply this realization that less *can be* more to our habit of despoiling the land.

I have spoken a good deal today about the unfortunate aspects of our ancestors' heritage to us. But they left us one priceless legacy, the confidence that as Americans we can achieve what we wish to. So I would ask you to join with us in the government to see that we *do* overcome the energy crisis we face today, and that we make this country all that it should be for all Americans.

Discussion

DR. EUGENE ODUM [University of Georgia]: When we talk about conservation in relation to the citizens, as we often do, we run into this problem—and it may be short-term—that, as people conserve and turn their thermostats down and insulate houses, the utility companies raise the rates because they are programmed on growth. In turn, people get discouraged and ask, "What difference does it make?" They say "it still costs me the same or more even though I am using less." Do we have a possible solution to this?

MR. SANT: The problem is a short-term one. In the long-term, of course, conservation will dampen growth and we will not require as many facilities to be put in.

What happens is that the plants are in place. Therefore, lower power usage has a tendancy to increase cost per kilowatt hour.. As a result, the utilities are going to want to charge more.

As I say, this is a short-term situation because when they find out, let us say, two years from now, they don't need another new plant or five years from now that they don't need another two new plants then, in the long run, consumer costs will be lower.

I have not yet found a way to answer that question simply.

But, the consumer is right. He says, "When I do the right thing, I get hammered for it." I wish the utility commissions would be a little more farsighted or take a longer view in looking at rate adjustments resulting from conservation. However, for the moment, this a short-term problem and, therefore, I'd hope that we could minimize the consumer's discouragement.

CO-CHAIRMAN WARMAN: What is the possibility of proposing a tax on all sources of energy as a conservation measure? You spoke, for example, about the tax structure in Europe, and also the possibility or probability of a tax within the United States. Do you wish to comment further on that?

MR. SANT: To my way of thinking, it is a long way off.

The practical possibility of putting a tax on all forms of energy, given the current political make-up, my view would be that it will be a long time before we get there. Perhaps that is understandable, at least until we have done all of the things we can do in other conservation measures. It will be then that we will have to begin looking at taxes.

Nevertheless, I have heard rumblings lately about people being interested in energy taxes because it has become apparent that the sources of supply that we have traditionally used are becoming harder and more expensive to get. They also have more environmental problems associated with them then we ever dreamed of.

So, I don't know, but I just think it is only a matter of time before it becomes apparent to everyone that we are going to impose an energy tax in order to dampen the rate of growth.

I just want to make one other comment. Hudson and Jorgenson in their study of the economic aspects of energy conservation, found that by the year 2000, their zero energy growth scenario only reduced the gross national product of the country by a nominal amount and yet reduced the total energy consumption by 46 percent.

This approach is something we are going to have to consider in order to preserve what little supplies we have left and to preserve some options for the future.

MS. POLLY DYER [University of Washington]: In our part of the country there is some talk about reducing the cost of the electricity to the person who uses it the least and by the same token, increasing it for the one that uses it the most. Would you comment on that?

MR. SANT: Inverted rate proposals have been talked about for awhile. Let me just say, however, that I have some personal problems with that.

I think the closer we can get to charging the real, marginal cost of electricity to the consumer, the better off we will be. Beyond that, I believe we ought to consider using a tax, as I have indicated.

The lifeline proposal, which essentially, would provide to everyone a certain number of kilowatt hours or natural gas therms at a low rate and then increase the rate substantially after that is more attractive to me than an inverted rate. I would like us to provide a certain amount of Btu's without price penalty. From then on, we would all pay through the nose.

In fact, of course, that would be inverting the rate because an average per unit just keeps moving up in cost. I believe several rate schedules like that will be developed and experimented with. As a matter of fact, some of the demonstrations we are running in FEA right now are looking at that concept and we will have enough information within the year or two to set some guidelines.

MR. JOHN VanDERWALKER [U. S. Fish and Wildlife Service]: I wonder if you could comment about some of our investments in relation to off-shore exploration. In other words, about the production equipment and the fact that it is taking a great deal of capital to go deeper and deeper for oil and we are investing our energies essentially in a dead-end street.

MR. SANT: I agree with that. It seems to me that what you just said is absolutely right—costs will get higher and higher. When we look at solar energy, for instance, there is enough solar radiation to handle all our energy needs. However, the problem is that it is not so much just capital cost, it is total cost to the consumer.

For example, I was reading an article about solar satellites and that, you know, has been talked about for some time. Right now, if their estimates were right and if we could do it technically, the cost of electricity from that source would be twice as much as that of New York City or, say, twelve cents to fourteen cents a kilowat hour. What I was suggesting is that the energy problem is one of being able to pay for those new sources.

It is not so much that we will run out of energy. We will run out of cheap energy and all of our traditional sources of energy, but there are others that are available, if we can afford them. This, of course, is becoming a bigger and bigger problem.

Net Benefits to Society from Alternative Energy Investments[1]

Howard T. Odum
Department of Environmental Engineering and Center for Wetlands, University of Florida, Gainesville

As energy resources for the economy of man begin to be limited and as more and more impacts of man's economy on the environment develop, procedures are needed for evaluating choices as to which energy sources are valuable and which environmental management plans are valuable. Since the economy of man and the economy of nature both run on energy, energy evaluation can be used to determine relative contributions of energy sources and environmental systems. This paper summarizes the way energy evaluation using energy quality factors gives us insight to which are best net benefits to society and to nature.

The interplay of environment and economic systems of man form one system to which many energy sources contribute. Sunlight, winds, waters, waves, tides, etc. come regularly from the renewable flows of the earth. Fossil and nuclear fuels flow through the technological part of the system mainly from unrenewable sources. One way of visualizing the combined actions of the many sources is as a large wheel (Fig. 1). Energies flow in from external sectors, become part of the circulating matter and energy within the economy of man, do work gradually as the energy flows around the economy, are released as used energy, and finally pass out as dispersed heat. In each case some part of the circulating energy of the main economy reaches out to engage the external energy source. Energy is pumped, captured, and processed to the economy with feedback interactions. Although Figure 1 can be thought of as an analogy, the symbols used are those of the energy language, and the same diagram is correct for an economy, for a wheel, or any other system. For more on energy analysis, diagramming and evaluations, see book summaries (Odum 1971, 1976).

To visualize the way energies are combined and gradually released, imagine Figure 1 as a rotating wheel with many people giving it impetus with their hands. Each hand contributes some momentum although the rotating wheel receives and stores the energy letting it go against friction gradually over the whole circle of the wheel.

Money flows as a counter current to energy making a closed circle within the economy. The action of supply and demand on prices helps to even out the distribution of energy around the wheel. Wherever some limiting factor develops in the circle of exchanges, prices rise, and that sector speeds up. In the wheel analogy as in the real economy the value of incoming energy is not recognized locally by money exchange or prices until the energy has been absorbed into the circulation that is shared by the whole system. Money paid for bringing in energy from the outside is not paid according to the energy content of the

[1]Work supported by Contract E-(40-1)-4398 between the Energy Research and Development Administration and the University of Florida.

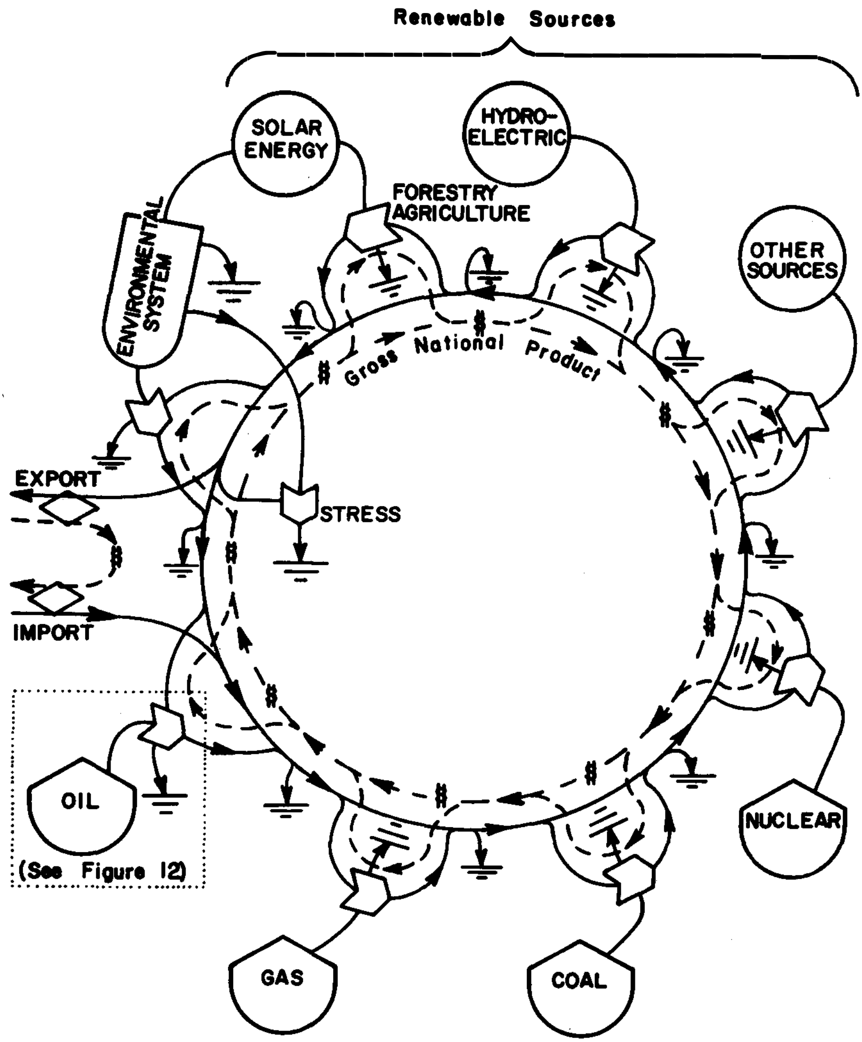


Figure 1. An energy model of the United States for examining the sectors concerned with inflows of external energy. Energy circulates counter clockwise and money clockwise.

inflows, but is paid to and is in proportion to the feedback energy from the main circle of the economy.

In each sector that brings in energy from the outside there are feedbacks of energy from the main circulation to do the work of processing. In some cases much energy is feeding out to interact with the incoming energy; in other cases very little feedback energy is required.

One question facing a country in times of energy shortage is which of the sources impinging on the economy wheel are supplying much energy and which are supplying little or draining energy? Which of those sources impinging on the economy are taking back out of the energy circulation more energy than they deliver? Which of the energy sources have more net energy?

Figure 2 shows three flows in the external sector, like those shown in Figure 1: external energy inflow, feedback of work from the main economy to the point of processing interaction, and yield of energy being pumped from the interaction into the main economy. This diagram may be used to define net energy and identify which energy sources are rich. If the feedback energy that is required is less than that yielded the source is a net energy contributor. Such sources are defined as *primary sources*. If the yield is less than the energy fed back, the source is using more than it contributes. It is partially a consumer. It does contribute some energy. Let us call such sources, that are without net yield of energy, *secondary sources*. To evaluate energy contributions of different types, energy quality is important.

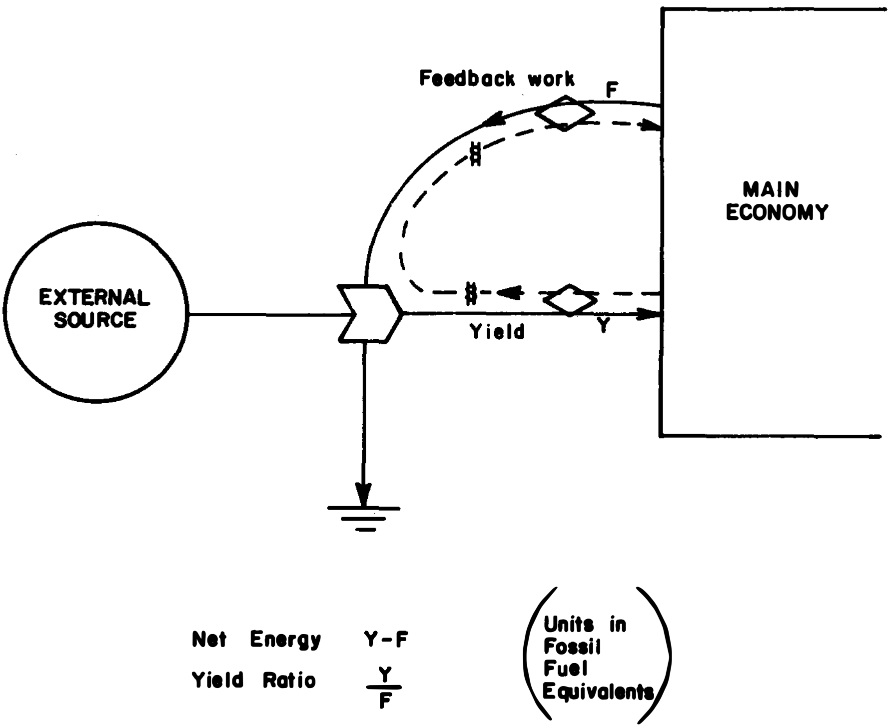


Figure 2. Energy flows where a feedback from the main economy (F) interacts and facilitates an inflow of energy from an external source. The feedback F includes some energy of Y that has made the cycle through the economy and is returned. A good primary source is one that has a relatively small return relative to the yield.

Expressing Energy in Units of Similar Quality

In a chain of energy transformations such as a food chain or a chain of successive steps in manufacturing in a human occupational chain, the final product emerging after successive operations gains quality. With more energy used in developing high quality products comes increased abilities that the product has for feeding back as an amplifier in doing work elsewhere in the system. The increased value of the high quality production in stimulating other work is a justification for the energy spent. It is proposed that the quality of the emerging product down the chain is measured by the energy that must be used to develop the product without waste.

For example, when the energy of the sun passes through the food chain from plants to animals and so on to top carnivores, the calories increase in their cumulative energy cost. The utility of the species to the system is believed to increase also. If value did not increase, it would not pay the surviving systems in their energy economy to provide for such high quality units. The calories of sunlight which produce a calorie of carnivore are a measure of the quality of the carnivore expressed in units of solar equivalents. For example, the ratio might be 20,000 calories of sunlight per calorie of lion.

For another example, coal generates electricity through a power plant and the calories of coal required to generate a calorie of electricity is the energy quality factor. The ratio is about 3.6 calories of coal per calorie of electricity (including coal used directly and indirectly in support of goods and services).

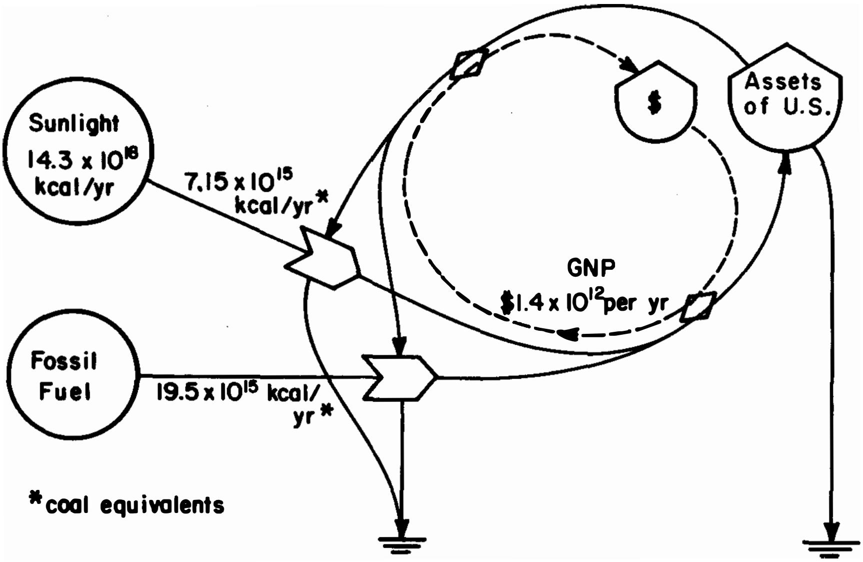
More on the theory of energy quality is given elsewhere (Odum and Odum 1976), and energy quality factors have been estimated for many transformations. It is an important part of the theory that the process be measured for its quality factors under conditions of the real world in which there is some competition and after some time in which maximum power and minimum waste may have been achieved.

To allow comparison, the energy flows in consideration of net energy (as in Figs. 1 and 2) have to be expressed in energy equivalents of the same quality, such as solar equivalents, lion equivalents or coal equivalents. The idea is to have numbers that truly represent comparative ability to do work. The feedbacks of energy from the main wheel of the economy include high quality flows such as technology, information, human services, and computer work. The energy that generated those flows already went into used heat. These flows carry the value, however, which is that of the energy it would take to replace them.

All energies can be converted 100 percent into heat, but calories of heat equivalents do not measure the energy required to develop a flow or the energy effect of that flow as a multiplier. Instead that flow is multiplied by energy quality factors converting the numbers that are to be compared to energy values of the same quality. In much of our work we use energy quality of coal mined and delivered at a point for use in heat engines as the common type of energy into which other data are converted. These are defined as coal equivalents. Evaluations of net energy, yield ratio, and other comparisons are made in units of coal equivalents.

Work of goods, services, labor and information are often omitted in energy analysis because they are not recognized as energy intensive. They have high values of coal equivalents and are very important. Figure 3 shows the average

1975



$$\frac{\text{Total Energy Flow}}{\text{GNP}} = \frac{26.7 \times 10^{15}\ \text{kcal/yr}}{1.4 \times 10^{12}\ \$/\text{yr}} = 19{,}000\ \text{kcal coal equivalents per } \$$$

Figure 3. Diagram indicating the flow of gross national product and the energy flows from fossil fuels and from natural renewable environmental sources. These flows are used to calculate the ratio of Kilocalories of coal equivalents to the dollar. The ratio is used to estimate the energy flows that are responsible for money flows in the general economy.

relationship of circulating energy and circulating money. Like Figure 1 it gives the reader an aggregated overview of money–energy relationships. Notice that renewable free, solar energies of nature contribute 28 percent of the energy for the economy when expressed as coal equivalents. To evaluate primary energy sources we evaluate in coal equivalents the ratio of energy yielded to energy fed back to get the energy. This is defined as the yield ratio. A synopsis of yield ratios for different energy sources follows.

Solar Energy.

When absorbed and transformed into heat, solar energy develops small gradients of temperature in solar water heaters or in daytime heating of the landscape. About 1 calorie of coal equivalents is generated per 10,000 calories of low temperature heating. If efforts are made to collect this energy by using solar technology such as solar cells, plastic and glass devices, the energy used in developing and maintaining the equipment is far greater than the solar energy collected. There is no net energy.

Net energy is generated by the biosphere from sunlight by developing wind from small temperature gradients, but it does so without energy-expensive installations.

Solar hot water heaters are secondary sources, but not very good ones as discussed below.

Solar energy when absorbed in photochemical processes of plant photosynthesis develops about 1 calorie of coal equivalent per 2000 calories of sunlight. This energy delivers net energy in subsistence agriculture with a yield ratio of 1 to 2 calories yielded for each one fed back by the farmer. Modern industrial agriculture may feed back as much as 10 calories per calorie yielded. In modern technological agriculture, the sun is not a net energy source but is a secondary source. Agriculture is a consumer with some energy contribution.

Coal

Coal requires energy to mine and energy to restore lands, and energy flows of nature interrupted by the mining have to be included as an inherent cost. Ballentine (1976) found yield ratios 4 to 36 depending on the distance of transportation and the type of distribution. If coal is transported two-thirds as coal for heating and one-third as electricity for use as electricity as in our current economy, the ratio of yield to feedback (both in coal equivalents) is about 6 to 1.

Oil

At the present price of oil, our economic exchange sends back to oil-supplying countries about 1 calorie coal equivalent of energy for 6 calories of oil yielded and refined. Whereas a rich deposit of oil near the surface yields oil with a yield ratio of 50 to 1 or more, deposits like this are mainly gone from the U.S. One field in Hendry County Florida for example is yielding 10 to 1 (DeBellevue 1976). The U.S. oil that has been price regulated at $6 per barrel has to yield 13 to 1 to be economic. The rapid rise of percentage of foreign oil shows that the quantity of such high yield ratio oil left in the U.S. is apparently not large. One estimate of oil from the North Sea showed almost no net energy. If oil prices by oil supplying nations are adjusted upward at the rate of inflation, the yield to the U.S. will tend to reamin at 6:1, the present ratio that is the basis for much of the U.S. economy. If refining is included the yield is 10 percent less.

Gas

Because it has been obtainable with so little cost, natural gas has been a very rich source with a high yield ratio and it is a high quality of energy. However, it has been used as a low quality energy in many uses. As the United States is now running out of gas, it is losing its richest net energy. As the country falls back on energies with a lower yield ratio, the activities outisde of energy procurement will have to decrease.

Nuclear Energy

When all the energy used cumulatively by the Atomic Energy Commission and all other inputs to nuclear energy are calculated, one finds there has not yet been any net energy from nuclear energy. It was mainly running on fossil fuels in its early years. When one power plant was considered through its full lifetime and fuel traced through the whole energy transformation chain, Kylstra and Han (1975) found a 2.7 yield for one fed back, much less than the fossil fuels of oil and coal now being used. If a major accident occurs and the energy losses of the disturbed area are subtracted, a lower yield ratio results. If these estimates are correct, nuclear energy may not be the preferred energy source; less economic vitality is possible with nuclear energy than with current fossil fuels.

Fusion and Breeder

Until actual operations are functioning (if they become practical), yield ratios cannot be calculated. The difficulties and costs of reprocessing byproducts of the breeder process back into fuel rods may make the yield ratio of the breeder low. Fusion may be too hot to yield net energy since so much energy must go back into controlling and reducing the temperature for coupling to the world of humanity. We don't know the outcome, but one suspects there may be no net energy.

Geothermal Energy

Where high temperature gradients exist as around volcanoes, geothermal steam power plants may yield 50 units to 1 unit that is fed back (Gilliland 1975), but the number of such areas is too small to be important for the United States as a whole.

Tide

Tidal energy as harnessed at La Rance, France yields 14 to 1, but the tide there is 20 feet on the average. Tidal energies are already important in our estuaries in maintaining fishery production, water cleansing, and transportation. Subtracting the energy of the tide would lower these values, and the net energy calculated overall would be less.

Oil Shale

The energy spent on the U.S. government test plant at Anvil Points, Colorado, was 80 times larger than the yield. There was no net energy. Whether test operations tried since are any better is not known, since the data are not available for public examination.

Wind

In most areas of the United States, wind speeds are low and erratic. Wind energy is dilute energy in these areas. If cheap materials are used and devices are simple, the wind may be used to pump water. However, electric wind mills have so much energy cost concentrated in them that they do not yield net energy when the wind is 10 miles per hour.

There is much yet to do in evaluating energy alternatives, but the work so far suggests that the sources available to the U.S. are mainly those of about 6 to 1 yield ratio. In a recent report to Congress (Odum et al. 1976), external inflows of Figure 1 were evaluated with net energy calculations of representative examples. A general summary was given in a new book (Odum and Odum 1976).

If the economy has been level since 1973 with this kind of energy availability, we should expect a fairly level economy for the immediate future since the net energy of sources is not expected to increase beyond a yield ratio of 6 to 1. In the long run, barring some new source or a better yield from fusion than expected, the net energy of the world and sources available to the United States will decline, and the economy will have to do less. The yield ratio provides a clear measure for choices about energy source alternatives.

Secondary Sources and Energy Investment Ratio

Evaluating secondary sources is done by comparing the feedback energy (F) with the inflow energy flow (I) being used (See Figure 4). The following theory is proposed. Natural energy that is free attracts investments of money or direct effort that bring in energy directly and indirectly from the main economy into interaction with local sources. For example machinery and fertilizer interact with sunlight in agriculture. For another example, tourists and their economy interact with natural areas to which they are attracted. The ratio of F to I is defined as the *Investment Ratio* where both are given in coal equivalents.

A secondary source is believed to be economic when the ratio of energy fed back is no more than competitors are using. Where both flows are expressed in coal equivalents, the typical ratio of purchased, fossil-fuel-based energy is about 2.5 to 1 of natural free energy.

When much more energy is used than 2.5 to 1 as in solar technology, the process is regarded as uneconomic. In contrast successful economic investments are those where purchased energy flows are brought into interaction with large natural subsidies of energy of sunlight, wind, and rain, and the investment ratio is small. Some evidence that low ratios stimulate growth are the counties of

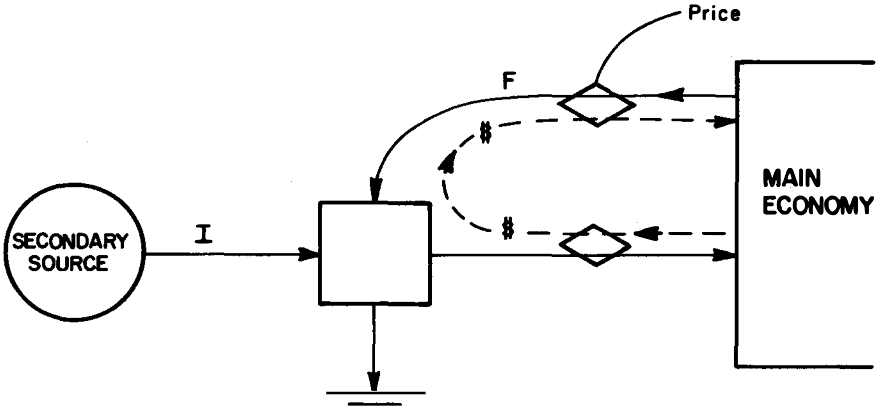


Figure 4. Money flows that are assoicated with energy investment in a secondary source. A secondary souce is economic when the contribution of the free external secondary energy I is larger than for competitors, when F/I is less than 2.5. F/I is defined as the investment ratio where F and I are expressed in units of equivalent quality.

southwest Florida which are undeveloped ones with lower investment ratios than Miami, for example.

Theories of low investment ratios favoring relative growth are believed to apply only to periods when the overall economy is not growing. When growth is rapid on rich energy sources, the areas that are ahead in growth can grow faster and out compete other areas even if they have lower investment ratios. As soon as growth levels, the advantage goes to those of lesser density and there follows a redistribution of invested energy flowing in from outside.

Evaluating Environmental Technology with Energy Analysis

Interactions between the main economy and the environment are part of the means for harnessing the secondary sources. Projects to develop environmental interactions need not yield net energy, but they must have a low investment ratio insuring a good return in conservation per unit energy brought from outside. Investing energy helps the economy when as much environmental energy is enlisted as would be the case in alternative investments.

In recent years laws for protecting the environment have not provided examination of the energy involvements. Some propositions such as tertiary treatment of sewage and cooling towers have very high energy investments relative to the area of natural energy being utilized or being protected from loss. Like solar technology, these solutions are poor energy uses. For conservation to be effective, the energy involved could protect or utilize as much as other investments of energy.

The economy of man and nature is a combined one, and poor uses of the energy of the main economy detract from the energy that might go into other conservation endeavors. Conservation like other activities serves and competes when its energy investment is effective. Where energy of the environment is well utilized in symbiosis with the energy fed back from the economy, the ratio may be closer to the average (2.5) or less.

It is proposed that the investment ratio is usable for estimating carrying capacity of an area for economic development, for evaluating projects that are supposed to stimulate the economy, and for evaluating environmental protection projects that are supposed to protect the environment.

Examples of Environmental Technology Which Are Poor Conservation Measures and Uneconomic

Many environmental protection measures propose very expensive technology that directly and indirectly draws energy in large ratio from the main economy. At Crystal River, Florida, Odum, Kemp, Smith, McKellar, and others (1975) found that a proposed cooling tower would have an investment of 100 coal equivalents from the main economy for each one coal equivalent of estuarine value saved. The investment ratio (100 to 1) was far above the 2.5 to 1 which we suggested was usual and economic.

As Figure 3 shows, any flow of money causes energy to use 72 percent from fuels and 28 percent somewhere from the environment that supports the economy with life support work. At Crystal River, with investment of 100 units, 28 units of environmental value are being drained elsewhere to protect one at the site. If this theory is correct, the environmental technology is hurting the environment and is in violation of the laws that cause environmental technology to be constructed in the first place.

Another example of environmental technology with very high investment of energy without much value for the environment is tertiary treatment by technological means. A value of 1800 to 1 was obtained by dividing the energy flow that goes with money flow by the energy flow of the land displaced. Since nutrients and water are usable as positive resources by most ecosystems, release of such wastes can be a resource. Little environmental protection is gained from eliminating these wastes technologically. There is a preferable way—developing domestic ecosystems as interfaces between economic activity and the environment.

Ecological Engineering of Interface Ecosystems

Self designing ecosystems can be allowed to adapt to wastes that are released in some dilution. Examples are the cypress swamps into which secondary sewage wastes are being added at 1 inch (2.54 cm) per week in Florida (Odum, Ewel, Mitsch, and Ordway 1975). The ratio of purchased energy to energy flow of the environment is not far from 2.5 and thus may be in the economic range for the investment ratio. The ecosystems that develop in adaptation to the special waste outflows develop species that can use the wastes with less stress and more as a resource than those that may have been replaced.

Energy Evaluation of Wildlife

In many decisions, direct evaluations are needed of wildlife. The energy value of a wildlife species may be estimated by diagramming the position of the species in a network diagram using energy language and showing the energy of nature and of humanity that impinge on its food chains and contribute to its protection. By estimating the solar equivalents required for the steady maintenance of a calorie of that species and using an energy quality factor for calories of sun to coal of 2000, one may estimate the coal equivalents required to maintain the species. The higher up the food chain, the more valuable is a species and the higher the cumulative energy used in its development. Theory suggests that the energy values indicate the importance of the species work to the ecosystem in generating value as an amplifier. Some higher animals have higher quality factors than electricity.

Endangered Species

When a species is endangered and the ones being evaluated are the last ones existing, the energy value may be estimated as the energy used for redeveloping the species by repeating the evolution or repeating genetic breeding artificially. One is evaluating the gene pool and the means for using the population later. This approach involves multiplying times like 10,000 years times the energy flows of larger areas. The energy value can be very large.

An alternative approach to evaluating endangered species with energy is to estimate the area of suitable habitat which might be prevalent if the world returns to a lower energy based more on renewable energies. Then the higher animals that were important in the ecosystem's own self management may cause it to produce more with its adapted animals than if they were extinct. For example, in Florida, Carolina parakeets and ivory billed woodpeckers were managers of seeds and insects respectively in the heavy cypress forests that were cut early in the century. These forests are partly grown back now and the acreages are large. If the birds caused higher productivity (gross production), then the amplifier value of the last ones would be the energy value of the increased productivity of the habitat over its whole range, a very large figure.

Trends for the Future

As energy sources decrease, the investment ratio that will be competitive will decrease also. The world ratio is only 0.3 to 1. Purchased energies will be used less and less and more and more scrutiny should go into getting a low ratio. Since there is net energy in subsistence agriculture—perhaps as much as in nuclear power, we need not fear the future of lower energy, but many propositions for development with public funds need to be scrutinized for their yield ratios and investment ratios. Private projects can be evaluated to determine if they are economic also. The energy analysis ratios (yield ratio and investment ratio) can be used to protect many resources that have high indirect energy contributions to the system of man and nature but are not evaluated in money cost-benefit procedures.

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Discussion

MR. JOHN CLARK [Conservation Foundation]: I have two questions which are somewhat related.

In relation to the Ganges River anecdote, first there is the problem that the cooling tower, for example, is there to protect the natural amenities and is not an energy source. I wonder how you figure that in?

Secondly, you are transforming energy from one source to another when you produce that heated water. It may be, for example, as dilute as the sun and it may be much more dilute than the other energy operations going on in the plant. It seems to me that there is a tremendous energy resource available which we are throwing away.

How do you relate those two?

PROFESSOR ODUM: Energy is never not used. It is a question of who uses it and how. For example, if you divert the Ganges River water, you shift energy from one source to another and you may then realize, after you have done this, that it was doing a lot of work for you.

Environmental impact should be measured after the system is redesigned and as to what it is going to do to match it. Survival of nature, and man is a part of nature and custodian of the biosphere, whether he realizes it or not, is dependent on the economies of man making sense with nature or otherwise there will be political circumstances in which conservation takes a beating.

Therefore, in totality here, you have to maximize the total energy of the combined pattern of man and nature for it to survive, meaning, of course, that in order for man to survive, his economic system must be in tune with that of nature.

If you were to set up something that isn't economic but political, then nature loses out in the long run because it gets defeated in the decision process. Therefore, we have to combine and maximize the combined power of the two in harmony so that both survive.

Meeting the Challenge of Future Energy Development

F. Eugene Hester
Associate Director, Environment and Research, U.S. Fish and Wildlife Service
Washington, D. C.

The national program for intensive future development of our energy resources presents us all with a challenge. It is not only a challenge perceived by us at the Fish and Wildlife Service; it is a challenge presented to all agencies and levels of government concerned with resource development and environmental protection. It is also a challenge to all those in the private sector concerned with habitat protection and safeguarding the natural environment—hunters, fishermen, conservationists who have been in the vanguard of the environmental movement, as well as the many others who may not fully comprehend how they benefit from preserving the Nation's living resources. It is not a challenge in the hostile sense, but rather, it represents a constructive opportunity for us to develop a realistic strategy directed towards proper implementation of and coordination with the national energy program.

By virtue of our legal mandates and our established mission of ensuring the American people of future enjoyment of our living resources, we see an important role for the Fish and Wildlife Service. Our responsibilities, both explicit and implicit, extend to active cooperation with and support of the many groups and agencies concerned with conservation. In the next few minutes, I should like to talk with you about our organization, function and strategy related to energy development and to point out how it should facilitate meaningful interaction among all of us in the field.

The Energy Program

Energy development is clearly a major part of our current national policy. National focus on energy is evident in such policy decisions as the launching of Project Independence. In announcing a 10-year energy program, President Ford called for the development of: 200 major nuclear plants, 250 major new coal mines, 150 major coal-fired power plants, 30 new oil refineries, 20 new synthetic fuel plants, and thousands of new oil wells. In such a program of intensive energy development, there is inevitably a high potential for adverse environmental impacts.

Whatever the source of energy, its development necessarily involves the conversion of large land areas to extraction and processing, and environmental threats are inherent in the by-products. Terrestrial animals, already under pressure from expanding human population, can be displaced, their breeding places disturbed, and their feeding ranges and migratory pathways denied. Energy production is a large consumer of water for power, cooling, and waste disposal. Waterways can be tapped to the point where even the minimum quantities of water necessary to sustain resident populations can be diverted to the demands of energy development. Cumulative effects of energy development require particular consideration. The vegetation, atmosphere, and water quality on which fish and wildlife depend can receive heavy pressure throughout an entire region, as fuel-rich regions are increasingly mined and as processing and power plants congregate around fuel sources, and centers of water availability.

It is significant, too, that the program for energy development probably represents the trend of the future. The "energy crunch" was dramatized not long ago by lines at gasoline stations and, currently, by incipient fuel shortages. Concerted efforts to expand production from American mineral resources in the near or mid-term future are clearly indicated. More extensive and intensive development of domestic sources will be necessary as the higher yield and readily exploited mineral deposits approach exhaustion.

Fish and wildlife values cannot be preserved simply by a blanket opposition to energy programs. Without full awareness of the national need for energy and its role in American life, conservation forces could lose many of the gains of the last few years. As the basis of the industrial revolution, energy transformed the Western world from struggling agrarian societies into the developed nations that we see today. The high living standard that Americans, in greater and greater numbers, have come to enjoy rests on an abundance of relatively cheap energy. There is no way that the real income of U.S. citizens, measured in terms of average worktime required to purchase food, clothing, and shelter—not to mention luxury items—could survive in a hand-powered society. Thus, in the long run, it seems inevitable that energy needs will be met to the limit of the Nation's capability. This does not mean, however, that we must abandon our interests or concerns for preserving the fish and wildlife resources and natural ecosystems that are so important to all of us here.

The energy strategy of those concerned with environmental protection must be based on anticipation and participation rather than reaction to energy development. It is important to take part in the planning phase so as to diagnose the potential environmental consequences in time to influence the selection of favorable alternatives. Environmental interests are at a disadvantage in influencing energy development if they become active only after a decision is essentially made. It is easier to influence decisionmaking and to divert adverse impacts by getting into the process while numerous options still exist, not when the only alternatives are "STOP" and "GO."

The Fish and Wildlife Service Program

Fish and Wildlife Service activities in these rapidly developing energy areas are mandated by several laws including the Fish and Wildlife Act, the Fish and Wildlife Coordination Act, the National Environmental Policy Act, the Endangered Species Act, and the Marine Mammals Act, as well as memoranda of agreement with other agencies and Executive and Secretarial Orders. We are approaching our role in these new areas with a new activity called the Biological Services Program, and by strengthening our existing capabilities in Ecological Services, Research, and Endangered Species.

Most of you are very familiar with our traditional programs so I will not delve into the specifics of them here today; instead I want to spend a few minutes discussing our new thrust—Biological Services.

The Biological Services Program of the Fish and Wildlife Service is organized into project areas, most of which are energy related. Project areas are designed to address the problems of each major energy source. Major energy oriented projects deal with coal, oil shale, and geothermal energy, power plants, Western water allocation, coastal ecosystems, and the Outer Continental Shelf. Functionally oriented activities, such as habitat classification and assessment provide tools, methodologies, and data bases useful to all the energy related projects. Information transfer activities support and draw together the outputs of all project areas.

A focal point of the program, which includes active participation by the Fish and Wildlife Service both in Washington and its field offices, is provided by the newly created Office of Biological Services.

National teams, strategically located on a geographic basis to supplement the efforts at headquarters, are focal points for scientific expertise on the ecological problems associated with energy development.

We have established four teams, each composed of a skill-mix of indepth capability in the various subject areas. They diagnose and address problems, oversee outside contracts, and provide continuing support to the operating personnel of the Service concerned with environmental decisions in the field.

These teams are the Western Energy and Land Use Team at Ft. Collins, Colorado; Coastal Ecosystems Team at Bay St. Louis, Mississippi; Power Plant Team at Ann Arbor, Michigan; and Stream Alterations Team at Columbia, Missouri.

The expertise in these teams is also available to provide ad hoc assistance to other federal agencies and state fish and wildlife agencies.

At the regional level we have established a cadre of operationally oriented people, called regional energy activity leaders. They have responsibilities similar to those of the teams, but stressing the identification of regional problems and implementation of findings from special studies.

Specific Biological Services studies are intended to provide a broader information base and improved techniques for presenting ecological values in the selection of options. In this way, they are directed to more effective decisions regarding energy development that will avoid or minimize potentially adverse impacts on fish and wildlife and on ecosystems in general.

A major program thrust centers around habitat classification and assessment which as we all know is basic to protecting fish and wildlife values. This activity will provide a basis for inventorying available resources and a methodology for determining the relative significance of these resources so that priorities may be set and the strategy for preservation developed. The Service is in the process of implementing a comprehensive program that will integrate ongoing work in classification and inventory, inhouse as well as in cooperation with other agencies, such as the U.S. Forest Service, which has a mandated responsibility to develop an inventory of natural resources.

This program begins with development of a comprehensive and uniform system for classifying habitats, both terrestrial and aquatic. The system will provide a framework within which specific data bases can be referenced and developed for use in habitat analysis across the diverse ecosystems of the United States. It will include not only a unified set of standards and procedures for habitat classification, but also appropriate procedures for assessing the value of habitats as a logical extension of this classification. The products of the program should greatly simplify and expedite the way in which environmental impact assessment is generally conducted at present—not only within the Fish and Wildlife Service, but by all agencies concerned with ecological protection.

The Three Arms of the Strategy

Our challenge, then, is to achieve effective decisions about meeting the national need for energy, while at the same time protecting America's fish and wildlife. Our strategy is based on recognition of three requirements: We must have sound information; we have to present it at the decision points in the right form; and we have to take part actively in the decision process. Accordingly, the Service is working to meet the challenge in three areas: information development, information transfer, and direct support to decisionmaking. In all three of these areas, we see ourselves interfacing actively with other participants in wildlife management and conservation. I would like to briefly summarize our activities in each of these three areas.

Information Development

Information development means deriving the information needed to answer critical biological and ecological questions. What are the habitat requirements of fish and wildlife that may be affected by energy development? What are the impacts—in terms of population, food-web interrelationships, and other considerations at the community and ecosystem level—of specific loss levels of given biota? What are the carrying capacities and resilience of specific ecosystems that might receive the brunt of fuel extraction and energy production? What species serve effectively as environmental indicators and how should they be monitored to determine whether significant ecological degradation is taking place?

Information development also includes problem-solving through improved techniques for applying existing data to find answers for specific needs. For example, how can we identify, in the larval state, fish species in the Great Lakes which are subject to damage from power plants? What methods and strategies will do the most in mitigating the impact of energy processing and in reclaiming lands after fuel extraction has taken place? What stresses on the fish and wildlife and on their supporting habitats will coal extraction or oil shale processing have on specific ecosytems?

The Fish and Wildlife Service is funding research in these area—some of it inhouse through our laboratories and research centers and much of it by contract. In addition to funds appropriated expressly to the Fish and Wildlife Service, we are applying "transfer" funds such as those established by Congress for allocation from the Environmental Protection Agency to other agencies for energy related research. We apply these funds to such research as the impacts of coal, oil shale, and geothermal exploitation on western lands; study of coastal ecosystems as they may be affected by oil and gas development; and problems of western water allocation. A national assessment of estuarine and near-shore marine environments was contracted to the Virginia Institute of Marine Science, using Water Resources Council funds. We are continuing our traditional collaboration with other agencies and with other arms of the Department of the Interior and we see ourselves moving increasingly into joint research with other agencies and bureaus. Ecologically oriented programs related to energy development are carried out particularly by the Energy Research and Development Administration, the Environmental Protection Agency, the Nuclear Regulatory Commission, and the Federal Power Commission.

The long-time program of maintaining fish and wildlife units cooperatively with universities, state conservation agencies and the Wildlife Management Institute is increasingly being paralleled by research contracts and by projects carried out in conjunction with state agencies and other institutions. Our Sea and Wading Bird Nesting Colony Survey is an example of such cooperative research. It is being carried out by Cooperative Wildlife Research Units in Maine, Massachusetts, and Louisiana. Universities feature prominently in conducting the research to develop baseline information on wildlife habitats in coal and oil shale regions and on the potential impacts of developing these resources. For example, through a contract study we are assessing the ecosystem implications of coal processing in the Four Corners area.

It is also our strong desire to work in full partnership with all states involved in energy development. In addition to their responsibilities for managing resident species, we recognize that the state fish and game agencies have data and insights into ecological relationships that are found nowhere else. We do not intend to duplicate this, but rather to fully utilize it in a mutually agreeable manner. For example, in addition to the above interagency and other contractual arrangements in which we are involved, we have also gone directly to state fish and game agencies on a contract basis.

We anticipate that these cooperative efforts with state agencies will expand as the program develops.

Information Transfer

Our second area of activity, information transfer, involves all phases of synthesizing existing data, interpreting it, and presenting it in suitable form for use by decisionmakers. We intend to make the capabilities and products of the information transfer activity more broadly available and readily accessible not only within the Fish and Wildlife Service, but also to assist to the extent feasible in serving the needs of conservation efforts at all government levels and within the private sector as well. A key feature of this overall effort is that information transfer is made an integral part of research and data gathering activities. Information specialists are assigned to monitor information in specific areas and to bridge the gap from the data source to the user needs. Much relevant data exists at diffuse locations and in varied forms, from handwritten notes and computer cards to finished reports and journal articles. Information transfer addresses the need for accessing data banks as well as for indexing bibliographic sources, retrieval from document files, and recognizing when results reported from research aimed orginally at one highly specific problem should be made avilable for other applications.

Integration and interpretation of data frequently require development of improved tools for analysis. These may emerge from workshops such as one to be held in Ann Arbor where techniques applicable to larval identification of Great Lakes fish will be compared and refined. Models provide another tool. Examples include computerized simulation of the dynamics of a short grass prairie ecosystem and model of the impacts of oil shale development on natural resources.

Manuals of guidelines and criteria and similar handbooks pull together various sources of information and provide ready reference for the decisionmaker—both within the Fish and Wildlife Service and outside—who must assess environmental reports and make recommendations on permits and other applications. Bibliographies, survey documents, and the results of technical symposia represent other products that are useful not only to the research analyst, but also to the technical community and the wildlife management and conservation movement.

Direct Support to Decisionmaking

In the third activity area, direct support to decisionmaking, the program is developing improved techniques applicable to the decision process. This includes such diverse activities as analysis of the legal bases for environmentally protective decisions and analysis of the structure and major modes of decisionmaking responsibility in regard to various kinds of energy development.

A participatory role in the decisions themselves is important. Without such a role, there is danger that the considerations affecting fish and wildlife—however relevant, accurate, and conveniently presented—may not actually be given weight in the decision process. Direct involvement by the Fish and Wildlife Service in the Department of the Interior's decision process with respect to energy development provides the best assurances that fish and wildlife values will receive appropriate attention. The Fish and Wildlife Service is an active participant through its representation on such panels as the Oil Shale Advisory Panel, an interdisciplinary team serving as staff to the U.S. Geological Survey Area Oil Shale Supervisor of the program for leasing public lands. In geothermal development, a Fish and Wildlife Service staff member serves on the Inter-Agency Geothermal Advisory Panel. A recent Secretarial order within the Department of the Interior has given Fish and Wildlife Service an enlarged role in Outer Continental Shelf development. Here, the Service will work with other elements of the Department in designing and managing studies, defining lease stipulations, and exercising control over design of plans for pipelines, drilling, and other exploitation of offshore energy resources.

These three activity areas—information development, information transfer, and direct support to decisionmaking—are essential to understanding and minimizing the impacts of major land-use changes on living natural resources. Only through active and continuing action on all three areas can we hope to provide the comprehensive effort required to meet the challenge of future energy development.

Rehabilitation Potentials and Limitations of Surface Mined Lands

Roger R. Bay
Director, Intermountain Forest and Range Experiment Station
USDA Forest Service, Ogden, Utah

Society's increasing demands for energy and domestic minerals have placed additional emphasis on the extraction of fossil fuels and a variety of other minerals located under forest, range, and associated lands in the United States. Many of the minerals and fossil fuels are close enough to the surface to allow extraction by a variety of surface mining techniques.

Landforms can be changed by removal of thick seams of minerals, and other resources can be greatly impacted. Besides affecting the immediate surface resources of agricultural land, range, or forests, such disturbances can influence resource management far away from the mine site. Aquifers may be altered, alkaline seeps created, and streams may be polluted affecting fisheries far downstream. Wildlife populations can be greatly affected if key seasonal range or migration routes are destroyed. Complete ranching and forestry operations could be altered by even a small disturbed acreage if it occurs in a strategic area.

The development and continuation of some mining operations may well depend upon adequate potential for successful rehabilitation. Local concerns and state reclamation laws and other environmental protection acts and regulations place increasing emphasis on rehabilitation procedures.

Although active surface mining for fossil fuels, minerals, and materials such as sand and gravel is being practiced in every part of our Nation, this paper will emphasize rehabilitation opportunities in the western regions, where concerns about surface mining for fuels and minerals are receiving much attention.

Concerns Over Rehabilitation

Although this discussion is directed primarily to the Western United States, we should also realize that surface mine rehabilitation concerns, research, and application of research results have a much longer history in the humid East. Early attempts to establish trees and shrubs on surface mined areas in Indiana started over 40 years ago (Medvick 1973). The Forest Service began research on reforestation of spoil banks in Ohio and Kansas during the 1930's, and launched a major multidisciplinary research program in the 1960's. Other federal and state agencies, universities, private foundations, and the mining industry have since accelerated research efforts in the Eastern and Central States.

Generally, revegetation of disturbed areas in the East is easier than in the West because of more favorable rainfall conditions, as well as a longer record of revegetation research. Both East and West, however, have difficult problem areas associated with unfavorable chemical and physical properties of spoils, steep slopes, and acid mine drainage. We still have much to learn about spoil bank stability, landscape design and esthetics, surface mine hydrology problems, wildlife habitats, and other multi-resource relationships. Much of our knowledge on rehabilitation of eastern mined areas was summarized in a 1969 symposium at Pennsylvania State University (Hutnik and Davis 1973).

The concerns over rehabilitation of surface mined land in the West were given increased national emphasis recently by two major studies: the National Academy of Sciences' study and report on Rehabilitation Potential of Western Coal Lands (1973); and the report of the Northern Great Plains Resources Program (USDI et al. 1975). On a state and regional basis, state agencies, university and federal scientists, and conservation and environmental organizations have emphasized surface mining and rehabilitation concerns and needs for some years.

Rehabilitating surface mined areas generally means returning land to an ecologically stable condition that conforms to a land use plan prepared before mining began. This may involve shaping spoils and overburden, applying topsoil materials and soil amendments, planting vegetation, and maintaining the vegetation. The local climate, particularly water availability, soils, the chemical and physical properties of spoil materials, the availability of seeds and plants, and the status of our knowledge all influence the success of rehabilitation efforts.

Rehabilitation measures should be integrated into each plan for the mining operation. The extraction process, the separation of overburden, the piling of spoils, the transportation system, and many other aspects of the mining operation can all influence the cost and success of rehabilitation. In short, rehabilitation should be an integral part of the general operational plan. And to be truly successful, the future use of the land must be considered as the ultimate goal of the rehabilitation program.

In mid-1974, the current knowledge on rehabilitation potentials and limitations for surface mined land in the Northern Great Plains was summarized by Packer (1974). This work centered primarily on coal areas. Another recent paper (Cook et al. 1974) proposed revegetation guidelines for mined lands in the interior West. These general papers, plus results of individual experiments, suggest important principles that can lead to successful rehabilitation in a number of vegetation-soil types.

Some Recent Research

The Northern Plains

Much of the Nation's federal coal lies under the Northern Plains area in eastern Montana, western North Dakota, northern Wyoming, and the northwest corner of South Dakota. The climate is classified as semiarid, with most areas receiving between 10 and 16 inches (254 and 405 mm) of annual precipitation, although some minable areas receive as little as 7 inches (178 mm). The native vegetation is mostly midgrasses and shortgrasses, with portions of the region dominated by sagebrush and ponderosa pine.

The probability for satisfactory rehabilitation is rather good for many areas of mixed grasses. Rainfall amounts and distribution are often adequate. Soils are fairly well developed in many areas, although high salt concentrations are definite hazards in specific localities. We also have a greater knowledge of agricultural development and range improvement in this region than in others. The basic potential for satisfactory rehabilitation was recognized in the National

Academy of Sciences' special study of Western Coal Lands (1973). More specific rehabilitation potentials and limitations were listed by the interagency, multistate Northern Great Plains Resource Program (Packer 1974).

Because of the current and potential development of surface mining for coal, probably more rehabilitation research has been initiated in this region than in the arid or mountainous terrain of the West. State agricultural experiment stations, various university departments, and several state and federal agencies are conducting a variety of research programs. Even so, most studies on specific surface mine sites have a limited history, generally 3 to 5 years.

Revegetation problems, as well as some potentially successful treatments, in the Northern Plains have been identified by a number of researchers (Hodder et al. 1972; May et al. 1971). The most recent information on rehabilitation research in eastern Montana and Wyoming has been summarized at a symposium sponsored by the Montana Academy of Sciences (Clark 1975).

Forest Service research, in cooperation with the Decker Coal Company (Fig. 1) near Decker, Montana, illustrates the care needed to develop potentially successful revegetation treatments (Farmer et. al. 1974; Richardson et al. 1975). Here, researchers intitially tested a variety of topsoiling, mulch, fertilizer, watering, and seed mixtures to establish vegetation on a mined area. Within 1 year, the best treatments were repeated in larger areas on more difficult slopes and aspects. A year later, the best combinations from these tests were installed in a larger scale pilot test to demonstrate and apply research knowledge in an opera-

Figure 1. Vegetation assessment work on research plots at Decker Coal Mine, Montana, in summer of 1974.

tional setting. Successful treatments were developed by employing sound scientific and ecological principles, by careful selection and application of seed, and by using care in seedbed preparation and maintenance of the experimental plots. At the end of 2 years, grass production on topdressed, irrigated, and even on unirrigated, raw spoils was better than on undisturbed native range.

Investigations by the Agricultural Research Service and the North Dakota Agricultural Experiment Station are providing valuable information on revegetating coal mining spoils in North Dakota (USDA et al. 1975). Studies of overburden and spoil characteristics have identified sodic soft shale areas as poor environments and glacial till or alluvium deposits as potentially best environments for plant growth. Other studies are designed to improve spoils for plant growth through a variety of amendments, protective covers, and topsoil materials. Still other research is directed toward the establishment and maintenance of perennial grass species on mined areas. Cool-season grasses have been successfully established on spoils with the proper use of fertilizer, amendments, and suitable topsoil material.

Other research projects in the Northern Plains are developing additional information concerning revegetation, spoil-bank hydrology, and baseline ecology on a number of specific surface mine sites.

The Southwest

Strippable coal reserves in the Southwest are concentrated in northeastern Arizona and northwestern New Mexico. The climate is arid, with annual precipitation normally less than 10 inches (254 mm) and maximum summer temperatures exceeding 100°F. (38°C). The native vegetation consists mainly of grasses and shrubs that can tolerate saline soils and resist drought.

Although some coal had been mined in New Mexico since the 1940's, major increases in production began in the 1960's and early 1970's in both states. The passage of the New Mexico Coal Surface Mining Act of 1972 created much interest in finding ways to rehabilitate mined lands. Since then, the Forest Service, universities in several states, and private companies have supported active rehabilitation research projects.

However, studies of plant establishment, development, and succession have been conducted by state and federal scientists for a long period of time in this area. These early studies were generally aimed at rehabilitating arid lands disturbed by excessive grazing or other agricultural activities, Thus, more recent research on surface mined land has started with some important knowledge of plant species with particularly desirable characteristics for growth and development in the arid climate and soils.

Recent studies supported by the Forest Service's SEAM program (Fig. 2) show that plants can be established on mine spoils in the Southwest if certain steps are followed (Aldon 1975a). Sprinkler and drip irrigation techniques, direct seeding methods, and ways of trapping and conserving water to enhance plant growth are being developed and refined. Some plants in the arid Southwest have very exacting establishment requirements. Two growing seasons are needed to insure stand survival. Studies are aimed at enhancing the probability of successful establishment through proper use of critical water supplies.

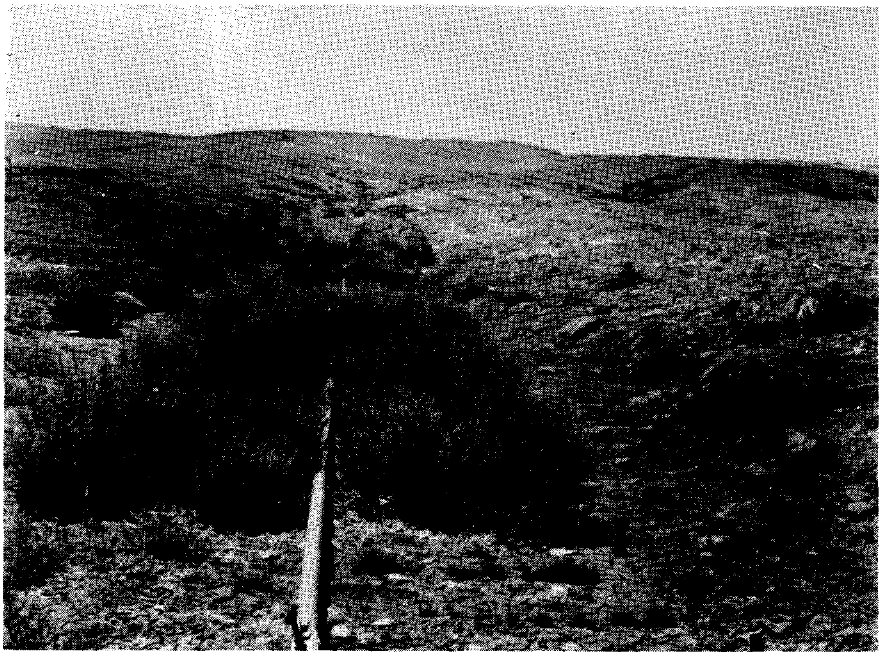

Figure 2. Fourwing saltbush (*Atriplex canescens*) and alkali sacaton (*Sporobolus airoides*) (foreground) grown on mine spoil in New Mexico. Studies of the establishment of these species were conducted on artificially created floodways. Supplemental water (applied by sprinkle irrigation pipe as shown in center of the plot) was used for the first growing season. Stand is shown after the second growing season on an area receiving less than 6 inches (152 mm) of precipitation annually.

Other studies have shown the importance of soil amendments such as fertilizer, topsoil additions, and mulch to the germination and growth of native plants. A recent study suggests a major role for certain mycorrhizae in the growth of important shrubs (Aldon 1975b). These types of field and laboratory studies will help in the rehabilitation of surface mined lands in the arid Southwest.

The Mountain West

Mineral exploration and development in the western mountains dates back to the early discovery and mining of gold and silver. Although coal deposits are fewer in the mountainous areas than in the plains and lower elevations, considerable mining activity for other minerals occurs in a wide variety of elevation zones. Modern mining technology employs large earth-moving machinery to develop shallow and deep open-pit mines, with a resulting high potential for environmental impact. Phosphate, copper, cobalt, chromium, precious metals, and oil shale are examples of sought-after minerals.

The potential for environmental impact is great in the mid- and upper-elevation mountain zones. These are prime landscape view areas, and visual impacts can be significant. The upper-elevation zones are also deep snowpack areas, producing much of the West's water. Soil erosion and resulting sediment production, and the oxidation of highly concentrated pyritic materials on some sites, can cause severe water quality problems. Many of the mid- and upper-elevation zones are also important summer range for wildlife and domestic stock.

The higher subalpine and alpine ecosystems are difficult environments to rehabilitate. Very short growing seasons, low temperatures, shallow soils, and small numbers of adapted plant species all contribute to rehabilitation problems. Drastic disturbances easily upset the balance between plants, soils, and climate. Revegetating disturbed sites is slow because plant successional processes are slow. Stable plant communities develop only over long time periods.

Our knowledge of successful rehabilitation techniques at alpine sites and at high elevation sites with toxic spoils is limited. Some recent research by Ray W. Brown and Robert S. Johnston of the Intermountain Station on the Beartooth Plateau in Montana indicates that native species are apparently better adapted for revegetation than exotic or introduced species. Fertilizer was also important to improved first-year growth and survival. Transplants of native species were successful after the first year of study. This research, and other work, indicates that some plant cover can be developed in the early years of rehabilitation on these high elevation sites.

Some aspects of rehabilitation are less critical below the alpine zone because of better soil development and more favorable climatic conditions. However, at the upper forested zones, climate can still be severe, with persistent spring snowpacks and relatively short growing seasons. And here—as well as elsewhere—the chemical and physical properties of mine spoils and overburden can greatly limit rehabilitation. Several studies in the Intermountain area illustrate the potentials and limitations of such efforts.

One study of acid overburden on a copper-cobalt mine near Salmon, Idaho, has developed potentially successful rehabilitation treatments (Fig. 3) in this high elevation forested zone (Farmer et al. 1976). Although only 2 years of results are available, the data already suggest several favorable treatments. Topdressing of mining wastes with native topsoils or subsoils to a depth of 8 inches (20.5 cm) or more, along with fertilization, produced favorable results. A mixture of native and introduced grass species has produced satisfactory stands across a wide range of soil conditions. Proper seedbed preparation and seeding techniques were extremely important.

These studies need additional followup to learn more about such unknowns as how long fertilization needs to be continued, how soon the topsoil-covered areas will reacidify, and how well the various grass and shrub plantings will develop over time. The scientists—in cooperation with the mining company—are already establishing larger demonstration tests of the most favorable treatments.

Another example of surface mining impacts and rehabilitation needs can be found in the mountains of southeastern Idaho, where the largest known deposits of phosphate in the Nation are located. About 30,000 acres of the Caribou National Forest are under lease, and additional thousands of acres of nearby lands are involved (Copeland and Packer 1972). Here, the physical properties—as well as the chemical properties of the spoils and overburden—are particularly important because of the steep mountain slopes and associated problems of spoil dump stabilization (Jeppson et al. 1974). Preliminary recommendations concerning spoil dump design have been developed and are being tested with the cooperation of the phosphate mining industry.

Research on the revegetation of phosphate mine spoils is beginning to show favorable results. Again, based on short-term research data, specific grass mixtures and combinations of fertilizer and mulch treatments are being recommended. In this region, as in others, other resource conflicts need to be identified and resolved. The area is particularly important to big game, and the headwaters of blue-ribbon trout streams are located here. Phosphate extraction and rehabilitation measures must be designed to consider such values.

Oil Shale Areas

Oil shale is a major undeveloped energy source. The richest deposits occur in northeastern Utah, southern Wyoming, and northwestern Colorado. Aside from the usual surface mining impacts such as degradation of visual qualities, deterioration of wildlife habitats, and production of sediments and chemical pollution in streams, serious environmental problems revolve around disposal of spent shale after the oil has been retorted out of it. Spent shale remaining after retort-

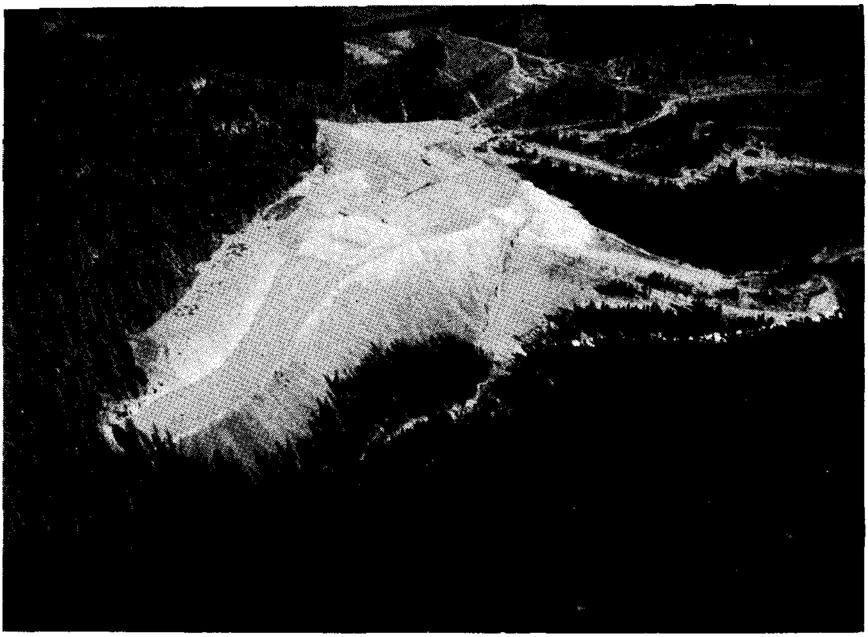

Figure 3. Aerial view of Blackbird mine. Several tiers of benches contain varying stages of research ranging from initial methods of treatment plots (upper left bench) to application demonstration.

ing occupies more volume than the raw crushed shale. Consequently, its disposal presents an environmental problem simply in finding places to put this waste. Other problems involve development of methods for revegetating highly saline, spent shale on sites ranging from high elevation, brush-covered mountain basins to low elevation, salt shrub deserts. While oil shale lands are sparsely inhabitated, they do occupy extensive headwater areas of the Colorado River.

Enough research has been done to determine that revegetation of spent oil shale is probably feasible, although more research is needed to develop suitable and economical revegetation alternatives for the wide range of sites that will be mined or utilized as disposal areas for spent shale. Also needed are alternative rehabilitation systems for water and wind erosion control and for reduction or prevention of downstream water pollution from leached salts and hydrocarbon contaminants.

Some Limitations

Research is well on the way to developing successful rehabilitation techniques in a number of areas, but limitations and constraints still exist. Although we do have a long background in that development of knowledge concerning vegetation establishment and maintenance, our knowledge is far from perfect. Rehabilitation of mined areas is very site specific. Ecological processes take place over considerable time, and man can add only so much speed to these processes through soil amendments, species selection, supplemental nutrients, and water. Studies of rehabilitation at specific sites are relatively new to the Western United States, and evaluations must continue for some years.

The availability of water to establish and maintain adequate plant communities is of utmost importance to rehabilitation in the West. Low precipitation in the Southwest and in many dry foothill regions will pose serious problems to successful revegetation. We cannot expect a "front lawn" effect because even natural plant densities are normally low.

Basic physical and chemical properties of mine spoils and other overburden materials will also limit revegetation efforts. Physical properties are important to the shaping of spoil banks, which influence hydrologic reactions as well as revegetation. Chemical properties, varying from high salt concentrations to extremely high acid concentrations, may limit plant establishment and growth, and contribute to water pollution problems.

On sites such as alpine tundra, basic ecological constraints will severely limit rapid rehabilitation. The long-term nature of succession on such areas requires careful assessment prior to mining.

Once successful rehabilitation has been started, other factors influence the continued maintenance of an area in an acceptable condition. Livestock, and even game animals, may need to be controlled on some areas to prevent excessive damage to plants and soils. Continued applications of fertilizers and other soil amendments may be needed to maintain soil development and prevent site degradation.

We have much to learn about the management and continued maintenance of rehabilitated surface mined areas.

Summary

Several major points need to be emphasized when considering surface mine rehabilitation needs and opportunities in the West:

1. Rehabilitation must be considered in the premining planning stage.
2. Climate, soils, and geology, the physical and chemical properties of spoils and overburden materials, and the availability of native plant materials are important keys to successful rehabilitation measures.
3. We have a large base of general revegetation knowledge upon which to build more site-specific research. New research should take advantage of this valuable background.
4. Rehabilitation potential is very site specific. Although general knowledge is available, specific studies are needed because ecological conditions vary and each mine has different needs and presents different opportunities.
5. Long-term commitments must be made to properly build sound and stable ecosystems at each site. Short-term success in shaping and revegetating disturbed lands is important to reduce immediate impacts, but short-term measures should be developed in terms of long-time needs.
6. The highest quality care must be committed to the design, installation, and maintenance of rehabilitation projects. Haphazard shaping, seeding, or maintenance will not lead to long-term success.
7. We need to consider and plan for the active management of rehabilitated areas to prevent degradation and to maintain stable landforms.

Mineral extraction and the rehabilitation of mined areas should not be considered in the narrow view of the processes themselves. We must consider the total job of resource management, and integrate mining and rehabilitation plans with multiresource needs and future plans for the protection and use of our lands in mineralized areas.

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Discussion

DR. EUGENE ODUM: In attempting to evaluate reclamation lands, the question we have relates to lands you do not plan to or are unable to use intensively in the future. If you merely reseed with major vegetation and then do nothing further, do you get much out of it? What do you get?

In other words, in relation to the soil and water structure which has formed over hundreds of years, when that is dried up, do you lose your ability to support natural vegetation and its pattern of deep root utilization of water?

DR. BAY: Long-term plant and soil development need to be studied on over a period of years. In many cases, we do lose these soil properties, as you well know, and that is the reason for the research and testing of replacement of top soil and even sub-soil material.

I think the important point in some of our research is that we are trying to develop treatments with minimum fertilization and water requirements. But to protect the site soon after disturbance, we may need some of these initial treatments of fertilizers and other types of materials on the soil to promote rapid plant development.

MR. YATES BARBER [National Marine Fisheries Service]: My own observations of trying to grow things in the coarse sand hills of the Southeast and casual observations of loss of existing vegetation in the vicinity of underground nuclear tests in Nevada, long ago have suggested to me the problem of leaching. In other words, loss of impervious land to hold water is one of the big problems.

On this basis, have you experimented with the possibility of providing an artificial, impervious layer for the retention of water and fertilizer available within reach of the plant?

DR. BAY: I cannot think of any specific studies that are now testing an artificial, impervious layer. It could well be, but I cannot think of any right now.

MR. SPELLMAN [University of Wisconsin]: I would like to know if you have some range of cost estimates for the reclamation program. The reason I am asking is that the State of Wisconsin does have legislation pending at this time, a mine reclamation bill, and even though conditions are different, I would like to get a perspective on the situation.

DR. BAY: I don't have any of this information with me. Some people, however, as you may know, are working on this at different places in the western United States.

One of the problems I am sure you realize in relation to research, is that we are going to a lot of trouble to attempt to establish successful treatments, particularly as we go to larger treated areas. Thus, cost of research trials tend to be higher than operational-scale programs.

MR. WOODY SEAMAN [Bureau of Reclamation]: I am aware that a number of mining companies are doing their own reclamation work. I did not hear you mention anything about the problems that might arise from nonindigenous species of plants brought in, where you might bring in plant diseases or something detrimental to the indigenous plant species. Therefore, I wonder if the Forest Service and/or others are paying attention to this thing insofar as private reclamation of these lands is concerned, or is this a problem?

DR. BAY: Some of the other agencies in the Department of Agriculture are working on plant disease in terms of introduced disease.

Most of the plants we often call introduced species are plants which have really been around for quite awhile. For example, some of our non-native grasses have been tested and used for a long time. Still we could have problems with introduced species particularly long-term adaptability. I don't think we have seen any particular problems with disease on our study plots because our scientists ususally use a mixture of various plant species.

MR. FRED JOHNSON [Pennsylvania Fish Commission]: We in Pennsylvania have a stripmining restoration bill, but in view of President Ford's double vetos, what incentive is there for the various states, other than their own state legislation, to perform this type of stripmining reclamation? In other words, is it left to the states in each case or is something of this done in relation to the watered down national law?

DR. BAY: The Western States have also developed their own reclamation laws and are requiring reclamation and rehabilitation of surface-mined lands. Thus, it is the states themselves which, in most cases, are developing their own particular laws. Some of those laws are quite strict.

MR. JOHN WATTON [Montreal Engineering]: You mentioned native use of major species. Do you know if there are cuttings being developed for these plants—that is, in usual quantity? Secondly, you mentioned at one point, I think, big game habitat. Is there any specific effort being directed toward restoration of wildlife habitat or wetland wildlife habitat?

DR. BAY: As to your first question, relating to seed source, there are not many really good commercial sources now. This is a real problem. Our people have had to go out and actually collect their own seed. This has some advantages and disadvantages, in that, for example, it takes a great deal of time and effort, but locally adapted plants are reseeded. I know of one Forest Service nursery which is now raising shrub species for public lands but availability is a real problem and will be a problem, as it is with mining companies. Some commercial nurseries are beginning to enter this field.

As to your second question, concerning big game habitats, we have some studies going on in relation to the use of revegetated areas. Of course, some of the vegetation treatments are selected on the basis of compatibility and potential use, primarily in connection with deer and antelope.

MR. ROBERT HOOVER [Colorado Division of Wildlife]: I, too, am concerned about restoration of big game ranges, particularly in the West. Many of our winter ranges for deer, for example, are situated in rather arid areas, typified by open slopes. The best forage now in many of these are on the north-facing slopes and the animal can get out of the weather on the south-facing slopes and then move over to the north slope where there are such species as mountain mahogany.

However, my concern is that in many of these areas, in reclamation work, you start with a land form that has these different climates, for example, and sites where these species can thrive. In connection with reclamation, you tend to end up with a very flat topography.

My question then is this—what can we do to restore this type of plant site so we can continue to produce big game forage?

DR. BAY: I think the important thing is recognizing the type of sites we need. Here is a case where we can develop our own landscapes—we could plan for these in our basic rehabilitation-reclamation practices.

Unfortunately, we already have a potential conflict with regard to some state laws that might require certain types of slopes or relatively flat surfaces. Those type of laws could be quite detrimental in the circumstances I point out.

Some of our research as well as some at Montana State University is exploring different types of microsites for plant establishment. This could, in turn, tie well into the big game habitat development.

Assuring Ecological Soundness in Coastal Energy Developments

John R. Clark
The Conservation Foundation
Washington, D.C.

The title of this paper is "plural" because it covers not one issue but many issues. The paper treats not one subject, but a great number of subjects.

The coastal energy developments spectrum consists of electricity production, oil, natural gas, etc. The products originate with, or are transferred to, the coastal zones. The effects of the recovery, shipment, and distribution processes on land, water and air are very different. To simplify the subject, I have chosen two major aspects of coastal energy development, with particular emphasis on the siting of facilities for nuclear power production and developments for outer continental shelf (OCS) oil. Together OCS oil and nuclear plants become the most immediate new sources of energy supplies for the nation in a period of crisis.

Also, the two are quite different. The facilities are structurally different. The land use requirements are completely different and operations of the facilities and their missions are also totally different. Further, the regulatory context of the two is quite different. Therefore, as one would expect, any ecological guidelines for development of these coastal facilities are likewise going to be different. The state of the art of our understanding of the ecologic effects of the two are very different as well.

We can be quite specific now about nuclear siting. We have had a considerable amount of experience in that there has been a lot of money spent in research and there have been a lot of court battles fought. There has been a lot of adjudication and things are settling down to a point where simple guidelines can be clearly stated. On the other hand, we have not developed anything so useful for industry oil onshore facilities. But this process has begun and is presently going on.

I will explain some of these differences in a little more detail. Nuclear power plant sitings are highly regulated, whereas OCS generated onshore siting is very loosely regulated. Environmental controls for nuclear power plants are highly centralized, while environmental controls for OCS onshore development are very dispersed. The Nuclear Regulatory Commission (NRC) licenses all nuclear power plants in the coastal areas, and the National Environmental Policy Act requires preparation of environmental impact statements in which the NRC takes the lead. The licensing function is quite consolidated and focused and even state involvement in these siting issues is centralized. However, with outer continental shelf facilities onshore, there is no agency in charge. The Interior Department does the leasing and local governments are in charge of land use. The state, with U.S. Environmental Protection Agency overview, takes care of most pollution. But the release of discharges of petroleum into international waters is a matter of international treaty. The states or local governments control the water supplies needed in processing. The Corps of Engineers handles dredging and port access matters. The marketing of some oil products is regulated by the Federal Government.

The power industry has always, in the past, dealt with local or regional markets but it is now changing fast to a national market as things get better organized. The price of power on this network market is partly controlled.

On the other hand, the products from OCS development have been sold on a world market, but now they may be forced more into the domestic market. The price of oil products by United States producers is more or less unregulated.

When nuclear power plants are proposed, the output of the facility is pretty clear at the beginning. However, when an outer continental shelf lease is proposed, there is great speculation over whether the field will produce or not. For example, there is a lot of talk about oil from Georges Bank off Massachusetts. However, when one looks at the statistics, one sees that the chance that there may be any economically recoverable oil on Georges Bank may only be 5 to 10 percent.

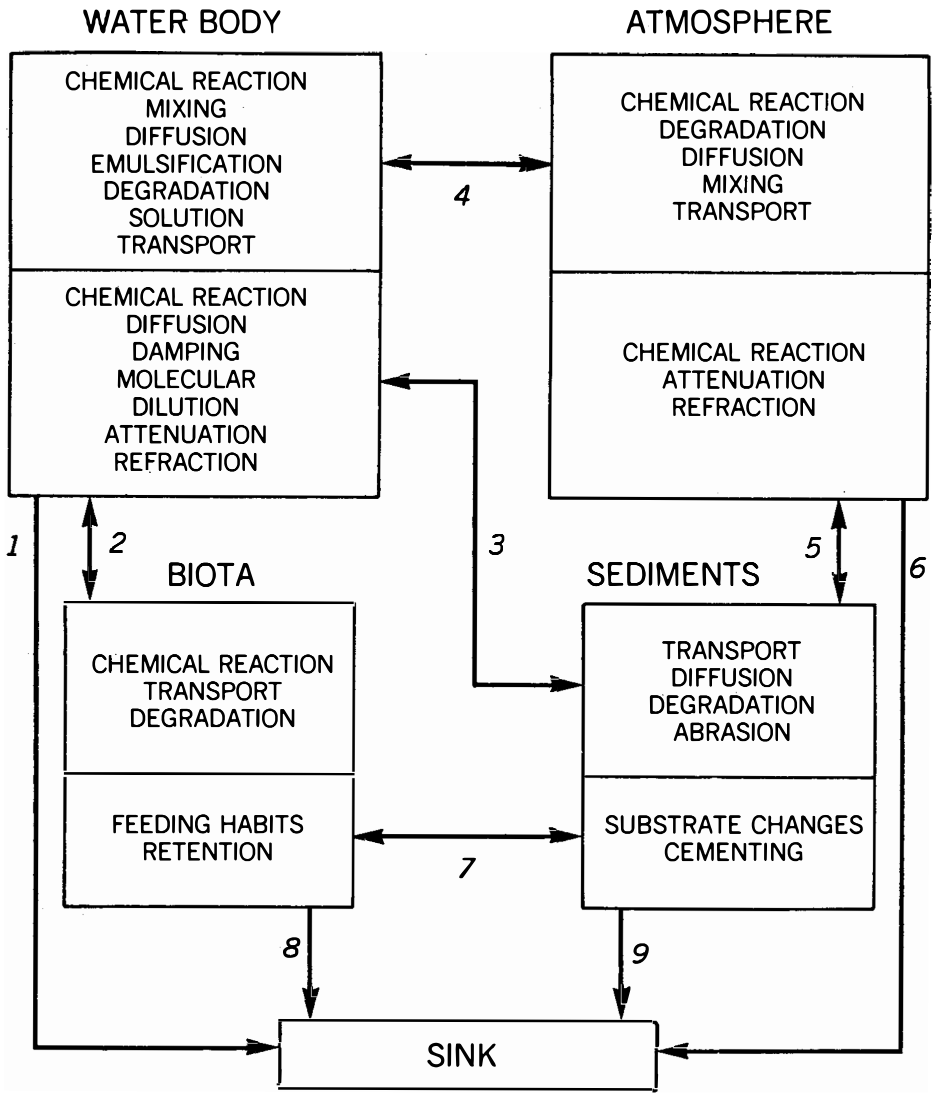
Nuclear power plants attract few associated industries which, in turn, amplify land use problems. But OCS onshore facilities may have a high attraction for industry, such as the petrochemical industry or the fertilizer or coke manufacturers that move close at hand.

The facilities themselves for nuclear power plants are greatly concentrated and a 2200 megawatt plant site may require only 200 acres, although it costs a billion dollars to build. However, OCS onshore facilities are often quite dispersed and many are traditionally on the coast. The drill rigs and geophysical exploration boats need some facilities. There are submerged pipe lines or tanker routes coming ashore and, onshore, there are service yards and docks, pipe storage and coating facilities, tank farms for storage of oil, partial processing facilities,and refineries. A refinery itself would require around a thousand acres of land for a 500,000 barrel per day facility.

Finally, in the area of environmental impact, we have a substantial difference. A nuclear plant has a very high requirement to use adjacent water for cooling. The kill of suspended life in the water that comes through the plant often amounts to a very high proportion of life in the surrounding water—40 percent for Indian Point No. 2 on the Hudson River and 55-60 percent for the Brunswick Station on the Cape Fear River, N. C. This is the main ecological problem that we are now having with many nuclear plants.

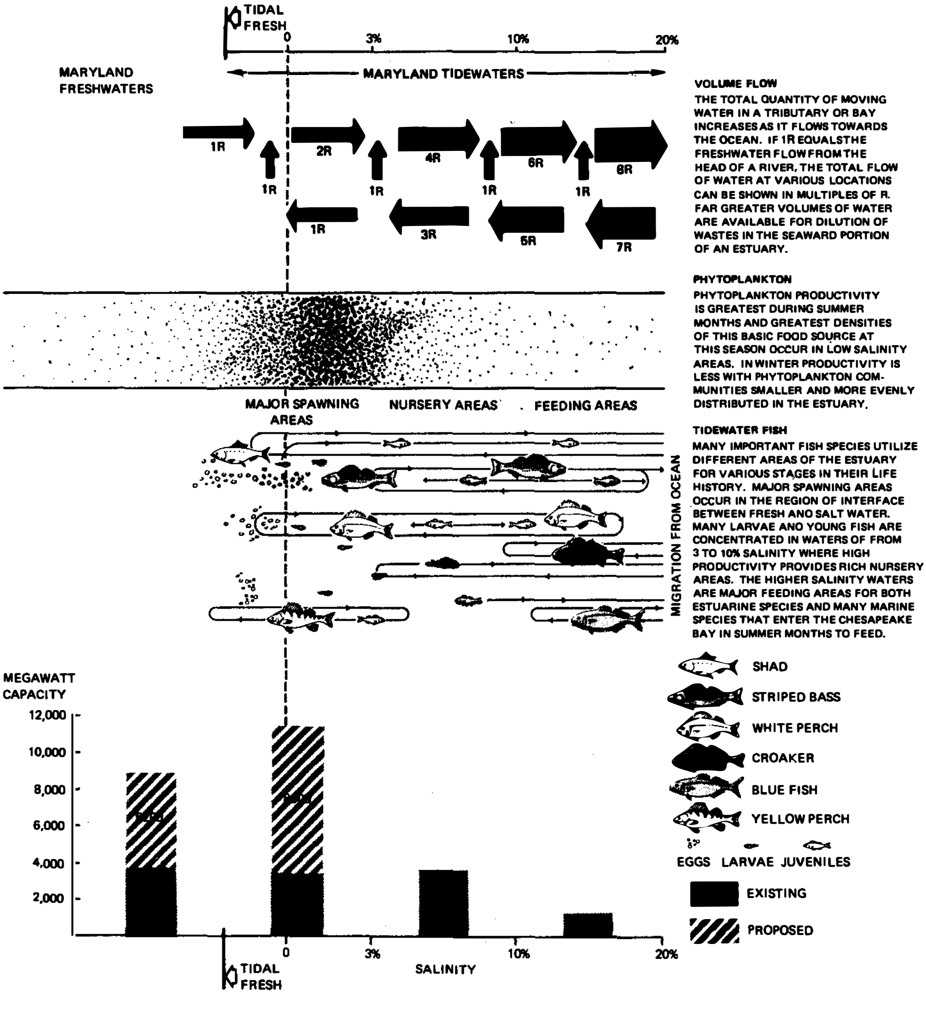
However, in connection with OCS facilities, we have to look at a very broad spectrum of environmental impact. We have to look at both persistent or accidental spills or discharges. We have to look at the physical alterations to the shore line, the land, the water, the wetlands and other vital areas, all of which have to be considered (Fig. 1). We have to keep in mind the surrounding water basin for spoils disposal. Withdrawal of ground water from the surrounding land also may be critical; for example, the 500,000 barrel a day refinery I previously mentioned requires 22 million gallons of water per day for processing, which is enough to supply a city of a quarter million people.

We find that impacts arising from OCS generated onshore facilities are quite unlike those for nuclear plants. We also find, in relation to the outer continental shelf leasing program, that the federal government is the landlord.



Source: *Fate of Oil in a Water Environment,* Phase I, Volume I. A Review and Evaluation of the Literature. Environmental Geology Program University of Southern California, Los Angeles, California. API Publication No. 4212. Oct. 1973.

Figure 1. The effects of oil spills on the water environment.



Source: Maryland Department of Natural Resources, "Power Plant Cumulative Environmental Impact Report", Power Plant Siting Program, Tawes State Office Building, Annapolis, Maryland 21401. September 1975.

Figure 2. Power Plants in relation to the ecology of the estuary.

While millions of dollars are now being spent on research, there are no guidelines yet formulated which I can give you.

However, we do have a fairly good set of guidelines for nuclear plants that have been formulated by the regulatory agencies and individual experts. Many apply to specific coastal localities but some guidelines can be applied across the board.

First, nuclear plants should avoid ecologically *vital areas*—wetlands, grassbeds, and breeding and spawning areas, nursery areas, etc. and, to avoid them, one must know where they are. This, in turn, requires a detailed inventory and biological study of the ecosystems adjacent to possible plant sites.

Secondly, closed-cycle cooling (cooling towers, lakes, or sprayponds) should be used whenever a plant is located on a confined water body—river, bay, lake, lagoon, etc. These are areas of *critical environmental concern* and they must be offered special protection. Technological improvements have to be made to the plants before they can be used. We have not yet found a true estuary where one can take a million gallons of water a minute out and run that through a plant and return it to the estuary without having a significant adverse impact through killing of suspended life (Fig. 2).

Thirdly, coastal sites are acceptable for open-cycle systems (that is, straight-through pumping from adjacent waters without use of cooling towers or other device) providing that they are not adjacent to vital areas and that certain precautions are taken. For example, intakes, outlets and other submerged structures must be designed with extreme care to prevent attraction and impingement of aquatic creatures. Chemicals are to be used sparingly in treating cooling water and are to be replaced, where possible, by mechanical systems of cleaning and balancing.

These three sets are merely rational guidelines which are as yet not implemented as fixed rules by state or federal agencies. Yet the basic philosophy and purpose are subscribed to by most federal and state siting agencies.

Obviously, a plan for the siting of nuclear plants is required in which ecologically *critial areas* must be designated for the whole coastal zone of each state in order that they be conserved. The even more valuable *vital areas* must also be identified to protect them. Siting requirements must coordinate with design and operational features of the plant. This all can be done readily in the context of the Federal Coastal Zone Management Program, which now involves 31 states and territories.

While these guidelines are specific to the facilities under consideration in the context of coastal zone management programs, it must be recognized that there is a much broader context. Any coastal resources which we hope to protect are part of a balanced ecosystem. The focus of ecological impact control must be on conservation of ecosystems, not on single parts of them. This is the most important result of the recent decade of ecological awareness.

As the activist environmental period ends and we again return to conservation as the goal, we are using a broader, more holistic approach. The new conservation is different in this respect but it still involves the old philosophy of long-term optimization of resources in balance with economic and social goals of our country.

Constructing and Managing Power Plants to Avoid Adverse Ecological Impacts

Frank L. Parker
Vanderbilt University
Nashville, Tennssee

It is impossible to construct and operate a modern, large electric power plant without creating adverse ecological impacts. The strategy to be followed then, must be two-fold: To reduce the impacts to the maximum possible extent, consistent with other goals and to maximize the benefits minus the adverse impacts subject to other goals and desires.

Impact of Siting Power Plants

Many studies of the impacts of siting power plants have been made (U.S. Nuclear Regulatory Commission [USNRC] 1975a: Office of Science and Technology 1968, National Academy of Engineering 1972; and Piper 1972). A comprehensive outline of factors to take into account in siting of nuclear power plants is given in the Regulatory Guide for Nuclear Power Plant Siting (USNRC 1975a). Nine topics are listed and discussed: (1) Geology/Seismology, (2) Atmospheric Extremes and Dispersion, (3) Population Considerations, (4) Hydrology (flooding, water availability and water quality), (5) Ecological Systems and Biota, (6) Land Use and Aesthestics, (7) Industrial, Military and Transportation Facilities, (8) Socioeconomics and (9) Noise.

Specifically noted to be taken into account are the following environmental considerations (USNRC 1975b): (1) Preservation of important habitats, (2) Maintenance of migratory routes of important species, (3) Limitation of entrainment and impingement of aquatic organisms, (4) Limitation of entrapment of aquatic organisms, (5) Maintenance of adequate water quality, (6) Maintenance of adequate water availability, (7) Maintenance of inviolability of established public amenity areas, (8) Maintenance of inviolability of prospective public amenity areas, (9) Conformance with established land use plan, (10) Protection of visual amenities, (11) Prevention of increased local fogging and icing, (12) Minimization of cooling tower drift, (13) Minimization of cooling tower plume length, (14) Minimization of cooling tower interactions, (15) Prevention of elevated noise levels and, (16) Reduction of the economic impact of pre-emptive land use.

The National Academy of Engineering's Committee on Power Plant Siting (National Academy of Engineering 1972) concluded that the crisis in the supply of electric power in the United States "results to a considerable extent from the conflict between society's requirements for more electric power and society's requirement for environmental protection and resource conservation."

Progress toward resolution of this crisis is inadequate because: The adversary legal process is too time consuming and "is inadequate to cope with the complexities of the engineering and ecological problems involved;" and public interests are not adequately represented and orderly, public decision making is lacking. This inhibits environmental protection and utilities from proceeding because of uncertanties and costly design revisions.

The problem of power plant siting is not unique, but is part of the general problem of siting large industrial facilities. The American Bar Association's Special Committee on Environmental Law has addressed the generic problem in a report "Development and the Environment: Legal Reforms to Facilitate Industrial Site Selection" (American Bar Association 1974).

They have concluded that "each state should provide for comprehensive and coordinated statewide planning to assure wise and prudent use and conservation of natural resources, and should provide planning criteria for evaluating proposed uses of those resources in relation to developmental objectives and environmental values, including biophysical, social, cultural and economic."

Possibly, most important of all, the National Environmental Policy Act of 1969 (U.S. Congress 1970) states that it is federal policy "to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans."

It is obvious that these objectives are not all compatible and that each of us has different views as to the order of priorities and there is no solution that will satisfy everyone. However, there is one solution that will be almost universally acceptable . . . conservation. If we can maintain present life styles without increased use of electrical energy, this would be the easient solution, and up to a certain point this is possible. For example Eric Hirst has shown that to achieve reduction in gasoline usage by 1985, we can increase car pooling to 10 percent and save 105,000 barrels of oil per day, increase mass transit from 2.5 to 7.5 percent and save 122,000 barrels per day or increase prices 20 percent and save 700,000 barrels per day. Or we can insist that automobiles get 22 miles (35.4 km) per gallon and save 1.4 times the other three alternatives combined and with no change in lifestyles (Hirst 1976). Alternatively, just removing the spare tire and tools (60 lbs., 27.22 kg) from the automobile would save a million barrels of oil a day.

Eventually, though, because of increased population, increased energy use for pollution control, and increased energy use to win the poorer grades of ore, it will become necessary to build new power plants. Then it is much better to avoid troublesome sites rather than to try to make them useful by engineering and administrative controls. Some of the more important considerations in siting a new power plant are (Nuclear Regulatory Commission 1975b): (1) The site should be compatible with existing land uses and current and projected federal, state, regional and local land use policies, plans and regulations. Of particular concern are the coastal zones and the location of power plants in them is prohibited in some states such as California and Delaware. The effect of the transmission corridors should also be considered. (2) Unique national resource areas such as parks, monuments, wilderness areas, wildlife refuge areas, wild and scenic rivers, and rare geological formations should be avoided. (3) Unique historical and archeological sites such as those listed in the National Registry of Historic Places should be avoided. (4) To avoid aesthetic discomfort, the plant should be located isolated from public view in variable and rugged terrain adjacent to compatible land use (e.g. industrial parks) and be screened by natural vegetation and/or topography. The impact may be reduced by having the texture, form and color compatible with the surrounding landscape.

Transmission corridors may be even more aesthetically disruptive than the plants themselves, as at Storm King and Palo Alto. The effects may be minimized by screening the lines, varying the alignment and the vegetation, cutting to avoid long tunnel-like corridors, avoiding heavily timbered areas, open water, crossing hills at high points and using the skyline as a backdrop, and crossing openings at right angles. In areas of high scenic beauty underground lines should be used. (5) Important breeding habitats should be avoided. The Calvert Cliffs Plant, unfortunately, proved to be located on such a site. (6) Important migratory pathways should be avoided. One of the major problems at the Indian Point Plant is that it impinges strongly on the anadromous fish runs on the Hudson River. (7) Habitats of rare or endangered species should be avoided. Tellico Dam which will increase the firm power of Fort Loudon Dam has created controversey which now hinges on the endangered "snail darter." (8) Adequate water supplies, both physically and legally, for condenser cooling must be available. Whether "once-through" or off stream cooling are employed, some consumptive water losses will occur. (Dry cooling towers have essentially no consumptive losses, but cost considerably more.) "Once-through" cooling for an 1000 MW_e plant at 35 percent thermal efficiency will consume about eight cubic feet per second while a mechanical draft tower system will consume about twenty eight cubic feet per second. (9) Adequate atmospheric dispersion of effluents must be available. Even so, non-degradation of air quality as mandated by judicial interpretation, could make the siting of plants in presently unpolluted areas impossible. However, the Environmental Protection Agency has classified the entire country as class two (December 5, 1974 - 39 FR 42510-42517, June 12, 1975 - FR 25004 - 25010) which allows for moderate development. This, of course, is being challenged in the courts. (10) Site size is a function of the type of power plant. An 1000 MW_e coal fired power plant with fly ash and sulfur oxide control, requires 941 acres (Council on Environmental Quality 1973). Cooling towers would add about 10 acres. An 1000 MW_e nuclear power plant would require 300 acres (This is primarily due to the exclusion area rather than for coal storage or fly ash and limestone sulfur scrubber waste disposal).

Recently, for a variety of reasons, security, licensing and environmental, it has been suggested that 10 to 20 nuclear reactors be sited in one place. The study, *Nuclear Energy Center Site Survey* (USNRC 1975c), states, "Many areas exist that offer potential for siting power NEC (Nuclear Energy Centers), based on general screening criteria involving water flow, seismicity, population density, and load center locations." Overall, however, the conclusion of the study was, "The Nuclear Energy Center Site Survey supports the conclusion that it can be feasible and practicable, depending on location, to construct up to about 20 nuclear power reactors on a single site. However, it does not indicate any great or unequivocal advantage or compelling need for such centers."

The report further states that the heat dissipation requirements constitute a major constraint on choice of suitable sites and will become even more important as the competition for available water becomes even more intense. Once through cooling is expected to be limited to sites with Great Lakes or oceanic access.

A study of such a site on the coast of New Jersey has indicated that the environmental effects there will be unacceptable.

Construction Techniques to Avoid Adverse Ecological Impacts

During construction, the ecological effects other than to the habitats distrubed, will be due to increased runoff or sediments, storm water, and other pollutants (e.g. pesticides, nutrients and construction chemicals). These can be reduced to manageable levels if one (U.S. Environmental Protection Agency 1973): (1) Prevents erosion and sediment transport by proper structural and vegetative controls. This would mean diverting runoff waters from the construction zone; controlling the rate of discharge of stormwater drainage by check dams, dikes, ditches, terraces and benches; and controlling the rate of erosion by grading, sodding, seeding, mulching, netting and chemical binders. Sediment transport off-site can be reduced by the use of natural buffers to not only slow and absorb runoff but also to remove sediment from runoff, by sediment traps, basins and reservoirs and by a temporary water treatment plant. (2) Prevents water pollution by runoff of pesticides, petrochemicals, solid wastes, construction chemicals, waste water, garbage, sanitary wastes, fertilizers, etc. by cleanup and prevention (good housekeeping practices).

Managing Power Plants to Avoid Adverse Ecological Impacts

The adverse effects of coal fired and nuclear fired plants are so different they they must be considered separately.

Thermal Pollution

Both coal and nuclear power plants must discharge heat from the condenser cooling water. Heat can be dissipated to either the atmosphere via cooling towers or to the hydrosphere via cooling ponds, lakes, spray canals or rivers, though eventually it all must be released to the atmosphere. The average thermal efficiency of modern large fossil fuel plants is 39 to 40 percent, while the thermal efficiency of light water reactors is 31 to 32 percent. The fossil fuel plant loses about 10 percent of the heat generated up the stack - and both fossil fueled and nuclear plants lose about five percent of the heat generated within the building. Consequently, nuclear fueled plants must dispose of about 50 percent more waste heat from condenser cooling waters to the atmosphere or the hydrosphere than do fossil fueled plants. If the choice is to the hydrosphere, then nuclear plants will consume more water, the exact amount depending upon whether once through cooling or cooling towers are utilized. Induced draft wet cooling towers have been designated as the best practicable treatment available. The majority of new large plants will therefore require cooling towers.

The adverse environmental effects mitigated by the use of cooling towers are higher temperature of the receiving waters, and effect on the biota and assimilative capacity of the receiving waters. "Once-through" cooling is still permitted by section 316(a) of 1972 Amendments to Federal Water Pollution Control Act, if the applicant can demonstrate to the satisfaction of the administrator that the effluent limitations proposed "will assure the protection and propagation of a balanced indigenous population of shellfish, fish and wildlife in and on that body of water." (U.S. Congress 1972).

However, the adverse environmental effects induced by cooling towers are concentrated heat and moisture sources, fogging, icing, noise, drift, chemical discharges to the atmosphere and the hydrosphere, increased consumptive use of water, decreased net power production (consequently, more fuel must be burned, resulting in more atmospheric pollution) and aesthetic disutility. Put in more specific terms, the adverse ecological effects of the cooling towers at the TVA Brown's Ferry Plant, Alabama (3300 MW_e Boiling Water Reactors) (Parker 1973) are: (1) Concentrated heat source. Approximately 3.5×10^5 WM^{-2} are released at the top of the tower structure, which is 35 times more energy release per unit area than tornado kinetic energy production. Though no such effects have yet been observed, the potential is there. There is, as yet, insufficient understanding and information on the processes to exclude the possibilities. The findings of the Nuclear Energy Center Site Survey - 1975 (USNRC 1975c), however, caution that "the heat flux density should not greatly exceed that which has resulted from other intense man made sources" (160 watts/square meter) and "Caution is advised if the incremental heat attributable to the center heat flux density approaches five or six times this average (160 watts/square meter) integrated over the entire project area on a daily average basis." (2) Concentrated moisture source. The moisture release from the Brown's Ferry Plant to the atmosphere at the top of the tower structure is 1.7×10^8 gm/sec-km^2. A NECSS-75 study stated that because insufficient experience with large vapor emissions exists, the rate of moisture injection into the atmosphere should be considerably less than the maximum natural advection of water vapor from convection processes (10^6 gm/sec-km^2). If the power plant waste heat were released at 2MW per acre, this would be about 7.5 times less than the rate on a humid highly convective day. (3) Fogging. The increase in fogging due to the Brown's Ferry Plant was estimated to be an additional 110 hours of fog on the Tennessee River. If one makes conservative assumptions and has the two barges decrease to one half speed in the fog shrouded area, this causes increased costs of about $1000 per year from the slowdown alone. The cost due to increased number of accidents has not been estimated. (4) Icing. Cooling tower induced icing would occur about 275 hours per year and river traffic on some occasions would encounter light to moderate icing. In addition, up to five days per year of icing on the secondary roads around Brown's Ferry would occur. (5) Noise. The operation of the fans and the falling water will cause 87 dB at 250 Hz at 50 feet (16.4 m) from the louvered face. OSHA limits noise in work places to 100 dB. (6) Drift and increased consumptive use of water. Cooling towers dissipate most of their heat by evaporation whereas in "once-through" cooling evaporation accounts for about 50 percent of the heat loss. This of course, is a function of meteorological conditions and the temperature rise across the condensers. The loss of 117 cubic feet (3.31 m^3) per second by the towers to the atmosphere is sufficient water to supply the needs of a population of 475,000. There is also the legal question of whether under riparian law this would be considered a "reasonable" use or whether downstream riparians might not sue for the loss of their water. (7) Chemical discharges to the atmosphere. The average concentration of dissolved solids in the Tennessee River is 107 mg/l which would be concentrated two times in the cooling towers. In addition, the chemicals introduced to the cooling system to prevent scaling, aquatic growths, corrosion, etc., would add alum, 0.04 mg/l; chlorine, 0.001 mg/l; polymers, 0.0002 mg/l; SO, 3.3 mg/l; Na, 1.9 mg/l; chromate, 0.0045 mg/l; HSO, 1.5 mg/l; NaOH, 1.5 mg/l assuming no carry over in evaporation. This would result in drift losses (0.03 percent of circulating water) of approximately 50 pounds of chemicals per day. (8) Chemical discharges to the hydrosphere. The chemical discharges to the hydrosphere by blowdown are 100 times those to the atmosphere or approximately 5000 pounds per day in addition to what was in the original water. (9) Decreased net power production. Three to 5 percent of station power will be lost due to higher back pressures and power for fans and pumps for cooling towers for the Browns Ferry Plant. This is equivalent to a loss of about 100 MW of capacity. The additional power required to meet this 100 MW demand would be from a coal fired system. For coal with 10 percent ash and 2 percent sulfur content and with cyclone furnaces and electrostatic precipitators, this would produce in pounds per day: 4780, (2168.20 kg) particulates; 41,800 (18,960.48 kg), sulfur oxides; 550 (249.48 kg), carbon monoxide; 165 (74.84 kg), hydrocarbons, 30,200 (13,698.72 kg), nitrogen oxides; and 2.8 (1.37 kg), aldephydes. (Parker 1974a) (10) Aesthetic disutility. The six cooling towers were each reported to be 73 (22.35m) feet wide, 60 (18.29m) feet high and 480 (146.30m) feet long and were constructed in two rows of three, roughly parallel to the shoreline. Some may admire their symmetry, but others will find this alien presence in a rural environment objectionable.

The present worth of the towers is $60,000,000. The present worth of the fish saved by the installation of the system according to the TVA data, is less than $1000 (Parker 1973). If the impact were to be evaluated for a fossil fueled plant, the quantities would be reduced by 33 percent.

Atmospheric Pollution

Nuclear power plants emit radioactive gases and some volatile fission products. These are limited by regulation to cause a dose no greater than three millirem per year whole body dose for the person at the perimeter of the unrestricted area. EPA has estimated from the BEIR report (National Academy of Sciences 1972) that 270 deaths and 300 genetic effects are caused by each million manrem dose (U.S. Environmental Protection Agency 1973). Therefore, the increased chances of death for a person at the perimeter of the plant under normal operating conditions are 8×10^{-7} per year.

The National Council on Radiation Protection and Measurements has cautioned against the use of this type of calculation. "The NCRP wishes to caution governmental policy making agencies of the unreasonableness of interpreting or assuming "upper limit" estimates of carcinogenic risks at low radiation levels, derived by linear extrapolation from data obtained at high doses and dose rates, as actual risks and of basing unduly restrictive policies on such an interpretation or assumption" (National Council on Radiation Protection and Measurements 1975).

In 1973, boiling water reactors with a generating capacity of 7745 MWe released to the atmosphere, on the average, 7.6, 0.5, 18.5 and 487,000 curies of halogens, particulates, tritium and noble gases, respectively. The new requirements for 3 millirem per year whole body dose will require the average released to be less than 5100 curies of noble gases and 0.11 curies of ^{131}I. The pressurized water reactors with a generating capacity of 13813 MWe released in 1973 on the average 0.08, 0.09, 27.9 and 71,100 curies of halogens, particulates, tritium and noble gases, respectively (USNRC 1975d). The new requirements for 3 millirems per year whole body dose will require the average release to be less than 2,200 curies of noble gases and 0.05 curies of iodine 131 at each plant.

Equivalent source terms for fossil fueled plants producing the same net electrical capacity of 21448 MWe as the nuclear plants did in 1973 would release to the atmosphere, in tons per year, particulates 1.0 x 10^5; sulfur oxides 5.4 x 10^6; carbon monoxide 7.1 x 10^4; hydrocarbons 2.2 x 10^3; nitrous oxides 3.9 x 10^7; and carbon dioxide, 3.9 x 10^8 for a cyclone burner plant utilizing electrostratic precipitators with an efficiency of 97 percent and with a fuel with a 10 percent ash content. In addition, the plants release radioactive material in microcuries per year ^{226}Ra, 115; ^{228}Ra, 94; ^{228}Th, 65; and ^{232}Th, 113 (Parker 1974b).

Looking at the health effects of the sulfates only and noting that "levels of urban sulfates relate quite closely to geographical clustering of fossil fueled power plants," Carl Shy estimates that due to sulfur oxide exposures in the Eastern United States alone, that illness as shown in Table 1 will result (Shy 1975).

In addition to the usual atmospheric pollutants, a large number of trace metals are contained in coal and emitted during combustion. In a recent study, based upon insufficient data, it was estimated that cadmium, cobalt, copper, mercury, molybdenum, nickel, tin and wolfram released in pounds per year for the same 21,558 MWe as ascribed to the nuclear power reactors in 1973 were 990, 6800, 150,000, 1300, 13,000, 48,000, 160,000, and 160,000 respectively (Vaughan 1975). These metals are concentrated by green plant tissue by factors of 4.8, 1.3, 1.1, 3.4, 1.6, unknown and 2.1 respectively.

Table 1. Estimates of adverse health effects attributable to sulfur oxide exposures in the Eastern United States

	Estimate of illness attributable to acid sulfates			
	Standards met		Standards not met	
Adverse health effects	1975	1980	1975	1980
Million days of aggravated heart and lung disease	5.3	1.2	24.4	33.8
Increased number (millions) of asthma attacks	2.5	0.8	8.6	11.5
Thousands of lower respiratory diseases in children	48	0	486	888

In addition, insufficient data is available to determine the amount of increase of galium, germanium, radium, tellurium, thorium, thallium, and vanadium.

The conclusions reached in the study were that direct inhalation of aerosolized elements will constitute a negligible health hazard; drinking water concentrations will be several orders of magnitude below proposed concentrations and ingestion of the elements incorporated into green plants "appear small in relation to those caused by modern agricultural practice." There still remain a substantial number of unknowns in this dose-response relationship.

Airborne radioactive releases from nuclear power plants can be substantially reduced. Most of the technology is in hand and for boiling water reactors would consist of catalytic recombiners, cryogenic distillation and liquid storage for 90 days, charcoal absorbers, and HEPA filters. Releases to the atmosphere would then be 4.1 x 10^3 and 1.6 x 10^{-2} curies per year per reactor (3500 MW_t) for noble gases and iodine 131, respectively. For pressurized water reactors (3500 MW_t) the technology would be pressurized 60 day holdup tanks, 100 meter (328.10 ft) stacks,charcoal absorbers and HEPA filters and would release 3.6 x 10^3 and 2.8 x 10^{-2} curies per year per reactor of noble gases and iodine 131, respectively. (USAEC 1973) Sulfates would be reduced to permissible levels by using low sulfur coal or stack gas scrubbers. Though a variety of techniques have been tried, limestone scrubbing appears to be the technology most commonly applied. As of April 1975, 116 units were either operational, under construction or in the planning stages (Pedco 1975).

Hydrospheric Pollution

In 1973, boiling water reactors released to the hydrosphere, 178 curies of mixed fission products and activation products and 333 curies of tritium. The pressurized water reactors released that year 54 curies of mixed fission products and activation products and 11,300 curies of tritium. (USNRC 1975d).

The projected liquid radioactive waste treatment for boiling water reactors would be demineralizers and 90 percent recycle and would limit the liquid releases to 0.8 curies per year per reactor. The projected liquid waste treatment for pressurized water reactors would include demineralizers, evaporators and recycle and would release 2.5 x 10^{-3} curies per year. (USAEC 1973).

Hydrospheric releases from coal fired plants are due to the leaching from the coal storage area, ash pits, and limestone scrubbing system. The supernatant waters from ash disposal and sludge dewatering will be 0.1 to 0.3 gpm per MW and can have dissolved solids of 5000 to 7000 milligrams per liter primarily of sodium, calcium, potassium, magnesium sulfate and sulfate (Cooper 1975).

It is estimated that the operation of the scrubber would cause the release of 12.5 and 5.5 tons of suspended solids and organics respectively per 10^{12} BTU (University of Oklahoma 1975).

Coal fired plants try to maintain a supply of coal for 90 days. Typically 780 to 2340 cubic yards of storage space are required for each MW of rated capacity. (USEPA 1974) For typical rainfall rates, pile runoff for 1000 MW plant would range from 17 to 85 million gallons (64.34 to 321.72 million liters) per year. The contact of coal with air and moisture results in oxidation of metal sulfides to sulfuric acids and precipitation of ferric compounds. Typical concentrations in mg/l in coal pile drainage for a high sulfur content coal from a 568 MW_e plant are total solids, 45,000; total dissolved solids, 44,000; acidity, 28,000; sulfate, 22,000; aluminum, 800; chromium, 0.3; copper, 0.3; iron, 93,000; zinc, 23; and pH of 2.8 (USEPA 1974).

Ground seepage can be minimized by storing the coal, ash or limestone sludge on an impervious base. Vinyl liners have been used for that purpose.

Lithospheric Pollution

The estimated quantities of solids from ash pits and limestone sludge from electric power generation in 1980 (200,000 megawatts) in million of tons per year are bottom ash, 17; fly ash, 40 and scrubber sludge, 71 (Cooper 1976).

For nuclear fueled plants, the estimated solid waste generated by a 3500 MW_t BWR per year are 1800 drums with activity of 1565 curies per year. For a pressurized water reactor of 3500 MW_t the solid wastes generated per year are 1050 drums and 6000 curies (USAEC 1973).

Accidents

If the estimated frequency and consequences of nuclear power plant accidents are correct (USNRC 1975) then the impact of accidents is negligible. Two annual fatalities and 20 injuries are likely to result of the 15 million people living within 25 miles (40.22 km) of the 100 U.S. reactor sites. The impact of accidents in fossil fueled plants are negligible in comparison to normal operations.

Conclusions

Construction and operation of large power plants will cause adverse ecological impacts. Through proper planning and technology these can be minimized. The major question, however, is determining the acceptable level of these impacts as a function of both the costs and the benefits of this technology.

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Discussion

DR. ODUM: Responding to your comment about the quality of life. The quality of life can be measured by the energy cost of developing it and the amount of quality of life, therefore, what is truly quality, meaning that it contributes toward the continued survival of the environment and man, is that part of the quality which has some kind of amplifier factor feeding back.

There are things that can measure this and I am not sure there is any difference between saying, for example, that you have to match energy and the quality of life.

DR. PARKER: In general, there are energy costs and there are energy benefits. If one tends to maximize the net energy, depending upon what the energy source is, one doesn't have to be very efficient in developing solar energy to make benefical use of it. Whereas, if you spend a great deal of energy developing something in a relatively short supply, then you have to have fairly good efficiency.

What I am trying to say is that our highest aim in society is not to be the most efficient in energy utilization but there are other aspects which we need to look at carefully. What the system is doing is maximizing itself to total energy, the total for the combined system.

MR. WEIZMAN: I would just like to make a comment and possibly also make a suggestion as to future action.

I don't know that there is time to say it but these have been very enlightening talks and, of course, we also have been reinforcing each other's feelings about protection of the environment. However, we still will all go away from here and feel frustrated, especially when we go out to do our real work.

In order to accomplish what we desire, we have to take these matters into consideration at the earliest possible stage of the planning program or perhaps sometimes we may have to go to court.

Two recent surveys, one conducted in 1972 in relation to university students across the country and the other by the U.S. Chamber of Commerce, show the attitude of the people of this country to be that they are not very much concerned with future economic growth. This is a world of generalizations. There are groups that feel differently about some of these things. There is a group of younger people who are concerned with protecting the environment and they are willing to pay the cost, which is considered to be from one to five percent of the G.N.P., depending upon the situation.

What I am trying to say here is that most of us agree that something has to be done and that we are doing it, at least to a certain extent, but we have always shyed away from working with the people who can make the difference.

For example, the societies represented here, to my knowledge, do not ever send representatives, for instance, to meetings of the U. S. Chamber of Commerce to make their desires known. I believe that it is time, especially in the light of the newly emerging attitudes, that we as citizens also participate in relation to the impact of these decisions, especially in order to avoid later heavy costs. In other words, to help in the decision making with regard to the environmental aspects. I think that this kind of participation on our part would take us a long way and a little faster than we are presently going. Thank you.

Using Animal Population Characteristics to Improve Management

Chairman:
RICHARD D. TABER
Professor, College of Forest Resources
University of Washington, Seattle

Cochairman:
FRED BUNNELL
Faculty of Forestry
University of British Columbia, Vancouver

The Use of Protein Variation in the Management of Salmonid Populations

Fred M. Utter
National Marine Fisheries Service, Northwest Fisheries Center, Seattle, Washington

Frederick W. Allendorf
University of Montana, Missoula

Bernie May
Old Town, Maine

Protein variations that are detected by electrophoretic methods and that reflect simple genetic variations have found increasing applications over a broad range of biological sciences during the past two decades following the initial description of starch gel electrophoresis (Smithies 1955). Much of the attention concerning this biochemical genetic variation has focused on the biological significance of the surprisingly large amount of variation that has been observed within most of the organisms studied, and considerable controversy persists concerning whether or not the bulk of this variation is selectively neutral (reviewed in Lewontin 1974). The basic biological interest in this genetic variation has strongly overshadowed the considerable value of biochemical genetic data as a tool in the management of both wild and cultured animal and plant resources. As a consequence, management scientists have not become adequately aware of the potential for practical application of biochemical genetic data.

Biochemical genetic variations of aquatic animals have been studied at the Northwest Fisheries Center for a number of years. The main purpose of these investigations has been to gain a better understanding of the genetic structure of populations and to use this information in the management of these resources. This practical orientation has led to cooperative studies with fish management agencies seeking specific answers concerning population structure of a given fishery. This paper describes the results of some of these studies. Its purposes include (1) a summarization of the current status of some of our cooperative investigations of salmonids, and (2) illustration—through this summary—of ways in which biochemical genetic data can be generally applied in the management of animal resources.

Methods and Materials

The electrophoretic and staining methods that we use have been extensively described elsewhere (Utter, Hodgins and Allendorf 1974; Shaw and Prasad 1970) and will not be detailed here. However we will briefly review three inherent features of the methodology—simple genetic expression, capabilities for collection of large amounts of data, and ease of sample collection and preparation—that are particularly useful for genetic studies of populations.

Electrophoretic separation occurs when an electric current is applied to a dissolved mixture of proteins placed in a starch gel. Different proteins that are genetically related are visualized by specific staining methods and are readily identified as bands migrating different distances in the gel. The protein variants that we select for genetic analysis reflect simple genetic differences. Analyses of such variants are based on purely genetic differences among individuals and populations in the form of genotypic and allelic frequencies. This genetic basis is a major advantage over most morphological variants which usually are affected by an unknown number of genes and an unknown environmental component. The ultimate test for the genetic nature of a variant is actual breeding data where genotypes of progeny occur in Mendelian ratios expected from the genotypes of the parents. Alternate criteria such as similarity to known genetic variants of other organisms, repeatability of expression, and conformance of genotypic frequencies to those expected from random processes (Hardy-Weinberg proportions) may often be used to validate the assumption of simple genetic variation in the absence of breeding data.

Starch gel electrophoresis permits collection of a large amount of data in a given time period. A trained worker can conveniently run, stain, and collect data from four gels in one day. Fifty samples can be run on a single gel, each gel can be sliced into six layers, and each layer stained differentially. Thus, a single trained worker can collect 1,200 units of data per day (and this ignores the fact that multiple loci are often expressed by a single staining procedure).

Most proteins examined can be taken from frozen tissues of intact carcasses. Thus special field processing is not normally a requirement except for large fish where it may be useful to remove portions of tissues of interest in the field. Even proteins normally expressed in the serum—which requires special processing—can sometimes be found in alternate tissues which can simply be frozen; e.g. transferrin, a serum protein, is also expressed in the eye of adult salmonids. Protein solutions are easily obtained by mixing tissue and water with a glass rod in a culture tube and centrifuging for a few minutes.

Species Identification

Adult salmonid species are usually unambiguously identifiable on the basis of external morphology, particularly during the time of spawning. However, morphological identification of very young salmonids is often not possible. Such individuals are readily identifiable to species from biochemical genetic data obtained from freshly collected material (Fig. 1). This capability permits precise species assessment in stream surveys—even at very early life history stages; it has proven particularly useful for identification of cutthroat (*Salmo clarki*) and rainbow (*S. gairdneri*) trout, which often occur sympatrically and are morphologically very similar. Hybrids among the salmonid species that we have studied are

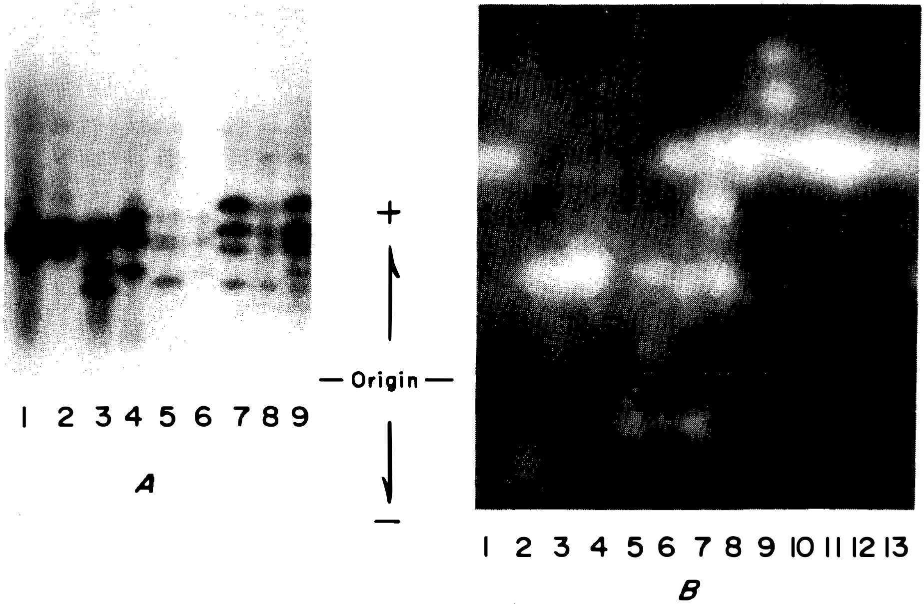

Figure 1. Enzyme stains useful in identification of nine salmonid species of two genera. Each species can be unambiguously identified through combined use of these two systems alone. Note expression of bands from both parent species in hybrids.

A. Creatine kinase (from muscle). 1. cutthroat trout, *Salmo clarki* 2. rainbow trout, *S. gairdneri* 3. masu salmon, *Oncorhynchus masou* 4. sockeye salmon, *O. nerka* 5. chum salmon, *O. keta* 6. pink salmon, *O. gorbuscha* 7. coho salmon, *O. kisutch* 8. chinook salmon, *O. tshawytscha* 9. chinook-masu salmon hybrid.

B. Tetrazolium oxidase (from liver). 1, 13. chum salmon 2. pink salmon 3. coho salmon 4. chinook salmon 5. pink x chinook salmon hybrid 6. masu x chinook salmon hybrid 7. cutthroat trout (heterozygous for common form and slow migrating variant) 8, 9, 10. rainbow trout (9 heterozygous for common form and fast migrating variant) 11. masu salmon 12. sockeye salmon.

usually clearly identifiable through biochemical genetic markers; we have often assisted other workers by identifying the appropriate ancestry of suspected hybrid individuals.

The absence of qualitative biochemical genetic differences among nominal species is insufficient evidence to demonstrate that these populations are conspecific, because sufficient genetic differences for reproductive isolation may exist at unsampled loci. Such data, of course, do not preclude conspecificity of the populations in question and are supportive of positive evidence derived by other means. A study of 20 biochemical genetic loci in rainbow trout, California golden trout, (*S. aguabonita)* and red-banded trout (*S.* sp.)—a group of trout indigenous to dessicated basins of eastern Oregon (Behnke 1965; Wilmot 1974)—indicated that these three natively allopatric groups shared common alleles at every locus (Allendorf and Utter 1974). Conspecificity of these three groups of trout is also supported by the tendency of rainbow and golden trout to readily hybridize when placed in the same drainages (Behnke 1965). The question of species remains unresolved, however, because of the tendency of rainbow trout and cutthroat trout—two valid species—also to hybridize under some conditons (Behnke 1965).

Identification of Major Subgroupings in Natural Populations

A major goal of our studies is the genetic characterization of salmonid populations of the Pacific Northwest. Fulfillment of this goal can provide major insights into the breeding structure of these species and lead to a sound basis for identification of areas of origin in mixed fisheries. The problem has been complicated by the transplantation of stocks from one area to another, but sufficient variation persists among major groups within species to characterize these groups on the basis of frequency differences of biochemical genetic markers. This section summarizes some of our more extensive studies of either natural populations or hatchery populations derived principally from native fish from the area of the hatchery. The data were obtained over a number of years and in many areas, and appear to reflect stable genetic attributes of the populations studied (regardless of whether the variation is maintained by random or selected processes.)

A biochemical genetic survey of 32 loci of anadromous (i.e. seaward migrating) rainbow trout—or steelhead—populations of the Pacific Northwest (Allendorf 1975) revealed considerable genetic heterogeneity among them and indicated some relationships that had not previously been known. A major division occurred at a point coinciding with the crest of the Cascade Mountains (Fig. 2A) and was based primarily on the distribution of variant forms of lactate dehydrogenase (LDH) and tetrazolium oxidase (TO). A similar east-west division of LDH variants has been reported for both migratory and non-migratory rainbow trout on the Fraser River (Huzyk and Tsuyuki 1974). Two major taxonomic units were proposed for rainbow trout of this area on the basis of these findings, a coastal group and an inland group. The inland group presumably descended from rainbow trout residing in large lakes formed from inland drainages of the Fraser and Columbia rivers during the last period of glaciation (McKee 1972). The coastal areas were apparently repopulated by another group—possibly the Asiatic rainbow trout (*S. mykiss*)—when the glaciers receded. The evidence indicating that geographic separation is the principle basis for genetic isolation of

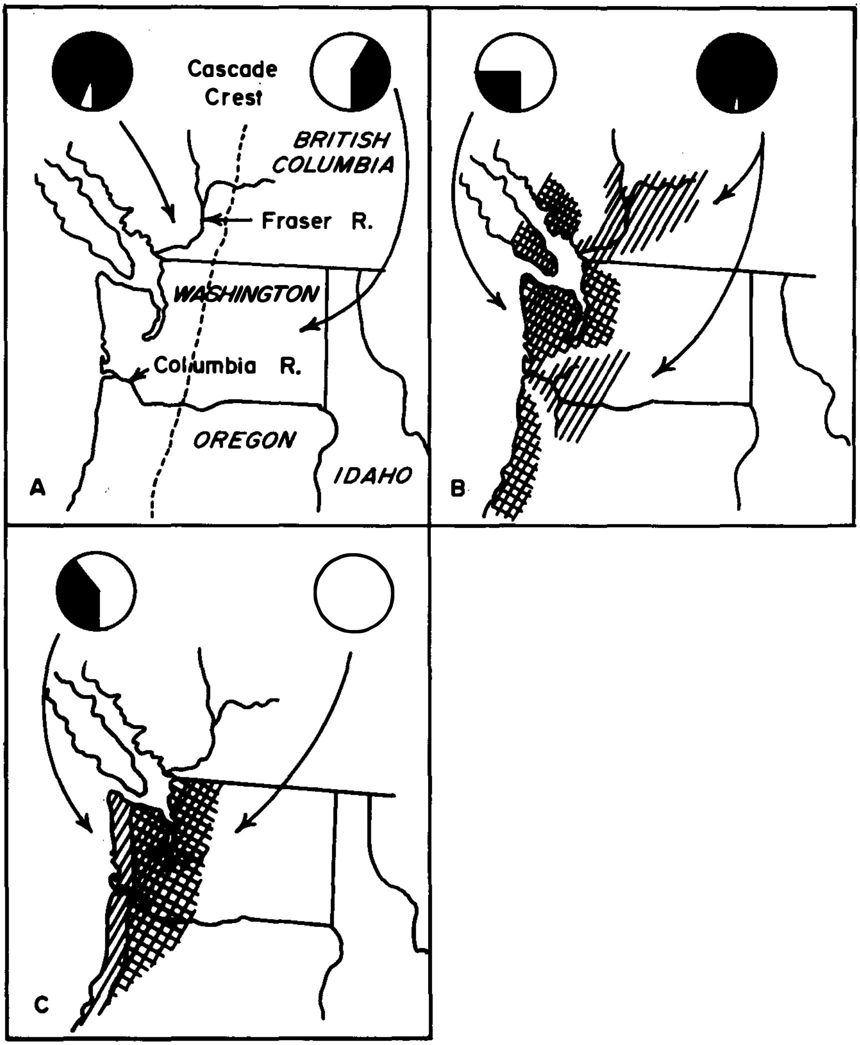

Figure 2. Major population groups in three anadromous salmonid species of the Pacific Northwest.

A. Average proportion of LDH-4 A allele in rainbow trout (represented by shaded areas of circles) in areas east and west of the Cascade crest in Washington, Oregon, Idaho and southern British Columbia.

B. Average proportion of Transferrin A allele of coho salmon (represented by shaded areas of circles) in coastal and Puget Sound drainages of Washington, Oregon and British Columbia (checked areas), and Columbia River and Fraser River drainages (lined areas).

C. Average frequencies of PHI-2(68) allele of fall chinook salmon (represented by shaded areas of circles) in Puget Sound and Columbia River drainages (checked areas) and coastal populations (lined areas) of Washington and Oregon.

rainbow trout populations differs from previous conceptions in which anadromy and time of return to fresh water were regarded as the primary indications of genetic differences (Withler 1966; Millenbach 1973).

Coho salmon (*Oncorhynchus kisutch*) of the Pacific Northwest have been examined in sufficient detail to identify some major population units. Populations of both the Columbia and Fraser Rivers and their tributaries are distinguished by high frequencies of the gene coding for the A form of the serum protein tranferrin (Utter et al. 1970; Utter et al. 1973; May and Utter 1975; May 1975). Coho salmon populations returning to other areas between and on either side of these two large river systems are characterized by a predominance of the C transferrin allele and the presence of the B allele (Fig. 2B). The discontinuous distribution of transferrin alleles among coho salmon populations cannot be directly explained on the basis of glacial events (as could discontinuities of rainbow trout populations on these rivers) because the predominance of the A allele extends the full length of both large rivers. This distribution may be related to environmental factors of the large rivers, a possibility which is currently being investigated.

Populations of chinook salmon (*O. tshawytscha*) returning to fresh water in the fall have been examined from Puget Sound, along the Washington and Oregon coasts, and in the Columbia River (Utter et al. 1973; Kristiansson 1975; May 1975). Coastal populations of Washington and Oregon have high frequencies of variants of phosphohexose isomerase (PHI) and also usually have phosphoglucomutase (PGM) variation; both PHI and PGM are invariant in samples taken from Puget Sound and the Columbia River (Fig. 2C). These differences indicate considerable genetic isolation of coastal and non-coastal populations of fall run chinook salmon and are potentially very useful for determining major areas of origin of ocean caught fish.

These biochemical genetic studies of salmon and trout populations have defined major natural population units that had not been previously identified. This knowledge is presently being used in the management of these fisheries. Allocation to one or another major grouping in mixed fisheries can be made using known gene frequencies from the major groups and gene frequencies obtained from sampling of the fisheries. An actual example of this application is outlined in Table 1 for coho salmon collected in the Pacific Ocean near Neah Bay, Washington during the fall of 1975. The data indicate that a sizeable proportion of this fishery is supported by the two large river systems.

These data can also be used to suggest modifications of current management practices. Steelhead returning to the Columbia River in the summer have previously been regarded as a single genetic unit, contrasted with those returning in the winter (Millenbach 1973). Planting of summer run steelhead derived from coastal fish in inland areas (where all steelhead are summer run fish) have been unsuccessful (Personal communication, Washington State Department of Game). This failure is more understandable now that the major grouping of steelhead appears to be based on inland and coastal populations rather than time of return, and it is not surprising that coastal fish were inadaptive to inland areas.

Statistical differences also exist among natural populations within major subgroupings of these salmonid species. For instance, coho salmon populations in

Table 1. Estimated proportions of Columbia and Fraser River fish in samples of coho salmon caught in the Pacific Ocean near Neah Bay, Washington.

Collection number	Collection date	Sample size	Frequency of transferrin A allele in ocean catch	Estimated proportion of Columbia and Fraser River fish in sample[1]
1	7-25-75	53	.537	.39
2	8-12-75	106	.425	.25
3	9-8-75	110	.464	.30
4	9-11-75	114	.504	.35

[1]Based on assumption of fixation of A allele in Columbia and Fraser Rivers, and average frequency of A allele of .250 calculated from 59 collections from other areas of Washington State; proportion (p) calculated by $p = \frac{F_m - F_w}{F_{fc} - F_w}$ where F_m is A allele frequency in ocean catch, F_{fc} is A allele frequency in Columbia and Fraser Rivers and F_w is A allele frequency in Washington State coastal and Puget Sound streams.

south Puget Sound are characterized by average gene frequencies of a variant LDH allele of about 0.05; this allele is virtually absent in north Puget Sound populations (May 1975). Differences among coastal steelhead populations are seen in the frequencies of alleles at many loci in addition to the LDH and TO variants that distinguish the major inland and coastal groups. These variations are generally more subtle than those observed between major subgroups; they are useful in defining populations and are potentially applicable in identifying component populations of mixed fisheries. The application in the latter case is complicated by multiple genetic variants and populations beyond the simple instance outlined in Table 1. Analysis is feasible—providing appropriate baseline data are available—by fitting the appropriate data parameters through computerized methods using the techniques of maximum likelihood and minimum chi-square (Kempthorne 1957; Krieger et al. 1965). Personnel of our group are presently developing and applying this analytical capability.

Biochemical Genetic Variation in Hatchery Populations

The emphasis to this point has concerned the management applications of protein variants of natural populations. The focus now shifts to hatchery populations.

Determining the effects of plantings of hatchery fish on native salmonids of the same species is a major concern to management biologists. Native fish are a valuable reservoir of genetic variation and provide a useful supplement to the fishery even in stocks that are largely maintained through hatcheries. Although native fish may be more adapted to a particular area than hatchery fish, they are potentially endangered through hatchery plantings by factors including (1) competition for spawning and rearing ground resulting from large hatchery releases, (2) possible earlier hatching of progeny of hatchery fish resulting in a competitive advantage, and (3) hybridization of native and hatchery fish resulting in disruption of adaptive gene pools.

Biochemical genetic markers are very useful for studying the effects of hatchery plantings on native fish providing there are differences in gene frequencies between the two groups. Genetically marked hatchery fish require no special handling prior to release, and long term effects of plantings can be measured because genetic markers are passed on to subsequent generations.

We are presently collaborating with the Washington State Department of Game in studying the effects of plantings of two stocks of hatchery steelhead maintained by the department which have been introduced in certain rivers of Washington State. The Kalama River, a tributary of the lower Columbia River, has been heavily planted in recent years with summer run steelhead from the department's hatchery on the Washougal River, which enters the Columbia River 30 miles upstream from the Kalama. Native fish from the Kalama River and winter run hatchery fish that have been planted in the river both lack genetic variants for alpha glycerophosphate dehydrogenase (AGPD) while the Washougal hatchery stock has a variant form of the enzyme with a gene frequency of about 0.15. This difference has been useful in tracing the effects of plantings of Washougal hatchery fish in the Kalama River and other river systems of western Washington.

Data from these preliminary studies indicate some interesting interactions of Washougal hatchery fish with other steelhead stocks of the Kalama River. Hatchery fish planted in the main stream of the Kalama River tend to enter tributaries prior to their seaward migration. Adult fish from hatchery plantings return near the point of release and many of them spawn successfully. Descendents of these fish apparently hatch earlier than those of other stocks based on their larger size in a given sampling area (although existing data cannot exclude other factors such as faster growth rates). Almost all of the residualized steelhead (i.e. fish that remain in the river rather than migrating to sea) appear to be from the Washougal hatchery. These data indicate considerable long term competition of Washougal hatchery fish with the native steelhead stocks of the Kalama River. Plans for more detailed studies of this competition are outlined in the next section.

Genetic Marking of Hatchery Stocks

The potential value of a genetic marker for the identification of populations increases as the differences in its frequency increases between populations. The sample size needed to demonstrate differences between two populations decreases to the point where individual fish can be identified if different alleles for a particular protein are fixed in the two populations. Such a situation rarely occurs naturally within a species—particularly among populations where gene flow is possible—but can be straightforwardly created through artificial propagation.

We are presently working with the Washington State Department of Game to create genetically marked stocks for maximizing genetic differences between these stocks and native fish in areas where the stocks are to be planted. One such stock is being bred from Washougal hatchery fish for introduction into previously unplanted tributaries of the Kalama River. Breeding is based only on the AGPD variation. Fish are selected for breeding by a screening process involving muscle biopsy, tagging and electrophoresis of muscle samples. The breeding scheme is outline in Table 2. Initial selection based on alternate homozygous males (A'A') bred with randomly selected females will be repeated each year for four years (we have presently completed two years). After that time the progeny of the first year's crosses will return as adults to the point of release; this point is a previously unstocked pond where only selected progeny have been reared. These fish will be screened for A'A' individuals of both sexes to be used exclusively as breeders, and this procedure will also be repeated each year for four years. The A' allele will now be fixed in this stock and spawning fish returning to the site of release can be spawned randomly. Fish returning to the pond should be screened periodically to assure that a signficant influx of unmarked fish does not enter the spawning population.

There are two potential genetic pitfalls that must be kept in mind in a breeding scheme of this kind. The first of these is the possibility that the variant form of AGPD (or any other protein that might be selected) has a selective disadvantage contrasted with the common form of the enzyme. If such a disadvantage exists, the selected stock would be less genetically fit than the parent stock and conclusions drawn from the selected stock pertaining to the parent stock would be biased. It is therefore important to select a marker that is not obviously associated with any negative characteristic, and to carry out controlled tests on selected and parent stocks to be reasonably sure that both stocks are comparable for measurable variables other than the selected marker. This danger is especially present when selecting for an allele which is very rare in the original population. An allele present at an original frequency of less than 0.01 is much more likely to have a potential harmful effect than an allele which is present at a frequency of 0.15 and is therefore already present in 25 percent of the fish in the

Table 2. Breeding scheme for fixation of AGPD A' allele in a derivative stock of Washougal hatchery steelhead.

	Genotype frequencies			Allele frequencies	
	AA	*AA'*	*A'A'*	*A*	*A'*
Parental population					
Total population	0.723	0.254	0.023	0.850	0.150
Breeding males	0.000	0.000	1.000	0.000	1.000
Breeding females	0.723	0.254	0.023	0.850	0.150
First generation after selection					
Total population	0.000	0.850	0.150	0.425	0.575
Breeding males	0.000	0.000	1.000	0.000	1.000
Breeding females	0.000	0.000	1.000	0.000	1.000
Final derivative stock					
Total population	0.000	0.000	1.000	0.000	1.000

orginal population (assuming Hardy-Weinberg proportions). We have not detected any differences among the three AGPD phenotypes of the Washougal stock, and relative attributes of the parent and selected stocks are being monitored.

The other genetic pitfall that must be remembered is inbreeding. Inbreeding depression is a loss of vigor that occurs in most sexually reproducing organisms as a result of the reduction of genetic variation accompanying excessive breeding of closely related individuals. This depression reflects factors including expression of deleterious recessive genes, and the reduction of beneficial interactions both within and between genetic loci. Inbreeding coefficients above 0.10 (this represents a loss of 10 percent of the genetic variation present in the original population) are often sufficient to result in detectable loss of vitality. The inbreeding coefficients, induced in founder populations originating from 100 females and 1 to 10 males are plotted in Figure 3. It is apparent that use of a single male would create a potential danger to the stock from inbreeding, and that this danger is reduced dramatically as additional males are used up to six, where a leveling off point is reached. Initial inbreeding is not noticably increased in subsequent generations provided selection is randomized and adequate numbers of individuals—say 50 or more of each sex—are bred. Both of these potential sources of genetic weakness must be anticipated in planning a genetic marking program but neither represents a serious obstacle if appropriate variants are selected within the parent population.

We foresee artificial genetic marking of hatchery stocks becoming a very useful mangement tool. The breeding scheme outlined in Table 2 was a special case

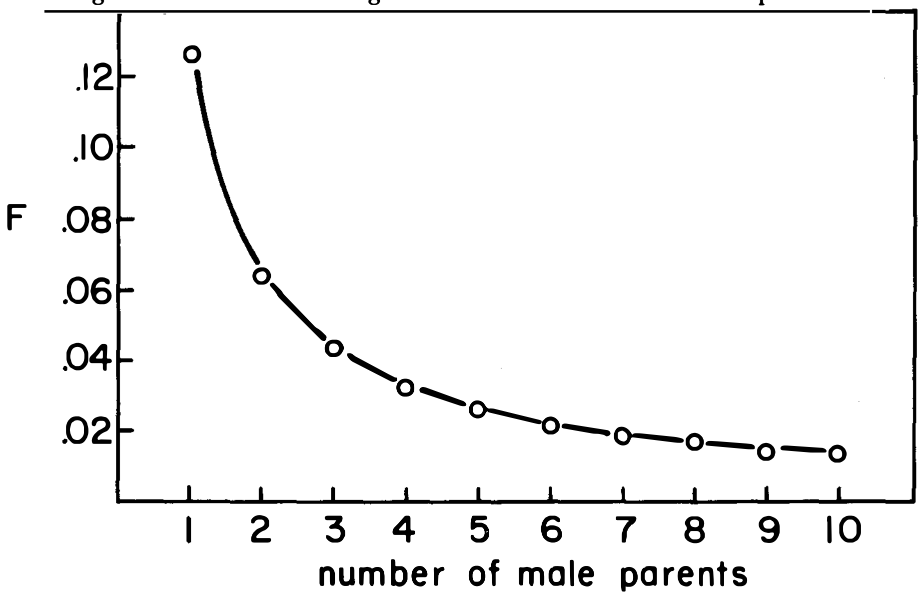

Figure 3. Coefficients of inbreeding (F) based on 100 female parents and varying numbers of male parents. $F = \frac{N_m + N_f}{8 N_m N_f}$ where N_m = number of male parents; N_f = number of female parents = 100.

of an anadromous stock being brought to fixation with males only being selected in the first generation. The process can be simplified in hatcheries where brood stock are maintained because the same individuals can be used in successive years. If fixation of a marker gene is not required, useful gene frequency changes can be achieved in a single generation even if only males are selected (e.g. Tab. 2). Change of gene frequency can obviously be accelerated if intial selection for both sexes is feasible.

The fate of hatchery and wild fish presently is of more than biological interest in salmonid fisheries of the Pacific Northwest. Recent Washington State court decisions have indicated that native Americans may be entitled by treaty to 50 percent of the natural spawning salmonids returning to rivers of ancestral fisheries, but to a lesser share of hatchery fish. Sea ranching is a concept being developed currently in which privately reared salmon are released to grow naturally in the marine environment, and are then harvested by the releasing organization upon their return. Genetically marked stocks have obvious management implications in both of these instances.

Acknowledgements

We wish to acknowledge the assistance of the following agencies in these studies: The Cooperative Fishery Unit, University of Washington; Washington State Department of Fisheries; Washington State Department of Game. We are grateful to numerous graduate students who have assisted in collection of some of the data, and to our associates; Jack Hitron, James Seeb, George Milner, Pete Davenport and Stew Grant who have assisted in the collection and analyses of data and who are presently continuing these and other programs at the Northwest Fisheries Center.

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Discussion

CO-CHAIRMAN BUNNELL: This was an interesting paper because we are having some real difficulties in British Columbia right now in the traffic of our fish population when they end up on the high seas.

MR. RICHARD WARNER [University of Florida]: A specific question relates, Dick, to the last slide.

We are thinking of using these procedures to determine regional populations of spiny lobsters which are found throughout the Caribbean, and which, in larva stage, circulate largely as plankton throughout the system.

Your last slide gave me considerable concern unless I did not understand it. You showed that the three coastal populations as being essentially asymetric and then you showed the two geographically separate river systems as having the same population characteristics. This should be sufficient geographical isolation to be demonstrably different between ethnic populations in some sections. Would you comment on that?

MR. MAY: This particular locus happens to be one of the few that was not under selection transference, and this may be why, for some reason in those two river systems, it is the same. But the mixing isn't really important. With regard to your inquiry as far as the larva stages are concerned, you might find some difference in protein between the larvae and the adult. I do not know whether you have tested that or not.

MR. GARY LAMBACHER [Lakewood, Ohio]: In the case of the Red Wolf, there is controversy as to whether or not it is a separate species or a cohort hybrid. Do you know what the species is? It is thought to be a hybrid between wolf and coyote?

MR. MAY: As long as there is sufficient difference between wolf and coyote, I would bet everything on it that it is. It would be possible to determine whether that is a hybrid.

Furthermore, I was speaking of first-generation hybrids, but it works as well on later-generation hybrids.

CO-CHAIRMAN BUNNELL: I notice that you have a gentleman from Morgan as co-author. I was curious to know whether there has been any work of this type done in Chicago?

MR. MAY: Actually, yes.

CO-CHAIRMAN BUNNELL: Despite the fact that I am associated with the University of British Columbia, we do a lot of work cooperatively with line agencies, both in Canada and the United States. A lot of times when I phone these individuals they tell me they are up to their knees in alligators.

I have often thought that was what we should be doing, is matching the alligators' success. I notice in this next paper we have a start, perhaps, in the crocodiles.

Jim Nichols is going to talk to us about that, and again we will note a gain. There will be several references this morning to computer simulation techniques.

The Use of Restocking Quotas in Crocodilian Harvest Management[1]

James D. Nichols
Department of Fisheries and Wildife,
Michigan State University,
East Lansing

Robert H. Chabreck
School of Forestry and Wildlife Management,
Louisiana State University,
Baton Rouge

Walt Conley
Department of Fisheries and Wildlife,
Michigan State University,
East Lansing

Historically, restocking programs have generally been regarded as ineffective tools in the continued management of wildlife populations (Allen 1974). Despite this history of limited success, however, restocking holds considerable potential for crocodile management. Recently, successful hatching and rearing programs have been reported for numerous crocodilians including the American alligator, *Alligator mississippiensis* (Chabreck 1967, 1973; Joanen and McNease 1971), the Nile crocodile, *Crocodylus niloticus* (Pooley 1966, 1969b, 1971; Blake 1974; Atwell 1973), and several other species (Yangprapakorn et al. 1971; Downes 1973; Honegger 1973). The restocking of areas with artificially hatched and reared young has also been generally successful (Chabreck 1971; Pooley 1971, 1973a). The potential importance of hatching, rearing, and restocking programs to alligator population growth has been demonstrated via computer simulation (Nichols et al. 1976).

In many underdeveloped countries crocodilians are overhunted and persist at relatively low densities, with harvest yields being achieved at the expense of population growth. In such low density situations, increased harvest rates result in temporary increases in yield and in decreased population growth. In this paper we examine the potential use of restocking programs as a means of reducing or eliminating the detrimental effect of harvesting on population growth, while still maintaining harvest yields. The feasibility of the proposed management system results directly from certain specific characteristics of crocodilian populations. We first discuss these characteristics and their relevance to restocking management. We then describe the proposed management system and provide a theoretical derivation of restocking quotas. Computer simulation is used to examine population growth rates and harvest yields for various restocking quotas and to demonstrate the general applicability of the management system. Practical considerations regarding implementation of the proposed program are discussed.

[1]Michigan Agricultural Experiment Station Journal Article Number 7579.

Crocodilian Characteristics and Restocking Management

One important characteristic of crocodilians is the behavior and viability of artificially reared animals. Unlike individuals of many wildlife species, artificially reared crocodilians respond as wild animals when released into natural populations (Chabreck 1971). This qualitative similarity between wild and artificially reared animals is essential to the success of any restocking program. Also, crocodilians exhibit little maternal care relative to many other commercially important wildlife species, and artificial rearing and restocking programs are thus relatively inexpensive and simple to operate. Although crocodilians do show some forms of maternal care (Cott 1971; Kushlan 1973), such behavior is primarily directed at release of hatchlings from the nest. Crocodilians do not actively incubate eggs or feed hatchlings; forms of parental care which would require expensive techniques in artificial programs.

Survival patterns of crocodilian populations form the basis for the applicability of restocking management. In the wild, crocodilian survivorship curves typically approximate the Type III theoretical curve of Deevey (1947). Crocodilian eggs and young generally suffer very high mortality rates, while adult animals exhibit high survival rates (Cott 1961; Pooley 1962, 1966, 1969a; Cott and Pooley 1972; Guggisberg 1972; Nichols et al. 1976). Artificial hatching and rearing programs can greatly reduce mortality rates of crocodilian eggs and young, and animals can be reintroduced to natural populations at a size and age of low vulnerability.

As an illustration of crocodilian survival patterns, we have plotted hypothetical female survivorship curves for the alligator population inhabiting the privately owned coastal marshland of Cameron and Vermilion parishes, Louisiana (Fig. 1). These two l_x schedules, corresponding to natural conditions and artificial incubation with 2 years of rearing young, were obtained from survival estimates synthesized by Nichols et al. (1976). Natural survival rates for this population apparently vary as functions of several abiotic and biotic factors. The l_x values were calculated assuming constant marsh water depths at .5 ft (15 cm), constant population density equal to that of 1973 (71,900 animals), and no severe winter freezes. The l_x values were calculated for freshly-laid eggs and thus represent the probability that a new egg will produce an alligator which enters age class x. The l_1 values include both egg mortality and mortality of hatchlings during their first year of life. A comparison of the two survivorship curves in Figure 1 illustrates the great increase in survival rate which can be achieved through the use of artificial incubation, rearing, and restocking methods. The finite rate of increase of a population (λ) is defined by the $l_x m_x$ schedule. Assuming a common m_x function, restocking management thus serves to increase the population λ, by increasing l_x values. Because of the unrealistic assumptions of constant and favorable environmental conditons, we do not wish to emphasize the l_x values themselves, but the magnitude of the difference between the two l_x schedules is worthy of note.

Harvest Management

The usual approach to wildlife harvest management is to obtain some sort of population density or growth rate estimate prior to each harvest season. Decisions are then made regarding the number of animals which can be removed from the population, and appropriate harvest regulations and quotas are established.

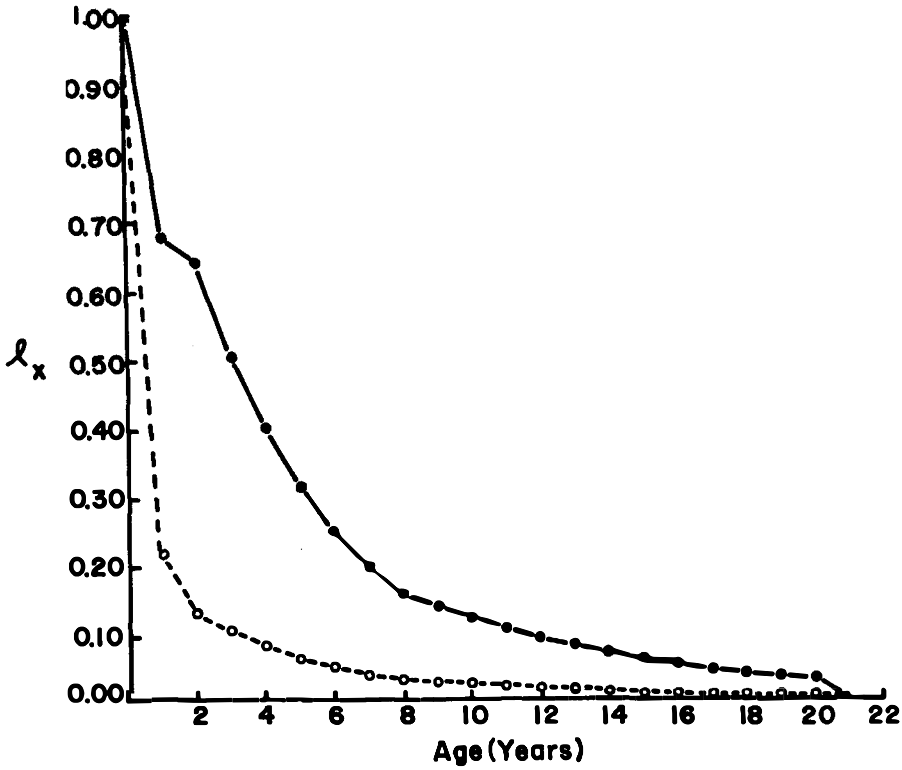

Figure 1. Hypothetical alligator l_x schedules corresponding to natural conditions (broken lines) and egg collection and incubation with two years of artificial rearing (solid line).

The best example of this approach to harvest management in crocodilians is provided by the alligator program in Louisiana. After 15 years of intensive alligator research (see summaries in Chabreck 1971; Joanen and McNease 1973), experimental harvest seasons were conducted in 1972 and 1973. Immediately prior to each of these seasons, alligator densities in the harvest areas were estimated by aerial nest count surveys (Chabreck 1966), and harvest quotas were established based on these census data (Palmisano et al. 1973; Joanen et al. 1974). Strict regulations were imposed in order to specify the size and sex composition of the harvest. The two seasons were apparently successful, and preliminary results indicate that the harvested populations suffered no detrimental effects (Palmisano et al. 1973; Joanen et al. 1974).

We propose a method of harvest management which can be used to supplement the scheme just described. Basically, the method involves the requirement that harvesters collect eggs and rear and release young animals in numbers which are directly proportional to the number of female crocodilians harvested during the previous season. Specifically, we suggest that eggs be collected during the first nesting period following each harvest, and that young animals be reared and reintroduced to the population 2 years subsequent to that time. As a practical consideration, we suggest that the actual egg incubation and rearing and release of young be conducted by the appropriate management agency and that the quota for harvesters take the form of financial compensation for this service. The number of eggs to be collected for each harvested female is specified by the management agency and is dependent upon the desired rate of increase for the harvested population. If annual harvest yields exceed annual restocking costs, then the proposed system will succeed in accomplishing its objectives of promoting population growth while maintaining harvest yields.

Theoretical Restocking Quota Calculation

As an idealized illustration, we consider calculation of restocking quotas necessary to maintain population growth rates similar to those of unharvested populations. For each year subsequent to a female's removal it is possible to calculate the number of young which she would have produced had she lived. However, this requires keeping extensive records, since young would have to be released each year throughout the original expected lifespan of every harvested female. It is more practical to assign single egg collection quotas immediately subsequent to each season, and we thus demonstrate the calculation of quotas for this management system. Reproductive value (Fisher 1958) is defined as:

(1) $$v_x/v_0 = \lambda o/l_x \sum_{y=x}^{\infty} \lambda^{-y} l_y m_y$$

where x denotes age, l_x and m_x are the life table survival and fertility functions, and λ is the finite rate of increase of the population. Reproductive value (v_x) represents the expected contribution to future population growth of a female aged x, expressed relative to the contribution of a female aged 0 (where $v_0 = 1$).

Total reproductive value (V_t) for the segment of the population harvested at time t is:

(2) $$V_t = \sum_{x=0}^{\infty} n_{x,t} v_x$$

$n_{x,t}$ denoting the number of females harvested in each age class x, at time t. V_t is equivalent to the number of individual females of age 0 (new eggs) which should be added to the population to compensate for the loss of the harvested animals and to restore to the population the total reproductive value it exhibited immediately prior to the harvest. If we assume (see MacArthur 1960) that populations with different age distributions which do not differ in total reproductive value also do not differ in instantaneous rate of increase (r), then the addition of V_t new female eggs to the population will result in maintenance of pre-harvest rates of increase.

The goal of the proposed restocking program is to increase the survival rates of eggs and young animals and then to reintroduce animals which have passed the period of highest mortality. For most crocodilians, a large reduction in natural mortality can be achieved with a rearing period of 2 years. Therefore, if Y_{t+2} denotes the number of 2-year-old females to be introduced to the population in year $t+2$, then:

(3) $$Y_{t+2} = V_t l_2$$

where V_t is the total reproductive value of the female segment of the population harvested in year t, and l_2 is the probability that a new egg will survive to enter age class 2 under natural conditions.

Given Y_{t+2}, we must finally calculate the number of eggs to be collected in year t, in order to obtain Y_{t+2} 2-year-old females in year $t+2$. This is accomplished by:

$$(4) \qquad E_t P l_2' = Y_{t+2} + E_t P l_2$$

where E_t denotes the necessary egg collection quota for year t, P represents the sex ratio for eggs (expressed as proportion female), and l_2' expresses 2-year-old survival rate under artificial incubation and rearing conditions. $E_t P l_2$ compensates for the number of collected eggs which would have survived to age 2 in the absence of egg collection. The final calculation of egg collection quotas is achieved by rearranging equation 4:

$$(5) \qquad E_t = Y_{t+2}/P\,(l_2' - l_2)$$

This expression stresses the importance of the difference between artificial and natural survival rates $(l_2' - l_2)$. The magnitude of this difference has previously been cited as one of the primary reasons for the feasibility of crocodilian restocking management.

The above calculations unrealistically assume constant l_x and m_x schedules. The described restocking calculations also require assignment of exact ages to harvested individuals. This is difficult for large, mature crocodilians. It would be advantageous to assume a relatively constant proportion of females of different age classes in the harvest, and then to use one specific egg collection quota for all females, regardless of age. In order to relax restrictive assumptions, to test the applicability of a single quota mangement system, and to examine the relationship between harvest yields and restocking costs, we have investigated various restocking quotas by computer simulations.

Experimental Simulations

All simulations were conducted using GATRAID, the FORTRAN version of a model constructed for the alligator population inhabiting the privately owned coastal marshland of Cameron and Vermilion parishes, Louisiana (Nichols et al. 1976). In the model, nesting effort, nest flooding, desiccation mortality, and rates of predation on alligator eggs and young are determined as functions of monthly marsh water depth averages. Cannibalism rates are determined as functions of monthly marsh water depth and total population density. The model includes freeze mortality based on minimum winter temperatures and a harvest option permitting application of various hunting rates. Harvest rates are expressed as a percentage of all alligators of harvestable size (> 4 ft). In all restocking management simulations, "proportional" harvest rates were applied, with animals of a given sex being taken in proportion to their abundance in the population (see Nichols, Conley, and Chabreck 1976 for rationale). A harvest sex ratio of 70 percent males was maintained. The model also permits stochastic treatment of monthly marsh water depths and minimum winter temperatures.

Simulated population response to management efforts was evaluated through the computation of mean finite rates of increase, λ, a measure of population fitness in variable environments (Giesel 1974a, 1974b). Realized finite rate of increase, λ_t, is defined by:

(6) $$\lambda_t = N_t/N_{t-1}$$

where t is time (in this case expressed in years), and N is total population size. The geometric mean of a sequence of realized finite rates of increase is given by:

(7) $$\lambda = \prod_{t=1}^{x} \lambda_t^{1/x}$$

where x is the total number of years over which the mean is calculated.

In the restocking management simulations, harvests occurred in September of each year. Egg collection occurred at the end of June and the first of July, immediately after egg laying. We have experimented with different restocking quotas, expressed as number of eggs to be collected per female harvested in the previous season. We have assumed in our simulations that a maximum of 50 percent of the nests produced by the population can be located in a given year. In practice this percentage will be a species and population-specific variable depending on nesting habits of the species (eg. whether the species is a "mound-nester" or a "hole-nester") and the nature of the habitat occupied by the population. In the Louisiana coastal marshland, a very high percentage of alligator nests can be located each year (Chabreck 1966). However, the hole nests of Nile crocodiles inhabiting swampland would be more difficult to locate.

During years of low breeding percentages in the simulated population, it was possible for the total egg collection quota to exceed the maximum number of eggs which could be located. In this case, the negative quota balance was carried over to the next year, and the normal harvest rate was reduced by a factor of .5 for that year and all subsequent years until the negative quota balance was eliminated. Negative balances were observed in only 3 of the 480 total years represented by the simulations.

In the proposed management scheme, eggs are incubated and young animals are reared for 2 years under artificial conditions and then reintroduced to the wild population. In the simulations, the number of animals introduced to the population as 2-year-olds thus depended on the number of eggs collected 2 years previous and on the 2 year survival rates (l_2') for artificially reared animals (Fig. 1). We allowed the actual l_2' values to vary randomly (using a uniform distribution) between $\pm$ 5 percent of the expected value. All experimental simulations were conducted for a period of 32 years. Harvesting occurred during years 1-30 of each simulation, and restocking occurred during years 2-32.

The experimental simulations were designed to test the potential utility of restocking quotas as a means of reducing the detrimental effect of harvesting on alligator populations, while still maintaining harvest yields. In these simulations harvest rates remained constant at 12 percent except during years of negative egg collection quota balances. The stochastic modification was employed to obtain five sequences of randomly generated marsh water depths and winter temperatures. A Monte Carlo approach was taken, and five simulations corresponding to these different sets of abiotic factors were run for each management option.

A summary of simulation results is presented in Table 1. Population responses to different management options for one specific set of environmental conditions are plotted in Figure 2. In the absence of restocking, the 12 percent harvest rate produced declines in the simulated population and resulted in an overall λ value of .9870. The simulated collection of five eggs per harvested female and the introduction of the artificially reared 2-year-old survivors from these eggs was sufficient to produce an overall λ value slightly greater than one. A collection quota of 15 eggs per harvested female resulted in an overall λ value which was slightly greater than that of populations not subjected to annual harvests (Table 1).

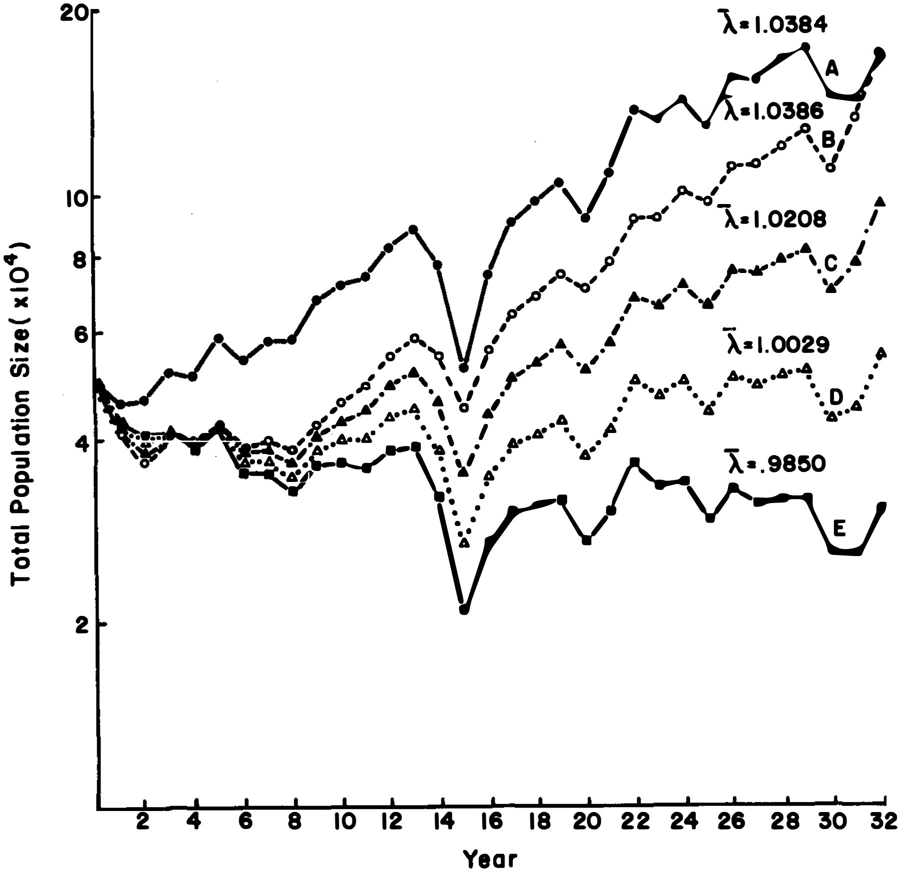

Figure 2. Simulated alligator population response to various restocking management options: (A) harvest rate = 0, egg collection quota = 0; (B) harvest rate = 12%, egg collection quota = 15; (C) harvest rate = 12%, egg collection quota = 10; (D) harvest rate = 12%, egg collection quota = 5; (E) harvest rate = 12%, egg collection quota = 0.

Table 1. Results of 32-alligator simulation runs under various management options.

Management option	Y	Mean eggs collected per year[a]	Mean annual cost of restocking program (dollars)[b]	Mean annual yield	
				Linear feet of hide	Dollars[c]
Harvest rate = 12% Egg collection quota[d] = 0	.9870	—	—	6,938(363	74,743(3862)
Harvest rate = 12% Egg collection quota = 5	1.0049	2,661(272)	13,304(681)	9,258(466)	99,045(4418)
Harvest rate = 12% Egg collection quota = 10	1.0227	7,356(343)	36,780(1717)	12,629(588)	134,231(6221)
Harvest rate = 12% Egg collection quota = 15	1.0401	15,312(564)	76,562(2820)	17,340(650)	183,256(6919)
Harvest rate = 0 Egg collection quota = 0	1.0398	—	—	—	—

[a]Standard deviations were calculated for mean eggs collected per year, mean annual restocking costs and mean annual yields, and these values are shown in parentheses. The standard deviations express variation between the different stochastic simulations.

[b]The cost of collecting and incubating 10,000 eggs and rearing hatchlings for a period of 2 years was estimated to be $50,000. The estimated cost of major expenditures include: food, $12,000; equipment and supplies, $10,000; labor, $18,000; facilities, depreciated over a 32-year period, $10,000.

[c]Montary yields were calculated using predicted future alligator hide prices. Predicted prices are $7.50 per foot for 4 feet alligators and $12.00 per foot for animals 5 feet and larger (Mirandona Brothers, pers. comm.).

[d]Egg collection quota refers to the number of eggs collected per harvested female.

Mean annual yields of hide and costs of restocking programs are also presented in Table 1. In all cases the net yields of the restocking simulations (mean annual yield - mean annual restocking costs) exceeded the mean annual yields from the no-restocking simulations. Thus, the restocking programs not only produced greater population growth rates than the no-restocking simulations, but also resulted in greater net monetary yields. It must be noted, however, that restocking costs and hide prices are variable and that the observed yield differences are subject to variation also.

Discussion

The simulated use of restocking quotas in conjunction with traditional harvest management was successful in elevating mean finite rates of increase for the harvested alligator populations. In addition, the simulated restocking system produced increased harvest yields, which exceeded restocking costs in all cases. Restocking thus appeared to be successful in both maintaining harvest yields and reducing the detrimental effect of harvesting on alligator population growth.

With the exception of the American alligator in certain areas of coastal Louisiana, we know of no harvested crocodilian population which currently exists at high densities. In fact, many populations of commercially valuable crocodilians are overhunted (Bustard 1971; Pooley 1973b). For such populations it would be highly desirable to enact restocking programs designed to elevate rates of increase. Because of the maintenance of harvest yields under restocking management, such programs should be acceptable to harvesters. We thus suggest that the use of restocking quotas may be a politically feasible method of promoting population growth in overhunted crocodilian populations.

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Discussion

CO-CHAIRMAN BUNNELL: Thank you for another interesting paper, and particularly interesting to me because I taught simulation, too.

MR. DALE McCULLOUGH [University of Michigan]: With a lot of population simulation models, very often the critical aspects are based on assumptions. If the assumptions are incorrect, of course, the model will produce questionable results.

What seems to be the critical question is, is there any compensatory processes operating in the population?

And this brings us back to the nature of your original natural letters curve. How was the letter X on the natural population determined? Was this a vertical or horizontal approach?

With the following given year class, do you think that your class is representative of what would happen in future year classes as population density varies?

MR. NICHOLS: There are many problems in the assumptions.

Before I answer the question, could I say that in many of these instances, particularly with crocidilians, people claim to know about the survival rate of the animals? They certainly should or they would not be setting the various harvests quotas that they are. So I think you have to adjust for these explorations of man using various fragmented techniques. Again we are talking about this type of conditional arrangement that Walter mentioned.

Specifically referring to your question of the letter X, two of our most essential letter X values were estimates by Bob Chabreck, who is probably the alligator expert of this country.

Two of the most essential ones came from the low, young-age class, midway to obtaining this, and these were estimates based on the field work in the marsh.

For the upper age classes we were able to follow a specific age class between two different harvest seasons and sample the different portions that we killed in these two seasons.

Specifically, these harvest estimates were not very rigorous and would not stand very close scrutiny, again relating to compensatory mortality. The fact that the crocodiles have been overhunted, and the fact that their populations do decline extremely in the face of hunting, and when hunting is lifted they increase again quite rapidly, I believe argues against some of the more extreme types of compensatory mortality in a way which apparently opts with some of the more prolific game species.

CO-CHAIRMAN BUNNELL: I would like to comment on the degree of compensation, because in the simulations we have done with various wildlife species, we run into the problem, time and time again, in trying to assist line agencies in establishing harvest policies, as to what might be the degree of compensation.

I am not certain just what aspect Bill Kiel will address when he discusses the bobwhite quail population later, but I know that one of the results that he obtained, or one of the parameters in his work is the reproductive value. Had Stirling and Pearson looked only at their letter X values and treated each of these separately, the harvest estimates that they would have had would have been disastrous to the polar bear population.

Feral Asses on Public Lands: An Analysis of Biotic Impact, Legal Considerations and Management Alternatives

Steven W. Carothers
Harold S. Colton Research Center, Museum of Northern Arizona, Flagstaff

Merle E. Stitt and R. Roy Johnson
Grand Canyon National Park,
Grand Canyon, Arizona

The feral ass, or "wild burro," (*Equus asinus*), a native of northeastern Africa, was introduced into North America in the sixteenth century by Spanish explorers. Their value as "beasts of burden" had been recognized as early as 3400 B.C. in Egypt and Mesopotamia (Peake 1933 and Antonius 1937; fide McKnight 1958) and they are still used as such in many portions of the world. Although the feral ass has been in North America since the sixteenth century, it has been reasoned (McKnight 1958) that the species did not become feral in the southwestern United States until sometime during the nineteenth century. Prior to this, the animal was much too valuable to both Indians and Anglos as a work animal, and possibly food, to be allowed to become feral. It was only after the great impetus of mineral exploration had subsided and the settlement of the region ensued that some animals were released, or escaped, and feralization began. By the end of the nineteenth century, the feral ass had become established in many isolated areas of the Southwest. Since their feralization, they have been credited with a considerable amount of habitat destruction resulting in allegedly depriving native animals of essential food and water. In many areas where the feral ass has become established, it has done so at the expense of the native desert bighorn sheep (*Ovis canadensis*), an animal whose numbers have been severely reduced in the Southwest (Russo 1956; Dixon and Sumner 1939; Ferry 1955; Laycock 1974). Also, in a recent analysis of the problem in New Mexico, Koehler (1974) has found evidence that the feral ass directly competes with the native mule deer on certain ranges.

In a recently completed study on feral ass behavior and ecology in Death Valley, California, an area well known for very high population densities of feral asses, Moehlman (1972) denies noticeable habitat damage by the feral ass by stating . . . "Contrary to a widely held belief, the burros I observed did not strip the land, foul water holes or endanger other animals." She adds . . . "Although heavy browsing occurred within a mile of water, my first appraisal of vegetation data indicates [sic] that plants on which burros feed do not suffer severely." Our photographic evidence from Death Valley and the data presented in this paper from our investigations in other areas show that these conclusions are not valid. Blong and Pollard (1968) found that ewes, lambs, and yearling bighorn were concentrated within .75 miles (.46 km) of water during the summer of 1965. Denniston (1965) working in the River Mountains of southern Nevada found that desert bighorn concentrated within .5 miles (.30 km) of their only water source during the hot, dry months of summer. In a brief review of alleged vegetation destruction by the feral ass, Laycock (1974) writes . . . "The destruction of vegetation may cut sharply into rodent populations, reducing food for birds of prey, while habitat for such small birds as quail vanishes." Moehlman (1974) further attempted to evaluate the impact of feral asses on small rodents by counting the number of supposedly active rodent burrows along transects ranging from high to low ass densities. By using this method, no difference was found in the number of apparently active burrows along these transects. Thus, Moehlman concluded on the basis of this questionable sampling technique that the asses were having little or no effect on the rodent populations.

The objective of our study was to quantitatively and qualitatively evaluate the influence of feral asses on desert and riparian habitats in the Grand Canyon, Arizona. Absolute densities of small mammal populations and vegetative composition and structure were investigated. We selected two similar study plots, separated by the Colorado River, with feral asses present on one plot, but not on the other, thereby providing a "control plot" and an "impact plot."

History of the Feral Ass in Grand Canyon

The history of the feral ass' success in the Grand Canyon may be considered typical of the problem throughout the Southwest. By the early 1920's, many rangers in Grand Canyon National Park were reporting to the superintendent that for the sake of the native wildlife, drastic control measures were needed to restrict the destructive and rapidly expanding feral ass population. Burros were credited with much of the overgrazed range condition within the Inner Canyon. This is illustrated by the following quote found in an unpublished report written by Chief Ranger J. P. Brooks in 1932: "Overgrazed conditions existed on all areas ranged over by burros. In many places herbage growth was cropped to the roots and some species of shrubbery were totally destroyed. Soil erosion was greater in burro infested areas . . . "

From 1924 to 1931, a "burro hunt" was conducted in Grand Canyon National Park. The animals were shot with high powered rifles and left to decompose. During this 7 year period, 1,467 feral asses were killed. It was believed that the burro population in Grand Canyon National Park had been reduced to possibly 50 to 75 head, thus, Park Biologists were confident that no more "burro hunts" would be necessary. Yet, between 1932 and 1956, an additional 370 animals were removed. Between 1956 and 1968, 771 more were destroyed with an additional 252 having been captured and taken out of the park. This represents a total removal of 2,860 feral asses from the park in the 45 year period from 1924 to 1969. No control has been attempted since 1969. One of the main reasons for the lack of control efforts has been the negative public sentiment engendered by the "burro hunts" of the mid and late 1960's. This public sentiment, largely initiated by articles written by assinophiles (burro lovers), was quite effective in pushing through protective legislation for wild horses and burros. An example of the severity of public hysteria with which land managers must deal may be found in the text of an article by Weight and Weight (1953): "From time beyond memory, the humble, gentle burro has been man's uncomplaining servant and the playmate of his children. There is a legend that because he carried Mary to Bethlehem and Jesus along the desert trails of Palestine, he was given the mark of the Cross—which you can see upon his back and shoulders." An accompanying photo of a dead burro bears the caption, "Sportsmen, satisfied with the thrill of shooting a friendly burro at point-blank range, often do not even carry out the pretense of hunting for meat, but leave the body as it fell. This burro was shot and left in Great Falls Canyon, not far from where the little colts, above, were found."

In the past, little quantitative data have existed to be used by those who suspected or knew of the environmental havoc that would be wrought by these "starlings" of the mammalian world. Logic and other examples of great ecological damage caused by introduced species, such as rabbits in Australia and red deer in New Zealand, fell way to anthropomorphized sentiments for "man's faithful friend." The result was Public Law 92-195 in 1972, which made killing a feral ass on most lands a felony. Killing bighorn illegally is merely a misdemeanor. We wish here to present quantitative and qualitative data on the environmental hazards wrought by wild burros and other information which raise questions concerning the wisdom of this law if not indeed its legality. It may very likely be that Public Law 92-195 is in conflict with the National Environmental Protection Act of 1969 (Public Law 91-190) and the Endangered Species Act of 1973 (Public Law 93-205).

Procedures

The duration of our field studies was from 1 March 1974 through 31 January 1975. Both study plots received identical quantitative and qualitative vegetational and mammalian analyses. Vegetation was sampled by means of the line-intercept technique (Canfield 1941) and the point-quarter technique (Cottam and Curtis 1956; Morisita 1959). Approximately 2,624 feet (800 m) of line-intercept transects and 50 point-quarters stations were censused per study area. Percentage infestation of mistletoe (*Phoradendron californicus*) was measured by absolute counts of parasitized trees and shrubs on each study area. The vegetation data presented herein are a condensation of our field data collected during May, June, and August 1974.

For mammal censusing, each plot was sampled with a 10 by 12, 5.3 acres (2.2 ha.) grid of Sherman live traps placed at 50 feet (ca. 15 m) intervals. These traps were baited with a rolled oat/scratch grain mixture. Traps were set for four consecutive nights at 4:00 p.m. during March, May, June, November, 1974, and January 1975. They were checked once each day at 7:00 a.m. The following data were recorded: species and individual identification, trap number, sex, reproductive condition, weight (0.1 gram), and age class. Females were classed according to obvious signs of pregnancy, lactation, or vulvar condition. Age classes were determined on the basis of adult or immature pelage. All animals were toe clipped for individual identification. The density of each species was estimated separately by a modification of the Lincoln Index (Bailey 1952). The mammal and plant species diversities of each study area were determined by using the diversity index, H′ (MacArthur and MacArthur 1961).

Description of Study Areas

The sites selected for this investigation are located within the lower reaches of the Grand Canyon in the Mohave desert scrub vegetative community (Lowe and Brown 1973). The impact plot, 209 Mile Canyon, is on the west side (right) of the Colorado River and is inhabited by a small herd (8 to 15 individuals) of feral asses. The control plot, Granite Park, is directly opposite 209 Mile Canyon and shows no evidence of occupation by feral asses. Both study plots are 5.3 acres (2.2 ha.) in size and include both desert scrub and riparian habitats on the alluvial fans of the respective drainages.

The riparian zone of the Colorado River in this section of the Grand Canyon is typified by co-linearly arranged belts of mesic to xeric vegetation. In addition, both study plots are fronted by sand and gravel beaches of river deposit origin. Elevations range from approximately 1,503 feet (458 m) at the river's edge to 1,601 feet (488 m) on the upper terraces above the historic high water line (Dolan et al. 1974).

Both plots show more similarities in gross vegetational composition and structure than differences. An east-west orientation, equal proximity to water and the relatively flat topography of the sites, tends to equalize the abiotic factors of irradiation, moisture gradients and protection from local weather for both sites.

Results and Discussion

Vegetation

An analysis of the vegetation on the control plot and impact plot is presented in Table 1. The control plot supported greater vegetative diversity including an understory of sub-shrubs and a dense carpeting of grasses and forbs (especially plantain). The ground cover and sub-shrub components were virtually absent on the impact area. The control plot contained vegetation cover on approximately 80 percent of the total transect area surveyed compared to 20 percent vegetation cover on the impact plot. The number of species found on the control area was 30 percent higher than that on the impact area.

The mean area (m^2) occupied by each individual cat-claw or mesquite on the control plot was $27.9 m^2$ per plant, while the same species on the opposite side of the river at the impact plot was not as large, occupying only $20.7 m^2$ per plant. Also, there was a higher infestation of mistletoe (*Phoradendron californicus*) on the impact plot, with 16.5 percent of all cat-claw/ mesquite (*Acacia gregii/Prosopis juliflora*) being infested with this parasite as compared to only 5.4 percent of the same species parasitized on the control plot. Cat-claw and mesquite shrubs on the impact study area had been heavily browsed by asses. The mistletoe infestation may be correlated with over-browsing, but a definite conclusion cannot be drawn without further study.

There was no significant difference in total species diversity from one plot to the next, however, the control plot showed a richer sub-shrub and grass component ($H' = 1.60042$ and .821670) than the impact plot ($H' = 1.28478$ and .422710).

Small Mammals

The results of the small mammal population censuses are presented in Table 2. The most striking difference between the populations on the two study areas

Table 1. The line-intercept vegetation data summary for the control and impact study areas.

Species		Control: Relative Density	Control: Relative Frequency	Control: Relative Dominance	Control: Importance Value	Impact: Relative Density	Impact: Relative Frequency	Impact: Relative Dominance	Impact: Importance Value
Shrubs									
Acacia	[1]a.	01.40	8.24	22.02	31.66	14.98	22.31	23.92	61.21
greggii	[2]b.	15.69	16.28	26.73	58.70	35.22	32.93	26.00	94.15
Baccharis	a.	...	...	...	...	00.96	01.65	03.00	05.61
sergilloides	b.	...	...	...	...	02.27	02.44	03.26	07.97
Brickellia	a.	...	...	...	...	02.90	04.96	01.68	09.54
longifolia	b.	...	...	...	...	06.81	07.32	01.83	15.97
Larrea	a.	01.40	09.41	13.14	23.95	03.89	03.30	02.47	09.66
tridentata	b.	15.69	18.61	15.94	50.24	04.54	04.87	02.68	12.09
Lycium	a.	...	...	...	...	00.48	00.83	00.24	01.55
pallidum	b.	...	...	...	...	01.14	01.22	00.26	02.62
Prosopis	a.	05.43	32.94	44.15	82.51	21.26	34.70	60.65	116.62
juliflora	b.	60.78	61.63	53.59	176.00	50.50	51.22	65.95	167.17
Sueda	a.	00.70	01.76	03.07	05.53	...	...	...	...
torreyana	b.	07.84	03.49	03.73	15.06	...	...	...	...
Sub-Shrubs									
Chaenactis	a.	00.52	02.35	00.18	03.05	...	...	...	...
fremontii	b.	26.09	26.65	08.28	61.02	...	...	...	...
Cryptantha	a.	00.79	02.35	00.18	03.32	...	...	...	...
spp.	b.	39.13	26.50	08.28	74.06	...	...	...	...
Dyssodia	a.	...	...	...	...	00.96	01.65	00.15	02.86
pentachaeta	b.	...	...	...	...	11.76	13.32	03.47	28.55
Encelia	a.	00.09	00.59	00.25	00.93	03.86	04.96	03.33	12.15
farinosa	b.	04.35	06.68	11.59	22.62	47.06	40.03	78.87	165.96
Ephedra	a.	...	...	...	...	00.96	01.65	00.12	02.73
spp.	b.	...	...	...	...	11.76	13.32	02.84	27.92
Lepidium	a.	00.44	02.35	00.48	03.27	...	...	...	...
montana	b.	21.74	26.65	21.85	70.24	...	...	...	...
Opuntia	a.	...	...	...	...	00.48	00.83	00.29	01.60
spp.	b.	...	...	...	...	05.88	06.69	06.94	19.51

[1]Data summary comparing density, frequency and dominance of all species in cat-claw/mesquite area.

[2]Data summary comparing density, frequency and dominance only between species of similar strata, i.e., shrubs, sub-shrubs and graminoids.

Table 1 (cont.)

Species		Control: Relative Density	Control: Relative Frequency	Control: Relative Dominance	Control: Importance Value	Impact: Relative Density	Impact: Relative Frequency	Impact: Relative Dominance	Impact: Importance Value
Sub-Shrubs (cont.)									
Porphyllum	a.	00.09	00.59	01.07	01.75	01.93	00.33	03.30	05.56
gracile	b.	04.35	06.68	49.34	60.37	23.53	07.89	26.63	58.05
Sphaeralcea	a.	00.09	00.59	00.01	00.69	...	...	...	...
fendleri	b.	04.35	06.68	00.66	11.69	...	...	...	...
Grasses and Forbs									
Bromus[3]	a.	43.13	28.24	07.85	79.22	45.41	20.35	00.85	66.61
rubens	b.	48.22	72.73	52.89	173.84	95.92	85.00	90.14	271.06
Festuca	a.	00.87	00.59	00.09	01.55	01.93	02.48	00.09	04.50
spp.	b.	00.99	01.52	00.58	03.09	04.08	15.00	09.86	28.94
Plantago	a.	20.56	04.71	04.01	29.28	...	...	...	...
spp.	b.	23.18	12.12	22.95	58.25	...	...	...	...
Sporobolus	a.	24.50	05.29	03.50	33.29	...	...	...	...
contractus	b.	27.61	13.63	23.58	64.82	...	...	...	...

[3]Exotic weed species.

is dramatically demonstrated by comparing the average absolute mammal density of both plots for the entire sampling period. The control plot had an average density of 128 mammals/acre (51.8/ha.), whereas the impact plot contained only 32.6 mammals/acre (13.2/ha.). It is also important to note that the species composition was different between the two study areas. The mammalian species diversity indices (H′) on the control plot and the impact plot were .78652 and .69022 respectively. The greater species diversity on the control plot was also complemented by a greater evenness of species distribution (J′) (.56736) than that found on the impact plot (.42886).

The total absolute densities of the small mammal populations on both plots were higher at the onset of this study (March 1974) than they were at its termination (January 1975). The fluctuations found in these densities (a decline of 77.3/acre [31.3/ha] to 10.6/acre [4.3/ha] on the impact plot and 219.7/acre [98.9/ha] to 43.5/acre [17.6/ha] on the control plot) were consistent for both plots and may be reflecting "normal" population fluctuations. Nevertheless, in all trapping periods, the density and diversity of the small mammal populations on the control plot were substantially higher than those across the river at the impact plot.

In addition to the total population densities, another striking difference in the rodent communities of the two study areas is in the relative species composition (Table 2). On the impact area, the density of the cactus mouse (*Peromyscus eremicus*) accounted for an average of 80.8 percent of the entire rodent commu-

Table 2. Small mammal population densities on the two study areas.

Control

Species	Absolute density (per hectare) Mar	May	Jun	Aug	Nov	Jan	Relative density (percent) Mar	May	Jun	Aug	Nov	Jan	x̄
Peromyscus eremicus	53.5	35.3	43.2	27.7	11.4	11.4	60.0	65.0	64.0	45.0	56.0	65.0	59.2
Peromyscus boylii	00.3	00.0	00.3	00.3	00.0	00.0	00.3	00.0	00.3	00.0	00.0	00.0	00.1
Perognathus intermedius	34.3	18.7	23.5	31.3	08.6	06.0	39.0	34.0	35.0	51.0	42.0	34.0	39.2
Neotoma albigula	00.8	00.5	00.8	02.5	00.3	00.2	00.7	01.0	00.7	04.0	02.0	01.0	01.5
Total	88.9	54.5	67.8	61.8	20.3	17.6	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Average total Absolute Density, March 1974 to January 1975 = 51.8 mammals per hectare.

Impact

Species	Absolute density (per hectare) Mar	May	Jun	Aug	Nov	Jan	Relative density (percent) Mar	May	Jun	Aug	Nov	Jan	x̄
Peromyscus eremicus	30.4	09.4	08.2	09.1	07.7	02.9	97.0	94.0	76.0	66.0	85.0	67.0	80.0
Peromyscus crinitus	00.0	00.3	02.3	04.4	01.4	01.4	00.0	03.0	23.0	32.0	15.0	33.0	17.5
Peromyscus boyleii	00.3	00.0	00.0	00.0	00.0	00.0	01.0	00.0	00.0	00.0	00.0	00.0	00.2
Perognathus formosus	00.3	00.3	00.3	00.3	00.0	00.0	01.0	03.0	02.0	02.0	00.0	00.0	01.3
Neotoma lepida	00.3	00.0	00.0	00.0	00.0	00.0	01.0	00.0	00.0	00.0	00.0	00.0	00.2
Total	31.3	10.0	10.8	13.8	09.1	04.3	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Average total Absolute Density, March 1974 to January 1975 = 13.2 mammals per hectare.

nity, whereas on the control plot, this species accounted for an average of 59.2 percent of the population. The only other species which contributed significantly to the impact plot population was the canyon mouse (*Peromyscus crinitus*), averaging 17.5 percent of the total population. The canyon mouse was never encountered on the control plot. Reasons for this are a direct reflection of the habitat requirements of this species and the state of the habitat on each study area. The canyon mouse prefers rocky, near barren areas that are usually devoid of vegetation and may be found commonly throughout the Grand Canyon on upper talus slopes and rocky outcrops. Clearly, the alteration of the impact area by feral asses has permitted a population of canyon mice to become established in an area not normally inhabited by this species.

The distribution and abundance of heteromyid rodents on the two study areas also further demonstrates the detrimental effects of feral asses. On the impact plot, only a few heteromyids, the long-tailed pocket mouse (*Perognathus formosus*), were captured, while the control plot contained a relatively large and stable population of the rock pocket mouse (*Perognathus intermedius*) (Table 2). The rock pocket mouse made up an average of 39.2 percent of the rodent community on the control plot while the long-tailed pocket mouse constituted an average of only 1.3 percent of the population density on the impact plot. In the Grand Canyon, we have found that the long-tailed pocket mouse is exclusively restricted to the north and west banks of the Colorado River and the rock pocket mouse is restricted to the south and east banks. However, where suitable habitat exists, there is no measurable difference in the population densities of these two species. On the two study areas, differences in the population densities of these heteromyid rodents were directly related to their dietary requirements and the availability of food. The primary food of both species of *Perognathus* probably consists of seeds, especially the seeds of forbs (Reichman 1975). As mentioned above (see Table 1) the forb strata of the impacted area has been thoroughly decimated through grazing and trampling by feral asses, thus rendering the habitat of this study area inhospitable to a population of *Perognathus*.

Summary

The results of this investigation demonstrate conclusively that the feral ass has a negative effect on the natural ecosystem of the lower reaches of the Grand Canyon. The principal impact of the feral ass is habitat destruction through grazing and trampling.

On the study area where feral asses occurred the vegetation cover and rodent populations were significantly reduced when compared to the study area where feral asses were absent. On the control plot, 28 species of vascular plants were found compared to 19 on the impact plot. The total vegetation cover on the control plot was 80 percent, compared to 20 percent on the impact plot. The mean area (m^2) occupied by each individual cat-claw or mesquite shrub was $27.9m^2$ on the control plot and $20.7m^2$ on the impact plot.

The mammal species diversity (H′) was higher on the control plot (.78652) than it was on the impact plot (.69022). In addition, the average absolute density of small mammals from March 1974 to January 1975 on the control plot was 128 mammals/acre (51.8/ha.), approximately four times the 32.6/acre (13.2/ha.) found on the impact plot. Thus, differences between the two areas in mamma-

lian species composition and diversity were attributed to the depauperate flora, particularly the forbs and grasses, on the 209 Mile Canyon impact area.

Alternatives and Priorities

We previously questioned not only the wisdom but also the legality of the Wild Horse and Burro Act (Public Law 92-195). News releases during 1975 announced that a three judge federal panel in New Mexico had declared the Wild Horse and Burro Act unconstitutional, stating that, "... wild horses and burros do not become property of the United States simply by being physically present on the territory or land of the United States." Even though Public Law 92-195 may eventually be declared unconstitutional throughout the land, the legal ownership of these exotic and destructive animals should not be a central issue. Clearly, the primary consideration should be whether or not wild horses and burros are damaging public lands. Our land managing agencies have been given the responsibility to protect public lands and to control their use in a manner compatible with legislative mandates and sound managerial principles. Although there is certain justification for some measure of protection for small, limited reproducing herds of wild horses and burros, our investigations lead us to the conclusion that Public Law 92-195 is not compatible with proper management concerns on our public lands.

Although the Wild Horse and Burro Act does not specifically apply to National Park Service lands, the public sentiment and political pressures engendered by the issue resulted in a reluctance on the part of National Park Service administrators to initiate or continue feral equine control measures. Recently, with quantitative data on habitat destruction by wild horses and burros becoming available, immediate control measures are being considered on park lands. In Bandelier National Monument a program of direct reduction by shooting for 1975 and 1976 was recently announced by National Park Service officials. The reduction in the Bandelier burro herd seems justified under the congressional mandates for management of park land. The 1975 "Management Policies" for the National Park Service (Washington, D. C.) states, "Control or eradication of noxious or exotic plant and animal species will be undertaken when they are undesirable in terms of public health, recreational use and enjoyment, or when their presence threatens the faithful presentation of the historic scene or the perpetuation of significent scientific features, ecological communities, and native species, or where they are significantly harmful to the interests of adjacent landowners."

There are actually very few control alternatives available to the resource managers on wild horse and burro infested lands. To take no control actions, a course vociferously advocated by some elements of our society, is truly an unacceptable alternative, not only on National Park Service lands, but on all public lands. The wild equines have few, if any, natural predators in North America, and if allowed to go further unchecked, our public lands could suffer irreparable damage, not only to native ecosystems, but also to economically important rangelands. Another alternative, trapping and removal, has met with mixed success. In some areas, with rough terrain and limited access, such as in the Grand Canyon, trapping and removal is virtually impossible. Fencing off some lands to keep wild horses and burros out of sensitive areas has been suggested.

Not only would this measure fail to solve the problem of too many wild equines, but also it would be incredibly expensive and extremely disruptive to the normal dispersal of the large native herbivores. Sterilizing large numbers of wild horses and burros has also been seriously suggested. Although this method might serve to control small herds in certain regions, it too would be an impractical solution to the overall problem now facing land managers. Over most of the isolated ranges currently suffering wild equine impact, the only viable alternative we are left with is direct reduction by shooting. If done properly, this method is the most humane, most effective and least expensive.

Control of the rapidly expanding herds of wild equines is an undeniable necessity on our public lands. Effective management will not be achieved until the resource managers and scientists alike collect adequate data on habitat destruction and relate it in a convincing manner to the general public.

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Discussion

MR. DALE JOHNSON: I do not have a question, but I do have a comment. Yesterday the Supreme Court heard the constitutionality case that was born in New Mexico and I do not know what the Supreme Court is going to do with it; but I would say that Mr. Harris, the attorney in New Mexico, did a tremendous job of arguing the point of unconstitutionality.

FROM THE FLOOR: I was curious about one portion of your paper. Are you starting this experiment with burros on a part of the range that has no current capacity for burros at all in the Grand Canyon?

MR. CAROTHERS: Obviously the range in Grand Canyon has carrying capacity for a large herd of burros. We cannot have both burros and vegetation which is our mandate in the Park Service to maintain.

Bobwhite Quail Population Characteristics and Management Implications in South Texas[1]

William H. Kiel, Jr.
King Ranch and Texas A&M University, Kingsville

Of the three subspecies of bobwhite quail (*Colinus virginianus*) that range in Texas, the Texas bobwhite (*C. v. texanus*) (Aldrich and Duvall 1955) inhabits the region of south Texas often described as the Rio Grande Plain (Carter 1938). This southern tip of Texas comprises some 22 million acres (8.9 million ha) in all or parts of 34 counties south of a line from Del Rio to San Antonio to Victoria. The data on bobwhite production, movements, and mortality were gathered principally during the 1968-74 period on the King Ranch near Kingsville. Information on acreages of rootplowed land and of introduced grasses established in the Rio Grande Plain was provided by the U. S. Soil Conservation Service, Temple, Texas.

Climate, soils, and vegetation of the Rio Grande plain were reviewed in detail by Lehmann (1969). The 16,000-acre study area near Kingsville has a semiarid climate; annual rainfall is about 25 inches (63.5 cm), and the annual evaporation from an open-water surface is more than twice the annual precipitation (Tharp 1952). Some characteristic native grasses on the predominantly sandy to sandy loam soils of the Santa Cruz and Rincon pastures are bluestem (*Andropogon*) *Setania* and *Paspalum*. Goatweed (*Croton*), western ragweed (*Ambrosia psilostachya*), and partridge pea (*Cassia fasciculata*) are among the important quail foods. Dominant woody species are mesquite (*Prosopis glandulosa*), huisache (*Acacia farnesiana*), and granjeno (*Celtis pallida*) (Gould 1962). The area is rangeland used for cattle production (Fig. 1).

The purpose of this paper is not to discuss in detail the intricacies of bobwhite population dynamics—for my data cover only a few aspects of bobwhite ecology—but to discuss briefly some population characteristics of bobwhites and attempt to assess the potential impact of regional land uses on bobwhite habitat.

Methods

Trapping and Banding

Bobwhites were trapped and banded during the 1968-74 period on the Santa Gertrudis division of King Ranch in Kleberg and Jim Wells counties, Texas.

Traps were constructed of 1 inch by 2-inch (2.5 by 5.1 cm) mesh welded wire with two funnel entrances. Dimensions were: length - 3 feet (.9 m), width - 2 feet (.61 m), and height - 10 inches (.25m). Sorghum (milo) was used as bait. Trapping sites were adjacent to ranch roads and were cleared of vegetation and pre-baited for several days before traps were set. Sites were selected to provide shade for the traps. Generally, birds were trapped only in the early morning to

[1]Technical Article 12466 from the Texas Agricultural Experiment Station.

Figure 1. A portion of the Santa Cruz pasture in January 1976, following rootplowing in 1971.

avoid the higher temperatures later in the day. Typical trapping routine was to set the traps before daylight and remove trapped birds no later than 2 hours after sunrise. Traps were then overturned and not reset that day. Trapped birds were placed in a loosely woven burlap bag that was tagged with the trap number. After being banded in a relatively cool location, birds were released at their trap site.

Only rarely were traps set more than two consecutive mornings on the same trap line. This practice avoided a high recapture rate for previously banded birds and seemed to keep mortality due to hawk predation at a minimum. Harris' hawks (*Parabuteo unicinctus*) are abundant in the area and are greatly attracted by birds in a trap. Bobwhite mortality due to trapping averaged approximately 3 percent. Because a particular trap line was used only two or three times during a trapping season (summer to fall), it is doubtful that baiting held bobwhites in the area to an abnormal degree.

Sex and age classifications were based on plumage characteristics (Leopold 1939, Thomas 1969). The category "young" includes only birds hatched in the year of banding. Birds hatched previous to the year of banding were classed as adults.

Band Recoveries and Wing Collections

Standard bands provided by the Texas Parks and Wildlife Department were used. Hunters on the King Ranch were requested to place recovered bands and wings from bagged bobwhites in boxes provided for this purpose at entrance points, and to indicate as nearly as possible, the recovery location. Bands recovered beyond the boundaries of King Ranch were reported directly to the Texas Parks and Wildlife Department.

Hunting seasons for the counties from which band recoveries were received were generally 60 to 90 days during the November 1-January 31 period. Intensity of hunting and hence opportunity for obtaining band recoveries from hunters was not equally distributed around the banding sites. Bobwhites are not hunted on some sections of the Santa Gertrudis division of King Ranch and intensity of hunting varies greatly between pastures. Opportunity for recovering banded bobwhites that moved off the King Ranch also was variable because of great differences in hunting intensity. The ideal condition of having evenly distributed hunting (opportunity for banded birds to be recovered) around the banding site did not exist.

Statistical tests follow Shefler (1969) and Steel and Torrie (1960).

Results and Discussion

Production

The high reproductive potential of bobwhites is well known. Jackson (1969) reported a 15-year average of 79 percent young in the hunting kill in north Texas, and in north central Texas, Gore et al. (1970) found an average of 72 percent young in the bag over a 5-year period. In east Texas, about 80 percent of the winter population was composed of young birds (Lay 1954). South Texas is near the western limit of bobwhite distribution (Aldrich and Duvall 1955) and according to Rosene (1969), is in a "fringe" zone where large fluctuations in populations can be expected principally because of rainfall deficiencies.

Weather, principally rainfall, and its relationship to bobwhite production in Texas has been studied and discussed by numerous investigators (Lehmann 1964a, 1953, Jackson 1969, and others). In the limitations of this brief paper, I will not attempt to discuss the various ways in which rainfall may directly or indirectly affect the reproductive success of bobwhites.

The rainfall pattern in south Texas is one of late spring and summer rains and relatively dry late fall and winter periods. Deviations from this pattern are not unusual. Occasional hurricanes, usually occurring in August or September, can deluge an area with 10 to 20 inches (25.4 to 50.8 cm) of rain in a few days, and spring and summer rains do not always fall. Based on records from two gauges in the Santa Cruz and Rincon pastures (the principal study area), annual rainfall during the 1956-74 period ranged from 12 to 43 inches (30.5 to 109.2 cm) with a mean of 25 inches (63.5 cm). Rainfall associated with tropical storms in late summer or early fall is an important factor in raising the mean rainfall to 25 inches.

Production, based on wings of bagged birds urng the December-January hunting season, ranged from 0.6 young per adult in 1969 to 7.0 young per adult in 1970. The 6-year mean was 3.7 young per adult (Table 1). Chi-square tests showed no significant difference in vulnerability to shooting between young and adult nor between males and females based on 374 first-season (direct) band recoveries.

Table 1. Hunting kill, first-season band recovery rates, and age ratios of bagged bobwhites. Santa Cruz and Rincon pastures, King Ranch. Numbers of wings examined and birds banded shown in parentheses.

Hunting season	Bobwhites bagged[1]	Young per adult	First-season band recovery rate
1969–70	2,101	0.6 (1,631)	0.086 (338)
1970–71	1,733	7.0 (1,338)	0.110 (372)
1971–72	2,012	2.7 (1,486)	0.066 (928)
1972–73	3,134	5.4 (2,399)	0.090 (1,087)
1973–74	3,121	5.0 (2,443)	None banded
1974–75	2,580	1.4 (1,639)	0.118 (787)
1969–74 Mean	2,447	3.7	0.094

[1]Hunting kill from 1961 through 1968 ranged from 655 to 4,225 birds annually with a mean harvest of 2,093.

Higher rainfall during May, June, and July was correlated significantly ($r = 0.96$, $t = 6.86$, $P<0.005$) with higher production of young (Figure 2). The mean rainfall (1956-74) for the Santa Cruz and Rincon pastures was 7.3 (18.5 cm) inches for May, June, and July. During the 6 years bobwhite production data were gathered, 1969-74, mean May-July rainfall was 8.1 inches (20.6 cm). It is apparent (Figure 2) that during these 6 years, rainfall less than 4 inches (10.2 cm) for the May-July period was associated with age ratios of less than 3 young per adult. Rainfall above 10 inches (25.4 cm) for the same period was correlated with age ratios of 5 or more young per adult.

To more firmly establish and define the correlation between summer rainfall and bobwhite production, additional years of data are needed. Undoubtedly rainfall before and after the May-July period has some influence on production (Reid and Goodrum 1960), and the pattern of rainfall during the breeding season likely is important. Overall, it might be said that in this semiarid region, rainfall at any time is beneficial, and particularly so during May, June, and July.

To relate age ratios to production of young per female, a measure of the sex ratio in the breeding population is necessary. In the Santa Cruz and Rincon pastures, 1969-74, the adult sex ratio, based on 2,519 bobwhite wings collected from hunters, was 58.9 percent males and 41.1 percent females, a highly significant difference from a 50:50 ratio ($P<0.01$). The sex ratio among young bobwhites did not differ significantly from 50:50 and was 50.6 percent males and 49.4 percent females based on 7,546 wings. Differences between years in sex ratios were not significant in either age class. In the adult sample, the percentage of females ranged from 39 to 44 percent and in the sample of young bobwhites, females comprised from 47 to 52 percent over the 6-year period. Hence, from one hunting season (December-January) to the next, bobwhite females are subjected to higher mortality rates than males which results in an unbalanced sex ratio in favor of males (59 males:41 females).

This disproportionate loss of females probably occurs during or shortly after the breeding season when females are under the stress of egg laying and incuba-

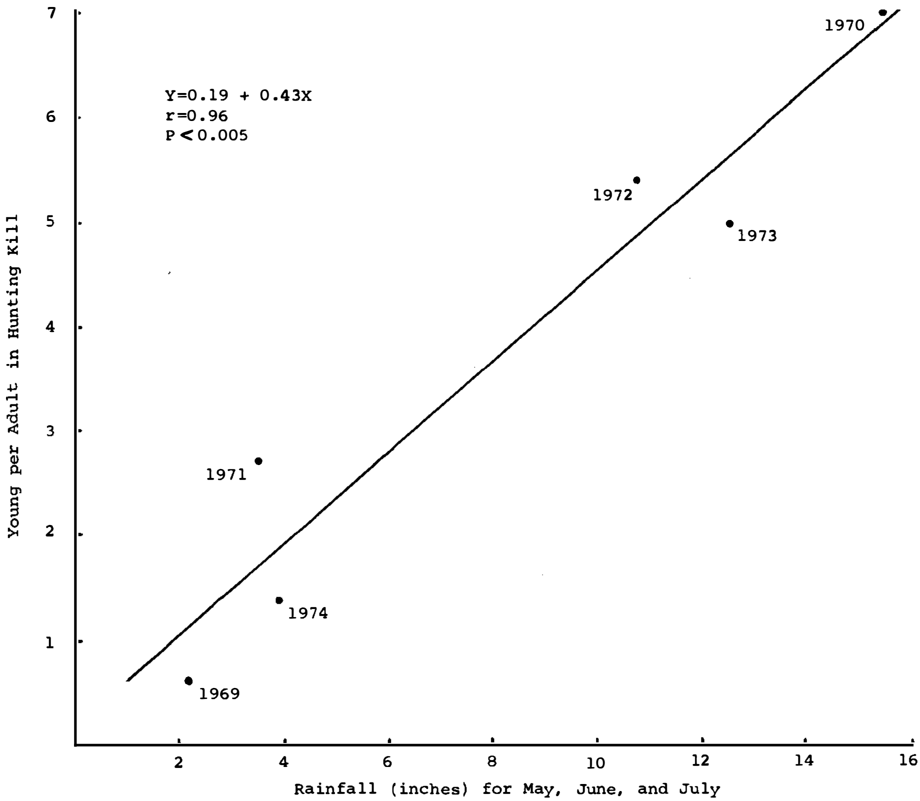

Figure 2. Linear regression of the ratio of young to adult bobwhites in the hunting kill on rainfall during May, June, and July. Santa Cruz and Rincon pastures, King Ranch, 1969–74.

ting. Wagner (1957) found pheasant (*Phasianus colchicus*) hens were subjected to accelerated mortality during the post-nesting period due to the stress of the nesting season. Predation on nesting bobwhites also may be a factor.

An intriguing and important question is how do bobwhites produce young in good breeding seasons at the rate of 10 to 14 young per female? Age ratios of this order were found in three of the six years (5.0 to 7.0 young per adult). Even assuming a 50:50 sex ratio at the start of the breeding season, which may be true of young adults entering their first nesting season but is not true of adults entering their second or later nesting seasons, almost every hen not only would have to hatch a full clutch of eggs but would have to rear the brood with very little mortality to the young. Springs (1952) reported little mortality in young broods under repeated observation in south Texas. Ratios of young per adult in the hunting bag would be reduced somewhat if it were assumed that the disproportionate loss of breeding females occurred after the nesting season during which they have produced a brood.

Such high ratios of young per adult could be attained during good breeding seasons by persistent renesting of hens and by high survival of young. In this region Lehmann (1946a, 1953) reported 46 percent nest success and clutches that ranged from an average of 18 eggs early in the nesting season to 7 eggs in late nests. Another possible explanation is that some hens produce second broods during one nesting season. Stanford (1972) in Missouri found that some wild-trapped bobwhites held in pens in the field produced second broods in one season. His review of the evidence and speculation concerning second broods led Stanford to conclude that second broods may well contribute substantially to quail populations.

On King Ranch, one wild-trapped pair of bobwhites held in a 12-foot square pen with supplemental feed and water, hatched a clutch of 15 eggs on June 24, 1971 and was laying again by July 22. Apparently most of the first brood escaped from the pen, but one chick about 2 weeks old was found dead in the pen. Four other pairs in separate pens nested, often several times, but did not hatch successfully, with the exception of one pair that hatched a clutch in August and did not renest thereafter.

To overcome the artificial environment of penned conditions, we back-tagged females that were captured with very young broods, but our subsequent efforts to observe marked hens were not successful.

Movements

Although bobwhite quail traditionally are thought of as being highly restricted in their movements, many studies reviewed by Loveless (1958) and Rosene (1969) indicate movements of several miles by a small portion of the population.

More extensive movements by bobwhites in Florida were reported by Loveless (1958) who found 10 birds that moved an average distance of 6 miles (9.6 km). Jackson (1969) in north Texas reported a bird moving 24 miles (38.6 km) and presented evidence that bobwhites moved considerable distances to occupy range that had been devoid of quail because of drouth or fire.

Lehmann (1946b) discussed population fluctuations that could not be accounted for by normal mortality or production in several Texas localities. Band recoveries indicated movements of up to 10.5 (16.9 km) miles. On a study area in south Texas, some 60 miles (96.5 km) southwest of Kingsville, Lehmann did not find long distance movements of bobwhites but he suggested that considerable movement may occur. His study employed a drive-trapping technique, and retrapping was largely restricted to a 960-acre (388.8 ha) study area. Surrounding territory was not hunted or hunted very lightly. Lehmann reported covey movements and interchange of birds between coveys, but as he pointed out, it was, by nature of the study area, largely a study of sedentary birds because there was little opportunity for obtaining band recoveries from birds that moved off the area.

In the study here reported, movement records are based on 473 band recoveries from 8,026 banded bobwhites (Tab. 2). Hunter reports of band recoveries involved some estimation in reporting recovery location. The broad categories of movements shown in Table 3 were established to show movements of several miles by a proportion of the population. Chi-square tests showed no significant difference in the degree of movement between adults and young, males and females, nor between direct (first-season) and indirect (two or more hunting seasons after banding) recoveries. Small samples were involved, however, particularly in the adult age class and indirect recoveries. In Florida, Loveless (1958) reported similar results by finding no difference between age classes or sexes in the tendency for long distance movements.

Movements over 5 miles (8.0 km) from the banding site, however, were not independent ($P<0.01$) of the time of banding. Bobwhites banded in June and July had a greater tendency to move distances over 5 miles prior to the hunting season than those banded in the August-September and October-November banding periods. However, a young male banded on September 23, 1968 was shot on November 27, 1968 about 65 miles (104.6 km) south of the banding site. This recovery was verified with the hunter. Another young August-September banded bird moved 18 miles (28.96 km) west. All (5) other bobwhites moving over 10 miles (16.1 km) were young birds banded in June-July. Four traveled 14 miles (22.5 km) southwest and one was shot 17 miles (27.4 km) to the southeast. There was some indication that young birds moved greater distances (over 5 miles [8.0 km]) than adults and that movement was greater in 1968 than in other years. Walter C. Sandifer (personal communication) believes, based on 28 years of experience in quail hunting and bird dog training on King Ranch, that bobwhites commonly move from drouthy areas that are short of food. Additional banding is needed to understand the pattern of such movements.

It is probable that the proportion of the population that moved considerable distances is minimized in this study because hunting intensity was extremely light if the banded birds moved over 5 miles to the east or north. Only in the west and southwest was there good opportunity for hunters to bag banded birds that moved more than 5 miles. Nine of 11 recoveries over 5 miles from the banding sites were taken in those directions. Obviously, banded birds that were not shot or not reported provided no data on movements.

Populations, Hunting Kill and Mortality

Hunting kill, as recorded by hunters in the Santa Cruz and Rincon pastures for the 1969-74 period, ranged from about 1,700 to 3,100 bobwhites bagged (Tab. 1). The mean number of birds bagged during the 5-year period when

Table 2. Bobwhite quail banded on King Ranch, Kleberg and Jim Wells counties, Texas, 1968–74 (M-male, F-female, U-unknown sex).

Banding period	Adults		Young			Total
	M	F	M	F	U	
June-July	262	148	246	237	657	1,550
August-September	614	406	917	845	376	3,158
October-November	443	285	1,170	1,042	378	3,318
Total	1,319	839	2,333	2,124	1,411	8,026
	Total adults - 2,158		Total young - 5,868			

Table 3. Relationship of time of banding to movements of bobwhite quail. Based on 473 band recoveries obtained from hunters, 1968–74.

Movements in miles	Banding period: June-July		August-September		October-November	
	No.		*No.*		*No.*	
Less than 5 miles[1]	45		156		218	
0.5 - 3	5	87%	16	98%	15	100%
3 - 5	4		3		0	
5 - 10	3		1		0	
10 - 20	5	13%	1	2%	0	
Over 20	0		1		0	
Total	62		178		233	

[1]Does not include birds moving *measured* distances of 0.5 - 3 and 3 - 5 miles, but undoubtedly includes substantial numbers of birds that moved from 0.5 to 5 miles but were not reported by a specific recovery location, only by pasture of recovery.

banding was done was 2,312. The mean first-season (direct) band recovery rate was 0.094, indicating that 9.4 percent of the population was shot, not including crippling loss. Crippling loss was not measured, but Rosene (1969) estimated that 20 percent should be added to the bag to account for such loss. Thus the mean fall population on 16,000 acres (6480 ha) over a 5-year period was an indicated 25,058 birds or 1.6 quail per acre (2,312/0.094 = 24,596+462 = 25,058). Calculated densities ranged from 1.0 birds per acre (.40 ha) in 1970 to 2.2 birds per acre in 1972.

Several important assumptions that underlie these calculations are (1) banded birds are representative of the population and all bands are reported, and (2) kill is reported accurately. I cannot assess the validity of the assumptions except to point out that hunters who used these pastures were very cooperative as shown by the high proportion of wings submitted from bagged birds (Tab. 1). Also, the hunters (about 50 individuals plus guests) are long-standing members of the clubs that use these pastures, and they were informed and interested in the purposes of the study.

Extensive movement of banded birds off the area would reduce the band recovery rate and result in an overestimate of the population. As discussed earlier, some movement did occur, but principally by birds banded in June and July. Only 5 percent of the 3,512 birds banded in these pastures were banded during the early period. Also, natural mortality occurring between the time of banding and the hunting season would reduce the number of banded birds available to be shot and lower the band recovery rate. On the other hand, factors that would result in a recovery rate that was biased upward (and result in an underestimation of the population) are (1) banded birds being more likely to be shot because they were banded near roads that also were used by hunters, and (2) recording fewer birds than were actually bagged. Whatever the limitations of calculating populations from band recovery rates and kill data, it can be said that hunters were bagging on the average at least 2,447 bobwhites on 16,000 acres (6480 ha) or one bird per 6.5 acres (2.63 ha).

Another indication of bobwhite density in the Santa Cruz and Rincon pastures is that in the fall following good breeding seasons from 8 to 15 coveys per hour can be located by working a bird dog from horseback in a transect pattern, not searching out the best habitat and not hunting (Walter Sandifer, personal communication). Although these are good bobwhite densities by any standard, Kellogg et al. (1972) reported two to three birds per acre in the winter in northern Florida on an intensively managed area. The Santa Cruz and Rincon pastures were not managed intensively for quail.

The high annual mortality or turnover rate of 70 to 80 percent characteristic of bobwhites is well known and will be discussed only briefly here. Of 333 band recoveries from 5,739 birds banded during 1969-72, 84 percent were taken during the first hunting season after banding (direct recoveries), 12 percent were taken during the second hunting season, and 4 percent during the third season. One bird survived until the fourth season, and it is possible that a very small fraction may yet be reported from the 1972 bandings. No significant difference (chi-square) was found between the survival rates of adults (76 recoveries) and young (257 recoveries). Hence, these data indicate that 84 percent of the bobwhites died within the time period from banding until the beginning of the second hunting season after banding. This interval is approximately 14 months because the midpoint date of banding was about October 1 and the hunting season opens December 1. Therefore, average monthly mortality might be estimated at 6 percent per month, giving a first-year mortality rate of 72 percent. Bobwhites need a high reproductive rate, for only 16 percent survived to nest in more than one breeding season after being banded.

The Santa Cruz and Rincon pastures were hunted more intensely than other pastures on King Ranch where bobwhites were banded. Direct band recovery rates for comparable years, 1969-72, were about 5 times higher in Santa Cruz and Rincon than in other pastures (0.084 versus 0.017, $P<0.01$), yet the distribution of band recoveries through three hunting seasons after banding (survival or mortality rate) was no different in Santa Cruz and Rincon than in the other pastures with lower hunting pressure (chi-square not significant). This is not unexpected since various authors (Jackson 1969, Rosene 1969, Young et al. 1974, and others) state that 40 to 50 percent of the fall population of bobwhites may be removed by hunting without causing a decline in numbers in the following years.

Land Use Trends

The recorded early history of vegetation on the Rio Grande Plain of Texas has been reviewed by Inglis (1964) and Lehmann (1969). By 1900, density of woody vegetation had increased greatly and range carrying capacity for livestock had declined. Efforts to control brush by mechanical methods began in the 1930's; yet in 1963, Smith and Rechenthin (1964) reported that 93 percent of the Rio Grande Plain had a "brush problem" of some degree. Based on a survey in

1958-59, Davis and Spicer (1965) estimated that 29 percent of the land used as range had received some type of brush control treatment. They noted a definite trend away from chaining or chopping extensive acreages and toward rootplowing (Wilkinson 1957) and seeding grasses on smaller units of rangeland. A 1976 survey by the Soil Conservation Service indicated that some 3.9 million acres (1.58 million ha) have been rootplowed in the Rio Grande Plain.

Establishing forage grasses in good stands following brush control can follow two courses: (1) natural recovery, involving deferment from intensive grazing for preferably two growing seasons, and (2) artificial seeding of native or introduced grasses with deferment of grazing until seedlings are well established (Rechenthin et al. 1965). Following rootplowing, the general practice in this region is to plant introduced grasses, principally buffelgrass (*Pennisetum ciliare*), coastal bermudagrass (*Cynodon dactylon*), and Kleberg bluestem (*Dichanthium annulatum*). According to 1976 estimates by the Soil Conservation Service, acreages established are: buffelgrass—2.5 million (1.01 million ha), coastal bermudagrass—619,000 (250,695 ha), and Kleberg bluestem—191,000 (77,355 ha). Some 13 other species or varieties comprise an additional 415,000 acres (168,075 ha), including 99,000 acres (40,095 ha) of kleingrass (*Panicum coloratum*).

Land Management and Bobwhites

The establishment of large blocks of solid stands of buffelgrass, coastal bermudagrass, and bluestem is not favorable for bobwhite quail. These grasses do not produce seed that is readily eaten by bobwhites, and their dense growth apparently impedes movement of quail. Although data are not available, I suspect that dense stands of these grasses allow only limited production of winter weeds which are an important food resource for bobwhites in this region. Insects, a necessity in the diet of young quail (Stoddard 1931, Hurst 1972), may also be limited in numbers and availability. Edges of tall, dense stands of buffelgrass and bluestem may be used as cover by bobwhites, but unless food is available nearby, large fields of such grasses hold few, if any quail.

Rootplowing, itself, did not adversely affect bobwhite populations in the Santa Cruz and Rincon pastures. Rincon was rootplowed in the fall of 1967 and Santa Cruz in late summer and fall of 1971. Though the hunting kill was low in Rincon in 1967, it was also low in Santa Cruz due to poor production in a drouthy summer. The age ratio of bagged birds in an adjoining pasture, not rootplowed, was 0.1 young per adult in the bag (Kiel 1969). Santa Cruz showed no reduction in hunting kill in the winter following rootplowing, and both pastures had good production and populations of bobwhites in the years immediately following rootplowing. In these pastures, some woody vegetation was left unplowed in mottes or clumps (Fig. 1), around the periphery of wet-weather ponds, and in some portions of the pastures where density of brush was low. Roughly 85 percent of the area was rootplowed, but native grasses continue to dominate.

Of the introduced grasses planted in substantial acreages, kleingrass holds promise of being of value as a seed-producer for bobwhites and other wildlife. It is a perennial bunch grass with drouth resistance and is recommended as an excellent forage grass for livestock by the Soil Conservation Service and the Texas Agricultural Experiment Station. As an introduction from South Africa, kleingrass was tested extensively in Texas, and a variety (Kleingrass 75) was released for planting in 1968 by the Texas Agricultural Experiment Station and the Soil Conservation Service. Research, partially supported by the Caesar Kleberg Wildlife Foundation and the R. M. Kleberg Research Foundation, is underway at Texas A&M University to explore the possibility of increasing seed size in kleingrass without diminishing its forage qualities. Larger seed not only would be of benefit to wildlife, including bobwhite quail, but should enhance stand establishment through increased seedling vigor. Progress thus far indicates that selection and breeding for larger seed size is possible and promising of desired results (Kieschnick 1974).

How long and how well the introduced grasses will persist in the region is not yet known. Monocultures historically have proven to be susceptible to insects, diseases and drouth. Rhodesgrass (*Chloris gayana*), a native of South Africa, was an outstanding forage grass that flourished on the King Ranch and in south Texas in the 1915-42 period. It was decimated in two years by the grass scale, *Antonina graminis*, itself a native of China and previously unknown in North or South America (Kleberg and Diaz 1957).

In relation to management for bobwhites, controlled burning of rangeland may prove to be a useful tool in increasing food plants and insects, as it long has been in the southeastern states (Stoddard 1931) and as Derdeyn (1975) recently reported for Oklahoma tallgrass prairie habitat. However, if herbicide treatment is applied after brush control or burning of rangeland, it should be judiciously planned to allow growth of food plants important to quail.

The economics of quail hunting are not documented in the region, but some leases, for bobwhite hunting only, are known to produce $2 per acre (.40 ha) income to the landowner. Most often quail are included in a general hunting lease for all game species that may net $3 or more per acre for landowners with good habitat and game populations. Such economic incentives are having an impact on land management programs in south Texas (Passey and Hicks 1970). Sacrificing a small portion of the range carrying capacity for livestock by conserving some woody vegetation and food-producing plants can be more than offset by the income derived from hunting leases. Also, land offered for sale often commands premium prices if some native vegetation, principally brushland, has been preserved. Additional values, unmeasured in economic terms, are the esthetic and recreational benefits derived from land that supports a variety of vegetation and wildlife.

In summary, bobwhite quail inhabit suitable range in south Texas in fluctuating, but normally good numbers. Their high reproductive potential allows them to recover quickly from low populations during drouthy times, and their mobility assures that suitable range will be occupied. A high mortality rate apparently is affected little by the hunting intensity found over most of the region. Landowners who want to enjoy the recreational and economic values of bobwhite hunting should consider the habitat requirements of bobwhite quail in land management plans.

Acknowledgments

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Discussion

CO-CHAIRMAN BUNNELL: Thank you, Bill.

One of the things that interests me, coming from an area where we are having difficulty predicting impacts of weather on our populations—these are high snowfall areas of North Canada—is that we never get a score of 1.96 with any of the weather variables and we never know what the weather is going to be. This affects the population because it happens during the hunting season or after the hunting season. So we are having to estimate what we think some of the weather phenomena, particularly heavy snows, are going to be before establishing harvest.

In this case, you have some idea of the influence of weather upon the population in May, June, or July, before you go into the hunting season. I am wondering if this is incorporated in any way at all?

MR. KIEL: It is a part of the paper I did not have time to present, but hunting pressure on Bobwhites in South Texas is so low that it is not critical to adjust hunting regulations to how productive they may be in that year.

Our band recovery rate on the area was about 9 percent on one of the most heavily hunted areas I know of in that part of South Texas.

So it is not critical, as it might be in big-game management, to know that production potentiality at that early date; but I agree that it would be possible if this sort of correlation continues and I am confident that it will, and you could predict what the fall population would be. Local people know it. And, they know if it rains, we are going to have a lot of quail.

MR. KEN WILSON [Winston-Salem, North Carolina]: Has any study ever been made on the cost of rearing these birds in the wild per bird on a huntable basis?

By that I mean you would have to have a census of your coveys at the end of the season, say in the spring, and then have another census in the fall. Just to pick a figure, you might have 500 birds on your study area after fertilization and the winter difficulties have come to an end. Then you would have your census in September or October, and if you had 500 birds here in the Spring, you might have say 1500 birds at the beginning of the hunting season. Have you ever made a study on what it costs per bird?

Do you plant food patches?

MR. KIEL: No, sir. In these particular areas of which I am speaking we do not. But in some of the patches we did seed food strips, but that is a very expensive operation. I would have to tally up the cost, but it would not amount to much.

MR. WILSON: To my knowledge I have never seen any data on that, and it has puzzled me. Maybe some of the research people figure it is just too difficult to compute.

I remember back in the 1930's, Ernie Vaughn and I had a quail project on the Eastern Shore of Maryland and we made an attempt at that and we did not have very high expenses. We used no fertilizer. We simply put our expenses in, as we were with the Resettlement Administration at that time. I think we came to a figure of 25 cents per bird on a sandy area where you had a lot of legumes, while on a clay area where you had to do a lot of plowing, the cost per bird went up to approximately 50 cents.

As far as I know, I have never seen any other data presented on that. Maybe it is just too difficult to compute.

MR. KEIL: I would think some of the plantations in Florida and Georgia and in the Southern states that manage quail very intensely would know. They would have figures on it.

MR. JOHNSON: Bill maybe you answered this when you indicated there was not too much hunting pressure on your property but one of the things that interested me was that in your surveys, if I remember right, in 1969 you only had two quail per adult. What is more important is that you had seven per adult the following year. In our area, when we do not get a good reproduction our quail harvest is a bust. Could you explain that?

MR. KIEL: You are exactly right, and my only explanation is that even with the relatively low production in that year there were still plenty of quail for the kind of hunting pressures that we have.

One comparison that we made with mortaility rates in lightly-hunted pastures versus the club pastures, which I call heavily hunted—actually they are not—there was no difference in the mortality rate between the lightly hunted and the heavily hunted areas.

Population Ecology Studies of Polar and Grizzly Bears in Northern Canada

Ian Stirling and Arthur M. Pearson
Canadian Wildlife Service,
Edmonton, Alta.

F. L. Bunnell
Faculty of Forestry,
University of British Columbia,
Vancouver

Polar bears (*Ursus maritimus*) and grizzly bears (*Ursus arctos*) are two of the most spectacular large mammals in North America. Both bears have a high value to the public, are prized as game animals by sport hunters, and have significant resource value to native people. Although neither species is imminently in danger of total extinction in Canada, subpopulations of both are vulnerable to local, and possibly more widespread, extinction as a result of overhunting or major changes in their environment. For this reason, the Canadian Wildlife Service, in conjunction with the Provinces and Territories, has been involved in active research on the population ecology of both polar and grizzly bears to facilitate better management and ultimately, the survival of the species (see reviews in Pearson 1972; Stirling and Jonkel 1972).

Our research has three broad objectives: (1) estimation of the size, reproductive rates, age structures and mortality rates of various subpopulations, or ecotypes, to enable us to make the best possible management recommendations; (2) evaulation of the effect of changes in the pattern of harvest, habitat, or environmental conditions, on reproduction, survival, and distribution; and eventually (3) modeling of all necessary data to evaluate the usefullness of various parameters to predict population size, reproduction, or survival in a sufficiently dynamic fashion to provide a useful tool for management.

Materials and Methods

The techniques used to gather data included radio telemetry, aerial surveys, total counts, mark-recapture, age determination from teeth collected from immobilized and hunter-killed bears, observations on the behavior of wild undisturbed bears, and denning surveys (Lentfer 1968; Pearson et al. 1968; Larsen 1971; Pearson 1975; Stirling 1974 a and b; Stirling et al. 1975).

To facilitate rapid analysis of data and incorporate them to test hypotheses about harvest rate, we have developed two models (Bunnell 1974, 1975). The first bear population model was a simple projection model much like those developed by Mertz (1970), Caughley (1967, 1974), Craighead et al. (1974) and Crowe (1975). This model uses age specific survivorship rates, age specific natality rates, and the sex ratio at birth to project the future population from an intial age and sex distribution (life table data) and to compute most of the currently used demographic statistics. Specifically, it was designed to establish limits to sustainable harvest rates.

The second bear population model, based on the first, allows selective harvesting of the adult population. In particular, it was developed to explore different but practical hunting policies, such as the difference between spring and fall hunts for grizzlies. It allows the association between a specific female and her cubs to be maintained rather than simply accounting for the number of females of each age and applying an average natality rate. Harvest rates can be applied to all bears or to bears without cubs.

Results and Discussion

Field Techniques and Data Collection

There are several differences between grizzly and polar bears that influence the sorts of data that can be collected from each. To generalize, in comparison with polar bears, grizzly bears tend to have less extensive seasonal movements, occur in relatively more accessible areas and have smaller but denser subpopulations. All grizzlies in Canada go into dens for the winter while polar bears, except for pregnant females, remain active. Pregnant female polar bears go into dens by about early November, give birth to their young in December, and return to the sea ice with their cubs in late March to early April. In general, it is more expensive to collect data on polar bears, particularly if marking and recapture is involved because of the greater distances that must be travelled. The available budget for polar bear research has to cover field work over a longer period of time because they do not all go into dens for the winter. In addition, during the dark period during mid-winter, an important, although short part of the year passes in which it is virtually impossible to obtain data of any kind.

With the use of aircrafts and telemetry, it is often possible to capture, mark, and follow a significant sample of a particular ecotype of grizzly bears because they occur at greater densities in a more discrete and restricted distribution pattern. Premolar teeth are collected for age determination from all bears when they are immobilized so it is often possible to have accurate data on the size, and age and sex composition, of a grizzly bear subpopulation, such as that in the vicinity of Richards Island, NWT. In comparison, radio telemetry of polar bears has not been very successful (Lentfer 1972; Anderka et al. 1973) for a number of reasons: the polar bears' neck and head are more conical in shape which resulted in a higher rate of loss of radio collars, the distances moved were so great that the bears were either lost or it was too expensive to keep following them or the radios malfunctioned.

Traditionally, standard wildlife techniques have been used to construct age frequency tables of the kill of each sex and to calculate mortality rates, (assuming a stable age distribution and no population growth or decline). This approach can be useful provided the sample is representative of the population and the underlying assumptions are acknowledged. However, the degree of bias may or may not be known. Bias could be suspected in the case of trophy hunting versus completely opportunistic hunting and Lentfer (1973) demonstrated quite clearly in Alaska that the average age of polar bears taken by non-residents in the aircraft trophy hunt was older than that taken by resident aircraft hunters or by natives. Similar biases are undoubtedly true of an age structure composed of specimens obtained from grizzly bears taken in a sport hunt and allowances must be incorporated in analyses of those data.

It might be assumed that since the Inuit in the NWT (where most Canadian polar bears are killed) are allowed to kill any bear one year of age and older, and harvesting is virtually non-selective, that the harvest would be representative of the population, and that monitoring of the population could continue solely from an annual examination of the age structure and mortality rates of the kill sample. However, Stirling et al. (1975) showed clearly that in the southeastern Beaufort Sea, the harvest was not representative of the whole population. The area that was accessible to Inuit for hunting polar bears was disproportionately low in adult males and high in family groups. This was because the largest adult males tended to be further offshore in the moving ice areas where they were less accessible to the Inuit while the females with cubs tended to segregate themselves from the males to some degree and thus were closer to shore and more accessible to Inuit hunters. The same may not be true for all areas in which polar bears are harvested. Clearly, for both grizzly and polar bears, each area and method of sampling will have to be examined thoroughly to ensure that we understand what it is that we are sampling.

Preliminary Results from Modeling

The bear populations we examined exhibited a range of natality and female survivorship rates, the critical factors which determine demographic statistics.

Natality, expressed in the model as female cubs/female/year, is determined largely by two factors, average litter size and the length of time that cubs remain with their mothers. Cubs usually remain with their mother a minimum of 2½ years so that the maximum rate at which females may reproduce is once every three years. Thus, the main source of variation in natality rates between populations is litter size. Recorded average litter sizes for grizzly bears range from 1.7 in the SW Yukon to 2.24 for Yellowstone (Craighead et al. 1974; Pearson 1975). Each populaton has its own characteristics for age of sexual maturity and the effect of this parameter is expressed through the age-specific natality rate.

Initially, bear model I was used to generate an upper estimate of the maximum harvest that a population of 100 grizzly bears could sustain for any specific average litter size. We assumed a stable population and thus adult survival rates were adjusted until the population growth rate, r, was zero. Cub survivorship was assumed to be equal to female survivorship, a potentially inflated estimate that assumes cubs only die if the mother dies but additionally that if the mother dies, the cubs also perish. Sub-adult survivorships were also assumed to equal adult survivorships although subadults may have higher mortality rates. Thus both cub and subadult mortality rates are likely conservative.

Because of the conservative mortality assumptions included in this model, the estimated adult survivorship was at a minimum for a population that would not decline given the specified natality rates. The minimum allowable adult survivorship ranged from 86.8 to 85.9 percent per year for average litter sizes of 1.7 to 2.2. Thus, a population of 100 bears could only maintain a loss of about 15 animals/year including cubs and subadults. A high *natural* survivorship of 0.90/year implies an additional harvest of only five grizzly bears per year per 100 animals. These are *conservative* estimates. A *harvest* of 15 animals per year would preclude any other source of mortality.

The most valuable insight has been gained through the application of bear model II. It was used to examine the differences between spring and fall hunts on grizzlies, assuming that female bears with young (cubs, yearlings, and 2-year-olds) were not legitimate targets. Thus, in the fall, mature female bears that weaned their young in June, and subsequently became pregnant, would be harvestable. Using natality and survivorship rates computed from the northern interior grizzly population of the SW Yukon and Mackenzie Mountains, an initial population of 400 bears declined to 200 animals after 30 years with no additional harvest. It must be considered that the natality and survivorship rates used in this simulation were calculated on the basis of data from a harvested population. Because of the traditional patterns of hunting grizzly bears, i.e. hunting the same, easily accessible yet restricted, areas year after year, it is impossible to calculate separately the harvest rate already inherent in the data base. It does not, however, mean that under current harvest rates, the northern interior grizzly population will decrease by 50 percent in the next 30 years. Adding a spring harvest of four animals per year reduced the population from 400 to 58 animals in 30 years, while a fall hunt of four animals per year reduced the population from 400 to only five animals in 30 years. The large difference was a consequence of having one-third of the reproductive females subjected to an increased mortality each year. Clearly, fall seasons on grizzlies can be devastating. It is important to note that natural mortality rates as estimated from age structures and simulated harvest rates are additive in the model. We presently have no information on the degree to which compensation may occur, or natality increase, in response to low densities.

The largest and most systematically collected set of data from a polar bear population in Canada were collected from the eastern Beaufort Sea and Amundsen Gulf from 1971-75 (Stirling et al. 1975). Those data indicated that polar bear numbers decreased by about 20-30 percent between 1973 and 1975, from about 1500 to possibly as few as 1000. The seal production decreased by about 50 percent (Stirling et al. 1975) and seal productivity by approximately a factor of ten (Stirling and Smith 1976). This great reduction in the prey population (and of its availability) apparently caused an increase in cub mortality (and probably of subadults as well) and appears to have stimulated a significant degree of emigration.

Because of the marked difference in the status of the population between 1971-73 and 1974-75, the data from those two time periods were analyzed separately. Table 1 compares the basic parameters of the population during those two periods. This separation of the data also permitted more realistic modeling of the effect of various harvest policies on the polar bear population in a relatively stable state (1971-73) and when declining (1974-75), apparently in response to the sudden marked reduction in its food supply.

Table 1. Comparison of basic population parameters of the polar bear population in the Western Arctic from 1971–73 and 1974–75.

Parameter	Year groupings 1971–73	1974–75
Survivorship of female	.920±.036	.858±.020
Survivorship of male	.874±.024	.856±.028
Natality		
3 yr female	.0450	.0375
4 yr female	.0450	.0375
5 yr female	.4034	.1494
6–18 yr female	.2125	.1070
Mean litter size (cubs of all ages pooled)		
5–18 yr female	1.69±.05	1.61±.08
6– yr female	1.70±.07	1.57±.08

The most dramatic difference was in natality of adult females which in 1974-75 dropped to less than one-half of the rate in 1971-73. That difference was even greater in 5-year-old females, the age at which most females first breed. It is of particular interest to note that the mean litter size (pooled for cubs of all ages) did not vary significantly. On inspection, this might indicate that little cub mortality took place prior to weaning. However if the proportion of females captured in 1971-73 that were accompanied by cubs of any age (37/45 = 82.2 percent) is compared to 1974-75 (35/64 = 54.7 percent) then the difference is highly significant (X^2 = 9.10). Apparently a significant amount of cub mortality took place in 1974-75. However, the lack of any significant reduction in litter size in 1974-75 suggests that females which could hunt successfully enough to support cubs as well as themselves kept their complete litters. Conversely, females that lost cubs prior to weaning tended to lose them all. These data suggest that it may not be accurate to attempt to calculate cub mortality prior to weaning from the mean litter size of cubs of the year, yearlings, and 2-year-olds. In addition, the loss of whole litters results in natality calculations being biased too low because the productivity of unmarked adult females, captured after the loss of their cubs, cannot be recorded. The potential for this bias was clearly illustrated in the spring of 1975 when three adult female grizzlies with radio collars were recorded emerging from their dens, two accompanied by two cubs of the year and one with a single cub. Two litters were completely lost about 21 days after emergence and the third litter disappeared about 56 days post-emergence. These data suggest that the natality and mortality rates of cubs prior to weaning for both grizzly and polar bears may be considerably higher than have previously been recorded.

A series of simulations were then done using two sets of polar bear data in Table 1, the sex-specific age structures of the captured bears in 1971-73 and 1974-75, an initial population of 1435 and a sex ratio of 1:1.

In the first simulation, we applied the 1974-75 survivorship and reproductive values to the 1971-73 population. In two years, the population decreased from

1436 to 1197. Although the loss of 249 bears (16.6 percent) was not as great as that estimated in the calulations of population size, it supports the contention that a marked decline took place and that the large differences recorded in parameters such as reproduction values (Table 1) were real.

In the Northwest Territories, where most of the polar bears killed in Canada are taken, bears may be taken legally after they reach 54 inches (137 cm) of length, which occurs at about one year of age. The hunting season extends from 1 October to 31 May. Thus, pregnant females and females with cubs one year of age or more may legally be taken.

We then did a series of simplistic simulations, using the 1971-73 age structure, to explore the effect of two different harvest policies, each of which removed 72 bears per year (the quota in the study area for 1974-75). In the first policy, the quota was removed proportionately from the total population 1-year of age and older. In the second, we simulated a spring hunt in which 90 percent protection was given to females 5-years of age and older and to cubs 0 to 2 years inclusive. (The 10 percent vulnerability allowed for hunter error in harvesting.)

Using the survivorships and reproductive values for 1971-73 (Table 1) the original population declined to 1008 in 15 years with a non-selective but proportionate harvest (Fig. 1a, line a) while under the policy of spring hunting and partial protection of females and young, the population increased to 2641 (Fig. 1a, line b).

Using the survivorship and reproductive values for 1974-75 (Table 1) and a non-selective but proportionate harvest, the original population declined to 131 in 15 years (Fig. 1b, line a). Under the policy of spring hunting and partial protection of females and young, the population still declined but after 15 years, was still 301 bears, or close to double the level reached with the non-selective harvest. Clearly, a selective spring hunt for polar bears would be most beneficial to the maintenance of a population for continued harvest.

Conclusions

Obviously the above summary is an oversimplification of reality, but it indicates the way in which simulation can be used to determine the effects of a variety of influences on a population. As Caughley and Birch (1971) point out, the above forms of analysis cannot be used to deduce growth rates for a population, but they can be used to explore the relative sensitivity or response of a population to various forms of manipulation. Clearly, one of the greatest problem areas in these models is not knowing the degree to which compensation takes place in either reproductive rates or subadult survival. For example, litter size, and age of first breeding differ significantly in different grizzly populations for which the information is available (Lentfer 1966; Hensel et al. 1969; Craighead et al. 1969; Novikow et al. 1969; Martinka 1971; Zunino and Herrero 1972; Pearson 1975). One explanation could be nutritive regime and physical condition of the members of the population under study, but just as likely is the presence of a compensatory mechanism responding to population densities. Such changes have best been recorded from some pinnipeds (e.g. Laws 1959). No such data exist yet for polar bears, but monitoring of the polar bear population in the western Canadian arctic, as it recovers from present low numbers,

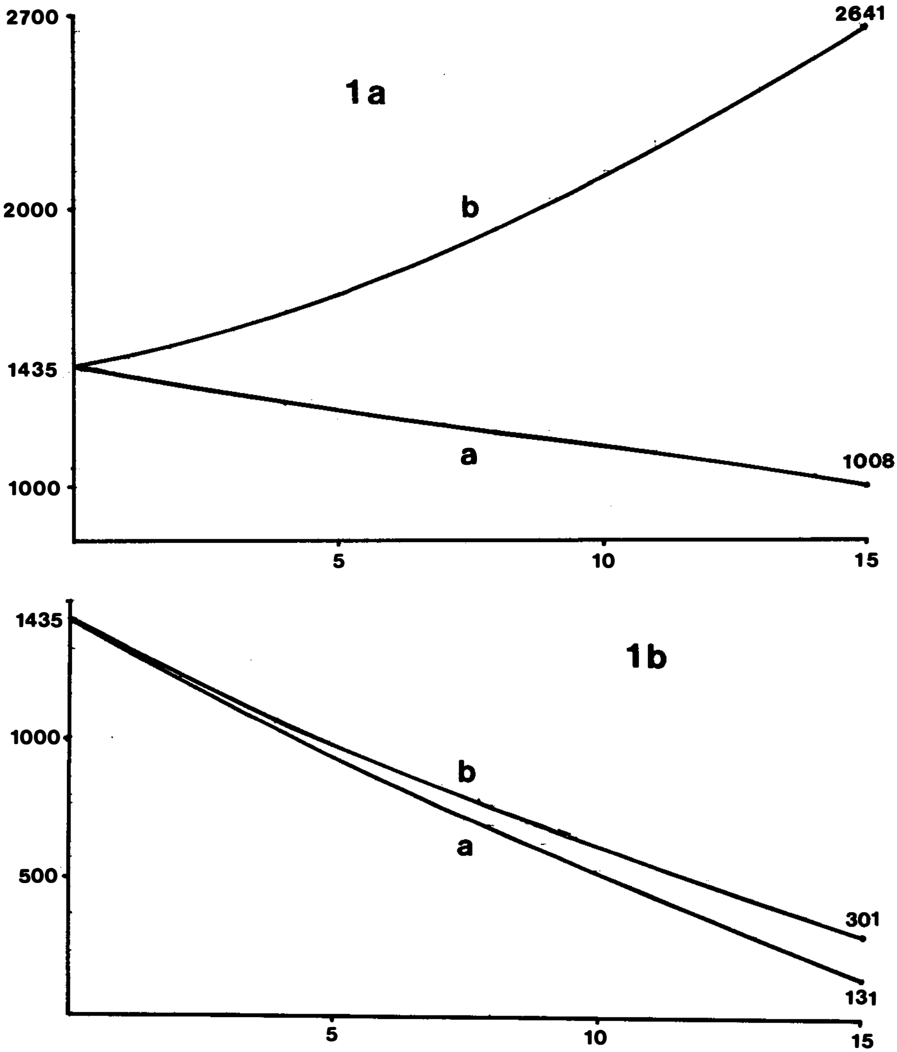

Figure 1. Simplistic simulations of the polar bear population in the Western Canadian Arctic using the data in Table 1, the 1971-73 sex specific age structure, an initial population of 1435 and a sex ratio of unity. (Details given in the text).

should provide valuable insight on this aspect. The area of compensation in reproductive and survival parameters is clearly the most critical area to be investigated in the future.

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Discussion

MR. KEN WILSON: This may seem a foolish question, but I would like to know what the maturation period of the polar bear is? Is it comparable to the black bear, the grizzly, or the other bear species?

MR. STIRLING: Yes, it is. Mating occurs approximately in May. Maturation occurs until approximately September, in which implantation takes place and the young aren't born until the middle of December or January. They are born at a pound and a half, hairless and blind.

MR. DAN KEPPIE [University of New Brunswick]: Perhaps you could give us an estimate of the numbers you have? Are they total numbers? Are you working with samples? How much you accept the accuracy of the information on numbers?

MR. STIRLING: I'm not quite sure I understand your question. Are you asking about the estimates of the size of the population?

MR. KENNY: Yes, particularly in the ranges of the far north, in which some areas are where the bears are distributed on floes.

MR. STIRLING: What we have estimated as the population has been based on mark and recapture statistics. This, of course, is long-term. It does not have the degree of accuracy that you might have on a population in a field where you can get a lot more marks and recapture. There is a fair amount of variability, but it is reasonable.

MR. MICHAEL SMITH [University of Georgia]: I was wondering whether you have good data on the date of maturation. I am surprised. The litter size is determined primarily by the rate of maturation. How has it affected the rate of maturation as a critical variable?

MR. STIRLING: Age of first reproduction is the thing that is most critical because the largest single class of female reproducing animals are in the younger years. So if you have 15 or 20 percent of your animals in four- or five-year age classes, come into reproduction it contributes significantly to the population, even though the eight- or nine-year-old litter size is smaller.

MR. KEN WILSON: What predator, besides man, takes the greatest toll? The wolf is a predator. What other predators would be important to the bears?

MR. STIRLING: I do not know any other predators that are important to bears other than bears themselves.

There is a certain amount of evidence in certain populations of grizzly and black bears that predation by dominant adult males may play a significant role. It has been suggested in polar bears as well. We have, as far as I know, only one documented case of specific mortality, although I have been told of a few incidents by eskimos.

In several thousand hours of observing polar bears in their natural habitat I suspect mortality is not significant in most circles, and that man is the major predator.

FROM THE FLOOR: I would like to ask about measuring natality. When do you get your first measurement? Are these cubs that are fed counted? Or, is there some way to determine natality that might have occurred from the time of birth and prior to the counting?

The second question is: In your model did you adjust natality to some other basis other than litter size, because natality rate and the litter size may not change, but the number in litters may change very greatly?

If you are killing the females, presumably they are coming into reproductive condition at a much earlier period, so the length of the time between litters will decline in those bears having litters early.

MR. STIRLING: If I can recall your questions in order, the first is, how do we calculate natality? We do not have any way. We would like a volunteer to do an investigation. We would be glad to send you out.

We have modified a specific natality or natality rates across all age classes. We are not in a position at the moment to be able to modify a specific natality to the degree we would like to. We are just getting into that now.

Do females come into reproductive condition at an earlier time? We do not know for polar bears, for example, whether or not that occurs, and it is the most critical single thing in bear management. It has become a big issue in Yellowstone, for example. Whether or not the Craighead population model of grizzly bears, is valid, because of the fact that it has no capacity for acknowledging compensation. Nobody knows how to measure it.

All I can say is we don't know, but we recognize it as the most important area.

Effects of Mast and Berry Crop Failures on Survival, Growth, and Reproductive Success of Black Bears

Lynn Rogers

Wildlife Research Institute, Minneapolis, Minnesota and Bell Museum of Natural History, University of Minnesota, Minneapolis

Knowledge of factors that limit black bear (*Ursus americanus*) populations is essential for proper management of that species and its habitat, but there have been few attempts to identify the key factors limiting black bear numbers. The black bear has few natural enemies, and its omnivorous food habits are commonly (but erroneously) believed to ensure an adequate food supply of some sort each year regardless of the failures of a few preferred foods. So by process of elimination, it often has been deduced that black bear numbers must be self-limited by social factors. However, recent studies in Minnesota (Rogers 1976) have shown that the social system of black bears varies with the distribution and abundance of food and probably serves to increase foraging efficiency, which leads to increased survival and enhanced reproductive success. Hence, instead of limiting populations below densities that can be supported by long term food supplies, social order may permit higher densities than otherwise might be possible. No evidence was found that social factors retarded growth and maturation other than through interference with feeding activities. Such interference appeared to be minimized by the observed social order.

Salient points of the social system as described by Rogers (1976) are the following: (1) Adult females are territorial but usually accommodate their offspring within the maternal territory for at least the years when the offspring are small and would have difficulty maintaining exclusive feeding areas elsewhere. (2) Adult males each establish a perennial mating range within which are territories of several mature females. (3) Transient young males often are prevented from settling in the ranges of established males where the transients would compete for food with the offspring and pregnant mates of the established males. Hence, the aggressive nature of adult males probably serves to increase rather than decrease the survival of their offspring. (4) The usual well-dispersed distribution of foods dictates solitary foraging, but where food is clumped, as in garbage dumps, aggregations occur; and social order adjusts accordingly.

Existing reports do not support the popular notion that black bears are able to secure an adequate diet each year. Unpubiished records of the Wisconsin Department of Natural Resources for 1954-1969 clearly show that failures of berry and mast crops, especially blueberries (*Vaccinium* spp.) and members of the red oak (*Quercus* spp.) group, correlate with marked increases in bear damage to farm crops, beehives, and livestock. The number of bears killed for such activities exceeded 100 only in years in which blueberry and/or acorn production fell below 20-25 percent of a full crop. Schorger (1946) reported an unusual influx of black bears into the vicinity of Duluth, Minnesota, during a shortage of wild fruits. Hatler (1967) reported that during a year of widespread failure of the blueberry crop in Alaska there were numerous emaciated black bears, increased use of garbage dumps, and several attacks on man. Rausch (1961) found that well fed captive black bears in Alaska developed more rapidly than wild ones. Jonkel and Cowan (1971) reported that in Montana reproduction in black bears approached zero when huckleberries (*Vaccinium* spp.) were scarce for three successive years.

The list of foods to which black bears can turn during shortages of preferred foods is not as long as generally is thought. The black bear lacks a cecum and has a simple stomach that is too acid to support the microflora and microfauna needed for digestion of cellulose. So the black bear's ability to digest vegetation is limited, and it must rely on a few of the more digestible herbs and on the parts of plants in which nutrients are concentrated as in berries, nuts, buds, catkins, tubers, and meristem. When forced by food shortages to feed on grass, the black bear loses weight or only slowly gains weight (Jonkel and Cowan 1971, personal observations). Its ability to secure some of its foods is enhanced by its adeptness as a tree-climber. But in evolving the short, sharply recurved claws that enable it to climb so well, it gave up some of its facility for digging; consequently, it seldom digs out burrowing rodents as does the grizzly. However, it does spend a great deal of time securing other forms of animal food such as colonial insects, carrion, and in some areas, fish. A free-ranging black bear in Minnesota spent more than three quarters of her foraging time in midsummer investigating sources of ants (Rogers 1976).

Assessment of the foods of the black bear makes it apparent that most are available only briefly or are too small and scattered to be gathered rapidly. The few foods that potentially are abundant, long-lasting, and easily secured are dependent upon the annual vagaries of temperature and precipitation with the result that over much of the range of the black bear there tends to be a surfeit of food in some years and, as will be shown, absolute or relative shortages (as defined by Andrewartha and Birch 1954) in others. This paper describes effects of shortages of mast (mainly *Corylus cornuta*) and berries (mainly *Vaccinium* spp., *Prunus* spp., *Cornus* spp. and *Rubus* spp.) on the survival, growth, maturation, and reproductive success of black bears as determined during a 7 year study in the aspen-birch-conifer forests of northeastern Minnesota. Development of wild vs. well fed captive black bears also are compared.

Methods

Methods were described by Rogers (1976). In brief, 272 black bears were ear-tagged, and 105 were radio-tagged during the seven years of study. Instrumented bears were radio-tracked to dens where they were weighed in autumn and spring. At the same times, growth and survival of litters of instrumented females were recorded.

Data on food habits were obtained from analyses of 1,120 fecal droppings and from observations of foraging bears. The abundance of each bear food was assessed during the radio-tracking of instrumented bears through all types of habitats. Abundance varied so greatly from one year to the next that ocular estimates were more than adequate for determining relative abundances. For this paper, food supplies are categorized as scarce, fairly abundant, or exceptionally abundant. During 1973-1975, 42 permanent transects were established in various habitats for more precise quantification of food abundance. Those data corroborate the ocular estimates for those years and will be presented in a future paper (Elwell, Arimond, and Rogers, in preparation).

Data on captive bears were obtained from records for 11 that were born in northern Minnesota and taken from the wild at 3-8 weeks of age.

Results and Discussion

Weights and measurements of captive vs. wild black bears showed that captive black bears that received rich diets developed more rapidly than wild ones even when the captives were caged with larger bears that dominated them. Captive bears of either sex commonly matured at 2.5 years of age, with females producing their first cubs at 3 years of age. By contrast, five wild females that had ready access to garbage did not produce cubs until 4 or 5 years of age (average 4.4 years), and nine that had little or no access to garbage produced first litters even later at 4 to 7 years of age (average 5.6 years). In other words, the better nourished bears developed more rapidly even though they experienced more contact with other bears, suggesting that any effects of social factors on growth and maturation as might be mediated through the endocrine system (Christian 1950, Christian and Davis 1964) were minor relative to nutritional factors at the densities encountered in this study.

Whelping data for wild bears were obtained following 2 years of exceptionally abundant food, 2 years of moderately abundant food, and 3 years of scarce food. Of the nine females with little or no access to garbage, five produced their first litters after years of exceptionally abundant food; three produced first litters following years of moderately abundant food, and only one produced her first litter following a year of scarce food. Moreover, in years of scarce food, some multiparous females that normally would be expected to be pregnant (because they had not been accompanied by cubs during the mating season, and black bears tend to be alternate-year breeders) gained less weight than usual and failed to reproduce. Such failure was especially common in virgin forests on the Laurentian Shield where food was particularly scarce. In summation, only 33 percent (14/43) of the females 5 years of age or older were accompanied by cubs following years of scarce food; whereas 44 percent (17/39) were with cubs following years of moderately abundant food, and 59 percent (23/39) were with cubs following years of exceptionally abundant food.

Females that did not gain sufficient weight prior to denning usually failed to produce cubs. Females 3.5 years of age or older that weighed less than 148 pounds (67 kg) on 1 October (N=16) produced no cubs, but those weighing more than 176 pounds (80 kg) on that date produced cubs in 28 of 30 cases in which the females had been without cubs the previous mating season. The two exceptional cases involved (1) a female with a broken leg and (2) a female that probably did not conceive (Rogers 1976). Females weighing between 148 and 176 pounds (N=8) had variable reproductive success. As examples, a 148 pound (67 kg) female produced three cubs that grew more slowly than most and died at 2-4 months of age. A 150 pound (68 kg) female produced two cubs that also grew very slowly, but the natural fate of these cubs was not learned because their mother abandoned them when hikers disturbed the den in April. The same mother reached a weight of 154 pounds (70 kg) the following autumn and produced three cubs which survived at least through their first summer. A 167 pound (76 kg) female produced only a single cub. Females weighing 152, 156, 169, and 174 pounds failed to produce cubs even though they were observed with males during the mating season or were captured during that time and found to be in estrus.

Although ovulation and conception occur in June or early July when accumulation of body stores has scarcely begun, implantation of blastocysts occurs in November or December after accumulation of body stores has been completed (Wimsatt 1963). This sequence of events together with the fact that females that were observed with males during the mating season usually failed to produce cubs if they did not gain sufficient weight lead one to speculate that bears may physiologically assess their supply of stored nutrients in the fall and prevent implantation in years when stores are too low to support both themselves and their young through the denning period. If such a protective mechanism were to exist in any mammal, it would be expected in bears because, of all mammals, they are the only ones in which the mother does not feed during a denning period of up to 7 months which includes the entire period of post-implantation development of the fetuses and approximately 3 months of the lactation period.

Nutritional stress upon females that raised cubs was evidenced by the fact that they often retired to their dens in fall weighing little more than when they had led their newborn cubs from the natal dens the previous spring. By the following spring, when the cubs (as yearlings) were nearly ready to begin travelling independently, mothers often weighed less than half as much as during the autumn preceding parturition. However, mothers that found rich food supplies did not undergo such drastic weight losses, and in some cases gained as much during years of lactation as they did in other years.

Food supply influences the development of bears more during the first year of life than at any other time. Growth during the 2.0 to 3.5 months of nursing in the natal den depends upon the milk supply which, in turn, depends upon the nutrients stored by the mother the year before. Predenning weights of pregnant females provided indications not only as to which females would produce cubs but also as to the weights of the litters at two months of age ($r^2=0.540$, $P<0.001$, $N=24$ females and 24 litters). Birth dates for light as well as heavy litters were pinpointed in the last week of January indicating that weight differences observed in dens in late March were due mainly to differential growth rather than to differences in ages of cubs.

Soon after cubs left their dens they began to supplement their diets with solid foods. They gained weight significantly ($P<0.0001$) more rapidly in years of abundant food than in years of scarcity. Predenning weights in years of abundant food averaged 48.6 ± 1.9 pounds (22.1 ± 0.86 kg, $N=29$) vs. an average weight of only 34.4 ± 1.1 pounds (15.6 ± 0.5 kg, $N=39$) in years of scarcity. At 6 months of age, well fed captive cubs weighed two to five times as much as wild ones.

More than 90 percent of the mortality among cubs and yearlings was from natural causes. Relatively few died from human-related causes that included cars, trains, electrical powerlines, gunshot, and disturbances of dens. Natural mortality among cubs and yearlings appeared to be nutrition-related because lightweight individuals suffered heavier mortality. Cubs that weighed less than 4 pounds (1.8 kg) in late March (N=15) experienced approximately four times greater mortality prior to family breakup (67 percent died) than did heavier cubs (N=47). Mortality was not as great among 22 yearlings, but the two (18 percent) of them that did die of natural causes weighed less than the median weight of 29.5 pounds (13.4 kg) in late March. Both were members of a cohort of six that not only was born in a year of poor food but that lived as yearlings in a second such year. It is unknown whether lightweight cubs and yearlings actually died of starvation or whether malnourishment predisposed them to die from other causes. The three carcasses that were found were almost entirely consumed by wolves (*Canis lupus*) or larger bears by the time they were found, and causes of death could not be determined from the fragments of bone that remained.

Mortality among cubs increased with litter size (Table 1). On the average, litters of three resulted in the maximum number of offspring per litter added to the population at weaning, and litters of three were strongly modal.

Table 1. Litter size and survival.

Number in litter	Litters	Cubs	Percent mortality prior to weaning	Average number of cubs surviving per litter at family breakup
1	2	2	0.0	1.0
2	8	16	12.5	1.75
3	22	66	18.2	2.45
4	3	12	50.0	2.00
Combined	35	96	20.8	2.17

Examinations of litters in natal dens showed that brown phase females produced significantly ($P<0.01$) larger litters on the average than did black females. Five litters from brown females averaged 3.40 ± 0.24 cubs (range 3 to 4 cubs), whereas 24 litters from black females averaged only 2.46 ± 0.15 cubs (range 1 to 3 cubs). However, cubs of brown females (N=17 cubs) weighed only 3.5 ± 0.22 pounds (1.6 ± 0.10 kg) on the average at 2 months of age, which was significantly ($P<0.001$) lighter than the average for cubs of black females (4.8 ± 0.13 pounds, 2.2 ± 0.06 kg, N=54).Thus, cubs of brown females experienced higher mortality in years of poor food. By the time the cubs were independent, litters of brown females (N=8 litters) contained the same number of cubs on the average (2.25) as litters of black females (N=36 litters). Conclusions based on these data should be regarded as tentative, however, because data from brown phase females were obtained from only five mothers that could have been from as few as only one or two family lineages.

Outside the study area, four black females that lived around large garbage dumps were observed with litters of four in late summer, suggesting that females that feed at large garbage dumps produce larger litters on the average and/or that survival is higher among well fed cubs nursed by well fed mothers. Rogers et al. (1976) reported that litters observed at sources of garbage in the Upper Peninsula of Michigan were significantly ($P<0.01$) larger on the average (3.1 cubs per litter, N=7 litters) than those observed by hunters in the same area but largely away from sources of garbage (1.99 cubs per litter, N=129) (Erickson et al. 1964).

In contrast to the causes of mortality among cubs and yearlings, more than 90 percent of the known mortality among bears 2 years of age or older was from human-related causes. However, little is known about the causes of mortality among dispersing subadult males because few of them were radio-tracked after they left the study area. It would not be surprising to find that they experience considerable natural mortality upon leaving the familiar area in and around their mothers' territories. Dispersing subadults not only must find new sources of food but they must do so in the face of stiff competition from unrelated bears that frequently displace them from newfound feeding areas (Rogers 1976). Many of them move straightline distances of more than 100 miles (161 km) before finding places to settle. Jonkel and Cowan (1971) captured subadults in May and June that were so thin and weak that they easily were handled without drugging. These apparently undernourished bears probably were vulnerable to a variety of mortality factors if not actual starvation. It would not be surprising if some of them eventually were killed by predators including other bears.

In addition to natural mortality, dispersing males often are killed as nuisances or by hunters as a result of their tendency to exploit sources of garbage. Thin and hungry transients easily overcome their fear of human habitation when there is the prospect of a nutritious meal. Moreover, the areas around sources of garbage often are free of large resident males because the latter have been killed as nuisances by landowners or as trophies by hunters. Young males that feed on abundant nutritious foods such as can be found in garbage dumps grow faster than otherwise (Rogers et al. 1976) and thereby hasten the day when they can compete successfully for space and mates. In Michigan, 34 percent of the bears (excluding cubs) captured at sources of garbage were 2-, 3-, and 4-year-old males (Rogers et al. 1976).

The main human-related cause of mortality for bears 2 years of age or older was being shot while attempting to secure garbage near human habitation. Such mortality was highest during years when natural foods were scarce as also was found to be the case in Wisconsin (see page 431). In the 7 years of study in Minnesota, nine radioed bears were killed as nuisances during 3 years of scarce natural food, and only three were killed as nuisances during 4 years of moderately or exceptionally abundant natural food. Additionally, at least 26 bears were killed within 6 miles (13 km) of the study area the year before the study began. Berries were extremely scarce that year (1968) according to reports by conservation officers, forest rangers, and local berry pickers (Rogers 1970). Cub survival probably was low that year because a gap in the age structure dating to 1968 was evident throughout the 7 years of study. Following the high mortality in 1968, the resident population of the 110 mile^2 (285 km^2) study area went through a period of recovery and then more or less stabilized at 60-67 bears for the last 4 years of study (Rogers 1976). The resident population remained fairly constant for those 4 years even though 60 cubs were born in the study area, and at least 53 transients traversed it.

It is difficult to prove what limits wildlife populations because of the large number of factors that must be considered. Nevertheless, annual fluctuations in food supply influence vital population characteristics so greatly that it is difficult to escape a conclusion that nutritional factors primarily are responsible for adjustment of the adult population of black bears in northeastern Minnesota to levels that can be sustained through frequent years of scarce food. Such a conclusion appears even more logical when densities of black bears in logged vs. virgin areas are compared. Food is more abundant in the logged areas due, in part, to increased sunlight at the shrub level (Elwell, Arimond, and Rogers, in preparation). Preliminary analyses of population data suggest that bear density also is higher in the logged areas than in the nearby virgin forests of the Laurentian Shield despite much greater human-related mortality in the logged areas.

If nutritional factors are important in limiting black bear populations as they appear to be, then habitat improvement programs should be useful in the management of black bears. Additional study is needed to determine the nutritional requirements of bears and to determine which nutrients are supplied by which foods in order to better understand how black bears are affected by failures of particular crops.

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Providing Habitats for Wild Fauna and Flora

Chairman:
MAYNARD M. NELSON
Regional Administrator
Department of Natural Resources
New Ulm, Minnesota

Cochairman:
FRANK B. BARICK
Chief, Interagency Wildlife Coordination Section
Wildlife Resources Commission
Raleigh, North Carolina

Opening Remarks

Maynard M. Nelson

Our program this afternoon deals with what I happen to feel is the most critical issue facing conservationists today—the problem of providing habitats for wild fauna and flora. We offer you a roster of six speakers recognized as leading authorities in their fields, authorities who will address such basic issues as the preservation of natural plant communities for their scientific and aesthetic values, enhancement of forest habitats through improved management techniques including the use of fire as a management tool, the opportunities for wildlife under government agricultural programs, and our responsibilities as individuals in preserving wetland habitat.

Our speakers have been asked to respond to two key questions: (1) Where do we stand in our habitat preservation efforts to date, and (2) What do you see as needs for the future? Please remember that one-third of the allotted time is available for a question and answer period following each presentation. This is your opportunity to stimulate further discussion.

Many of us here today are what might be called environmentalists. The diversity of our natural habitats is an essential part of our well being—and we treasure the brief moments that they afford for reclaiming the inner peace that comes from being a part of what Aldo Leopold simply referred to as "country."

Others among us have what some would call selfish interests. We are hunters. I guess I am some of both—but mostly I'm a hunter. And as a hunter, I am mighty concerned about the future. Let me tell you why.

This year we are celebrating our nation's Bicentennial. Yet the development of this great country is really a very recent event. Seventy-five short years ago my father came to the fertile prairie of southern Minnesota as the son of an immigrant farmer. While my grandfather broke the prairie sod and carved out a farm, his sons helped prepare the household for the winters ahead by shooting and salting down stone crocks full of wild ducks and prairie chickens.

A few short years later, in 1942, the prairie chicken was all but gone from southern Minnesota, and the hunting season on them was closed statewide, never to be reopened. Fortunately, the immigrant ring-necked pheasant had become quite abundant by this time, and the hunt went on, literally undiminished. Yet, the intensity of agriculture was increasing, and the small game hunter was beginning to feel the pinch by the late 1940's and early 1950's.

Today, after almost 25 years as a wildlife biologist, I fear that I am witnessing a last ditch effort for survival by virtually all wildlife in the cash-grain farming region of Minnesota. Pheasants and rabbits have declined by 90 percent in a time span of less than 20 years. The versatile white-tailed deer survives the winters of heavy snowfall by raiding cribbed corn or through supplemental feeding. The land over broad areas is fall-plowed from roadside to roadside—and the habitat is gone. And Minnesota's problems aren't unique. Populations of farm game are in trouble across the north central states which comprise the nation's breadbasket.

Habitat restoration may not be a cure-all for our dwindling wildlife populations, but it clearly is a necessary first step in many parts of this great country.

Maintenance of Natural Diversity: Approach and Recommendations

Robert Jenkins
The Nature Conservancy
Arlington, Virginia

The United States is experiencing unprecedented human growth—of population, technology and consumption. That this unchecked anthropological explosion has produced catastrophic ecological consequences for much of the rest of the country's biota and the systems of which they are parts is incontestable.

In this paper I will consider one particular aspect of this problem—the reduction of natural ecological diversity through the elimination of species, communities, natural features, and phenomena. The single cause of most of this reduction is the direct destruction of habitats by conversion of natural landscapes to more intensive uses.

Reduction in ecological diversity is detrimental to our own long- and short-range interest, and we would be well advised to take whatever steps we can to retain as much diversity as practicable. Until we can bring our runaway growth under control, we must look to ways in which diversity can be maintained in the context of what some people refer to as the "world packing problem."

I contend that the maintenance (or preservation) of natural ecological diversity is just a different way of stating what has always been one of the main objects of the American Conservation movement. Even the Soil Conservation Society of America, many members of which sharply distinguish between "conservation" and "preservation," has a Soil Benchmark Program to maintain undisturbed examples of each major and minor soil type. In like fashion, other conservation groups attempt to preserve selected elements of overall diversity such as waterfowl, endangered fauna, forest types, cold-water game fishes, and so on. Unfortunately, there is considerable competition and pursuit of narrow interests, and the movement lacks the sort of cohesion that the expression "maintenance of natural diversity" implies. As a result, many organisms, biological communities or other ecological entities are simply ignored in the fragmentation of conservation objectives and under present circumstances such neglect is apt to lead to their extinction. What is needed to avoid this is the integration of efforts to preserve natural habitats for all forms of natural diversity in the face of strong countervailing pressures for homogenization.

The scope and complexity of this subject prevents more than a skim of it here. In this paper, I shall particularly emphasize the vital need for better information and information management systems as a basis for effective action. Fuller accounts have been published elsewhere and The Nature Conservancy's report to the Department of Interior, "The Preservation of Natural Diversity; A Survey and Recommendations" (Humke et al. 1975) should especially be referred to.

Loss of Diversity

Mankind probably constitutes the most profound geological force in the earth's history. "Not all the winds and storms and earthquakes and seas and seasons of the world have done so much to revolutionize the earth as Man . . . has done since the day he came forth upon it and received dominion over it" (Bushnell 1864). Other major forces such as plate tectonics, continental glaciation, and isotonic sea level fluctuations occur so slowly as to be imperceptible. More dramatic forces such as floods and volcanism have primarily localized effects, and operate within a confined range of physical and chemical variation. Human beings work fast, have metastasized into nearly every foot of the earth, and don't recognize any limits except those which we shortly plan to exceed. During a mere 200 years of nationhood, we have directly caused the loss of one-half of the topsoil, polluted every major river, cut down almost all the forests at least twice, plowed 90 percent of the tall grass prairie, destroyed perhaps 30 percent of the Eastern salt marshes, drained over half of the interior wetlands, impounded or reconfigured almost all of our streams, turned our atmosphere brown and poisonous, and by and large have made a positive nuisance of ourselves.

Among the effects of this virulent activity have been pervasive destruction and simplification of natural ecological communities and associations, often with an attendant extinction (or near extinction) of species. Extinct species among higher vertebrates, such as the passenger pigeon and the Stellar's Sea Cow are so well known as not to require reiteration. Less well-known species have suffered even more.

Aquatic organisms, inhabiting a medium which is a sink for pollution and a target for intense use, have fared particularly badly. The fishes of the Southwest, for example, have been decimated by water withdrawals and aggressive introductions (Hubbs and Echelle 1973) while the southeastern molluscs have been similarly damaged by dams and channel modifications (Stansbery 1971). Among vascular plants, the recent Smithsonian list includes about one hundred species believed already extinct and fully 10 percent of the continental flora which is either threatened or endangered (Smithsonian 1975).

Many endangered species, even those which have received much attention such as the California Condor and the Whooping Crane, are hanging on in extremely low numbers and the prognosis for them is not good. We can only surmise that the proportion of extinct and endangered species in groups like insects or cryptogams of which we are less knowledgeable are at least as high and probably higher, since they haven't received even as much direct attention and care as more conspicuous organisms. The data for North America, which as a large continental land mass is mostly inhabited by widely distributed and adaptable organisms, is made to seem benign by comparison with some other areas. Our 50th state, Hawaii, suffers from the notorious ecological fragility of islands. Over 10 percent of its higher plants are already extinct and another 40 percent are threatened or endangered (Smithsonian 1975). Forty percent of the unique Hawaiian Honeycreepers are also believed extinct. (Berger 1972)

Besides species, other main elements in preserving ecological diversity are the communities or ecosystems which they constitute. Existing information in this area is very inadequate but what conclusions we can derive from existing sources are discouraging. The Society of American Foresters natural area system includes representatives of only 111 out of 156 forest types (Society of American Foresters 1972). The latest summarization of the existing Research Natural Areas of the various federal agencies, indicates that only two-thirds of the Society of American Foresters forest cover types and only 50 percent of the non-forest types (classified according to Küchler) are presently protected within the system (Federal Committee on Ecological Reserves 1976). Actually, the situation is probably much worse than this data suggests, because the community classifications used are relatively gross. In the single State of Tennessee, our Natural Heritage Program's more detailed classification distinguishes over 130 plant communities. After six months of data collection, only 65 good quality occurrences have been reported for all communities combined, with nearly 100 so far entirely unrepresented. We are still hoping that to some extent this is an artifact of the abysmal state of available information, but we know enough to realize that in many areas there is really very little existing landscape in anything approximating its natural condition. In another state, we held a workshop of leading botanists, foresters, ecologists, and natural scientists to discuss classsifications and sources of information. The first item of business on everyone's mind, however, turned out to be ecosystem restoration, because in the words of one of the participants, "For most of our natural communities and habitats, there is simply nothing left."

The Uses of Diversity

Readers of this paper are probably professional wildlife biologists and should be well aware of the importance of diversity, but a brief review may be appropriate for completeness. The subject has never really had adequate treatment from a conservation point of view, but has been treated at some length elsewhere (Ehrenfeld 1972; Evans 1966; Jenkins 1975). A few of the main arguments are summarized here.

Each biological species (and to a lesser extent each isolated, interbreeding population or gamodeme) has unduplicated attributes which may cause it to play a unique role. How important this role may be—in the function of an ecosystem, in the maintenance of system stability, as an ingredient of a food chain or participant in other relationships—is ordinarily very unclear. It would be prudent to retain as many of these entities as possible in case we need them.

Each species is a unique biochemical factory which may at some time prove to be a renewable resource of practical significance in human affairs. The sum of species and genetic diversity is our largest single source of future resource options. Any species, therefore, is a potential resource of indeterminant value for applications in scientific research, pest control, pharmacology, crop creation or improvement, and so on. Retention of the greatest possible diversity of species, then, is just good resource management.

Associations of species or plant and animal communities are also important resources (as well as being the only feasible and economical focus for species preservation). Each biological community is composed of interacting species collectively adapted to coexistence and the occupancy of some particular part of the earth's surface. As such, these ecosystems are examples of healthy local ecosystem function which serve as experimental controls, design models, and material reservoirs (or "parts departments") to improve our management of contrived ecosystems under otherwise similar circumstances. In the worst of cases, we may need the restorative capacity of such functional communities for total correction of really egregious miscalculations or landscape abuse. They have a long history of serving us well in this capacity.

Some people believe that human beings have psychological needs for association with, or stimulation by, diverse natural landscapes. This psychological symbiosis may be obligate or simply enriching. Nearly any enjoyable human activity has a strong component of diversity, and the opposite situation is boredom or monotony. Even if we determined that natural diversity was only a psychological luxury, it would still seem well worth having.

Maintaining Natural Diversity: The Primacy of Information

As stated in the introduction, it is so self-evident that the reduction of natural ecological diversity is overwhelmingly caused by a loss of habitat that it will not be debated here. It follows that the preservation of natural diversity will depend primarily on the protection of land areas where natural conditions are allowed to prevail. The fact that more species are not already extinct is partly owing to the many existing reserves, but the skewed distribution of those lands provides for only a fraction of total diversity.

Now that recreation subdivisions, energy projects, and "plant the hedgerows" agricultural practices are reaching into every corner of the nation, we should be carefully selecting lands for future reserves as "lifeboats" for diversity. Unfortunately, most of the lands being set aside are largely chosen for recreational and open space purposes with little or no thought to the importance of ecological diversity. With the Federal Government allocating less than $10 million a year for the acquisition of endangered species habitat and $300 million to the Land and Water Conservation Fund, perhaps no other single change could have so immediate and beneficial an effect on natural diversity as incorporating the objective into the decisions of state and federal recreation land agencies. This could easily be done with no negative effects on other aspects of their business. Other land holding agencies should do likewise.

Beyond recognizing maintenance of natural diversity as an important objective, accomplishing it will depend on identifying the proper lands, protecting them from adverse influences, and managing them as necessary to perpetuate the desired conditions. Though none of these is being adequately carried out today, I believe that the identification process, or more correctly the process of gathering, organizing, and analysing the information needed for good decision-making is particularly crucial as it is hard to do an adequate job on any other aspect of the problem until this is dealt with. Therefore, the rest of this paper will be restricted to this topic and its ramifications.

Our ignorance of the existence, condition, status and distribution of the elements of natural ecological diversity in this country today is unbelievable. Ecogeographic complexity, of course, has made it difficult to even adequately conceptualize the problem, but from a conservation point of view we should have done much better. Had we ever created the sort of systematic process for biological and ecological survey that we have for geology or soils, every scientist, land manager, conservationist, planner and decision-maker in this country would be using the standard data output from such a system as routinely as they presently use topographic maps. If someone then suggested abolishing the effort, they would be met by a combination of outrage and incredulity. Getting such as effort started, however, is something else again.

I believe that the availability of such information would have immensely more powerful effects than anyone imagines. At the simplest conceptual level, it would give systematic guidance for the establishment of additional reserves. By providing comprehensive comparative data on rarity, endangerment, and distribution of the elements of natural diversity, on the relative quality of known examples of given elements and of aggregations and current locations of important elements and features, our effectiveness in allocating limited resources would be tremendously increased.

This would make it possible for us to employ a much greater range of protection techniques in an efficient mix. For example, many critical natural areas might not be particularly threatened. Individual landowners and managers could be acquainted with the location and importance of significant features on such lands, but perhaps all the protection they require is to add them to a registry of areas to keep an eye on. The National Natural Landmarks Program of the National Park Service, for example, has had extremely good experience with such an approach. Although they have designated over 300 such landmarks, many privately owned, they only know of one landmark intentionally damaged or destroyed. After all, natural diversity in this country is rarely destroyed by necessity, because we are simply not that land poor. If the last prairie were to be plowed to make way for the zillionth cornstock, it would be out of ignorance, not need, and good information may be its best defense.

For lands that are slightly more threatened, inexpensive incentives might be sufficient for their protection. This progression of increasingly strong (and expensive) methods of protection continues on through dedication procedures, through leases to easements or acquisition of less than fee interests to acquisition and management and finally to binding legal commitments as in a trust document.

An efficient multi-level protection strategy of this kind is not without precedent. The British Nature Conservancy Council, a quasi-governmental agency, building on better ecological information than we have available, has "scheduled" thousands of ecologically significant areas for protection. Although only a modest amount of acquisition funding is available in any given year, that money is spent with maximum efficiency. In a typical year, the most important areas which come under threat are protected through acquisition, the least important are given up with some regret, and a lot of areas in between are rescheduled or protected through negotiated settlements. This excellent system is made possible by the intelligent use of good information.

Such information would be of great use to planners, whether oriented toward preservation or development. The data base can provide guidance on what ought not be destroyed, and the documentation and comparative perspective may strengthen the potential for proper implementation of plans. The recurrent spectacle of equally qualified experts contending in adversary proceedings may be largely eliminated, as comparative data should often place the burden of proof on one side or the other.

An extension of this reasoning leads me to believe that such a data bank could make a profound contribution to the environmental impact assessment process. At present, surveys of potential development sites can only generate descriptive information and deal with questions of carrying capacity, such as whether the soil is suitable for septic tanks or where water supplies will come from. Criticisms of environmental impact statements, on the other hand, often boil down to the contention that there are species, communities, or habitats on the surveyed sites which are unique, outstanding, or rare for the region in question. Since there is currently nowhere that either side can turn for the broad regional perspective necessary to evaluate such questions, the process breaks down.

There are obviously many other applications for such a data bank, and one function of particular importance is the use of a common information base to provide indirect coordination among currently fragmented programs. Unification would not be complete, but coordination through this mechanism is a great deal more feasible than the simultaneous administrative re-direction of all the agencies, bureaus, programs and institutions in question.

The State Natural Heritage Program: A Unified Approach

The Nature Conservancy is the only national conservation organization whose whole business is the preservation of ecological diversity through the protection of appropriate pieces of land. The organization is perhaps best known for its acquisition program which in the last 20 years has directly preserved over 1,500 varied natural areas totaling over 800,000 acres (324,000 ha). The organization has an even longer history of involvement in "natural areas inventory," since, beginning in 1917, that had been the major interest of its precursor body, the Committee for the Preservation of Natural Conditions of the Ecological Society of America. In one way or another, the organization has been involved in nearly every such inventory ever conducted anywhere in the United States, but it must be confessed that these have, for the most part, been a severe disappointment. In recent years, our experiences with inventories has given us the opportunity to identify a pattern of mistakes and shortcomings, and to attempt to rectify them. The effort to improve and apply our knowledge in this area had evolved into what we call our State Natural Heritage Program. This is described below in general terms.

This program began in 1974 when officials of the South Carolina Department of Wildife and Marine Resources requested our assistance in devising something along the lines of the earlier Georgia Heritage Trust program with which the Conservancy had been somewhat involved. The South Carolinians liked certain aspects of that program, but naturally wanted an improved version. They wanted a more scientifically sophisticated and systematic process which could produce benefits beyond just the immediate acquisition of natural areas.

Today, there are nine such programs in some stage of development or maturation. As presently structured, a multi-disciplinary task force in the Conservancy's National Offices assists state agencies to create an on-going systematic process of inventory, data banking, and protection planning for the preservation of natural ecological diversity and other elements of a state's irreplaceable heritage. The task force works from a constantly evolving model, modifies it to accomodate individual state variation, trains the personnel, installs the technology, directs the inventory during the establishment phases, helps to evaluate protection capability and after one or two years, transfers the total machinery to the state government for operation.

The State Heritage Programs are carried out in four phases as delineated in Table 1. The inventory itself, which involves continuing cycles of data collection, processing and analysis, is the main focus of attention, and its continuity is the crucial objective. The creation of the classification system, the installation of the data management system, and the application of standard operating procedures are the key elements in achieving this.

Table 1. The state natural heritage program.

Phase I. Program Development	Phase II. Data Cycle Initiation	Phase III. Protection Planning	Phase IV. Program Continuation
1. Establish Operations	1. Collect Data	1. Evaluate In-state Situation	1. Transfer of Operational Management to State
2. Develop Classification	2. Process Data	2. Compare to National Overview	2. Protection Implementation
3. Install Data Management Apparatus	3. Analyze Data	3. Recommend Alternatives for Improving Capabilities	3. Continued Cooperation by the Conservancy
4. Develop Operations Handbook			

The classification delineates a manageable number of "elements" which hopefully captures the full array of ecological diversity. This list of elements defines our preservation targets, acts as a framework for the compilation of data, serves as the basis for ascertaining rarity or endangerment of the discrete elements, and makes possible the comparison of replicants of recurring types. We use a "coarse filter/fine filter" approach as a simplifying assumption to make our classification feasible and functional. Most species are treated in "coarse filter" community aggregates characterized by identifiable Plant Communities and Aquatic Types. A first objective of preservation efforts is the representation of at least one good example of each of the ecosystem types found in that state within a system of preserved or non-jeopardized lands. In this way, the majority of species will occur at least on some protected landscape. Increasing the number of representatives of each type in the protection system will gradually increase the number of species preserved, but at a decreasing rate. The "fine filter" for the system are the specific Special Species (endangered, threatened, endemic, specialized, rare) which are most likely to fall through the cracks of the coarse filter. These are the kinds of species which are infrequent components of major community types or those which are indicators of highly specialized micro-ecosystems which are better defined by the species themselves than by any other attribute.

Effective data management was a key missing ingredient of earlier inventories and we have attacked this problem with a vengeance. Our data management concept is toward a "balanced" system, involving the use of very carefully cross-referencing manual, map and computer files. For various reasons, we have worked very hard to confine the role of the computer. Though essential to such a program, uncritical application of computers can be perilous. We are most confident of its utility, at least in the early stages, as an indexing device on certain highly standardized items of real information. Further, we use the computer as a mechanical generator of reports, maps, and permuted directories. The important unit of information collection and storage is the "element occurrence," and the fundamental computer system is appropriately called the Lowest Common Denominator Element File (LCD-ELF) (Moyseenko et al. 1976).

Inventory and data management strategy can perhaps be understood by reference to Figure 1. The classification system is represented by the right hand face of the irregular data block in the diagram. It is composed of a series of the element classes, including plant communities, aquatic types, special species, and as many other larger classes of diversity as the state may wish to include. In several states, we are treating historic and cultural types, archeological or paleontological diversity, and recreation. Soils, geology, and any number of other classes could be added. The classification system also stays "open" in the sense that additional elements can be added within any class as experience or new information dictates.

Basically, the purpose of the inventory is to find and describe extant occurrences of the individual elements within the system. The inventory phase concentrates first on organizing existing information in concentrated secondary sources, and figuratively spirals outward to collect and organize information from increasingly diffuse sources until the ultimate point of the real landscape is reached. Since the preservation of diversity is best accomplished by concentrating on the rarest elements, this is a very efficient system for our purposes. The outward search into more diffused information sources obviously produces diminishing returns which in some earlier inventories has essentially led to cessation of the search before the rarest elements (which are obviously the very ones we should be focusing on) have been dealt with at all. This problem is evaded by concentrating searches on the least reported elements in each recurrent cycle of data collection.

I stated earlier that this would be a rank simplification, but in fact, even though our operations materials total upwards of 1000 pages, the concept is almost as simple as it appears. Analysis focuses primarily on the rarity and under-representation of element types which gives us an index on endangerment and therefore predicates our activity both in continuing data collection and in active preservation. However, because of the accumulation of complex information (essentially all we can get our hands on) in readily retrievable manual files, this simplicity does not rob us of any capability inherent in other inventories. We have in effect emphasized quality without in any way sacrificing quantity in the process. The system has the potential to gradually evolve into a really

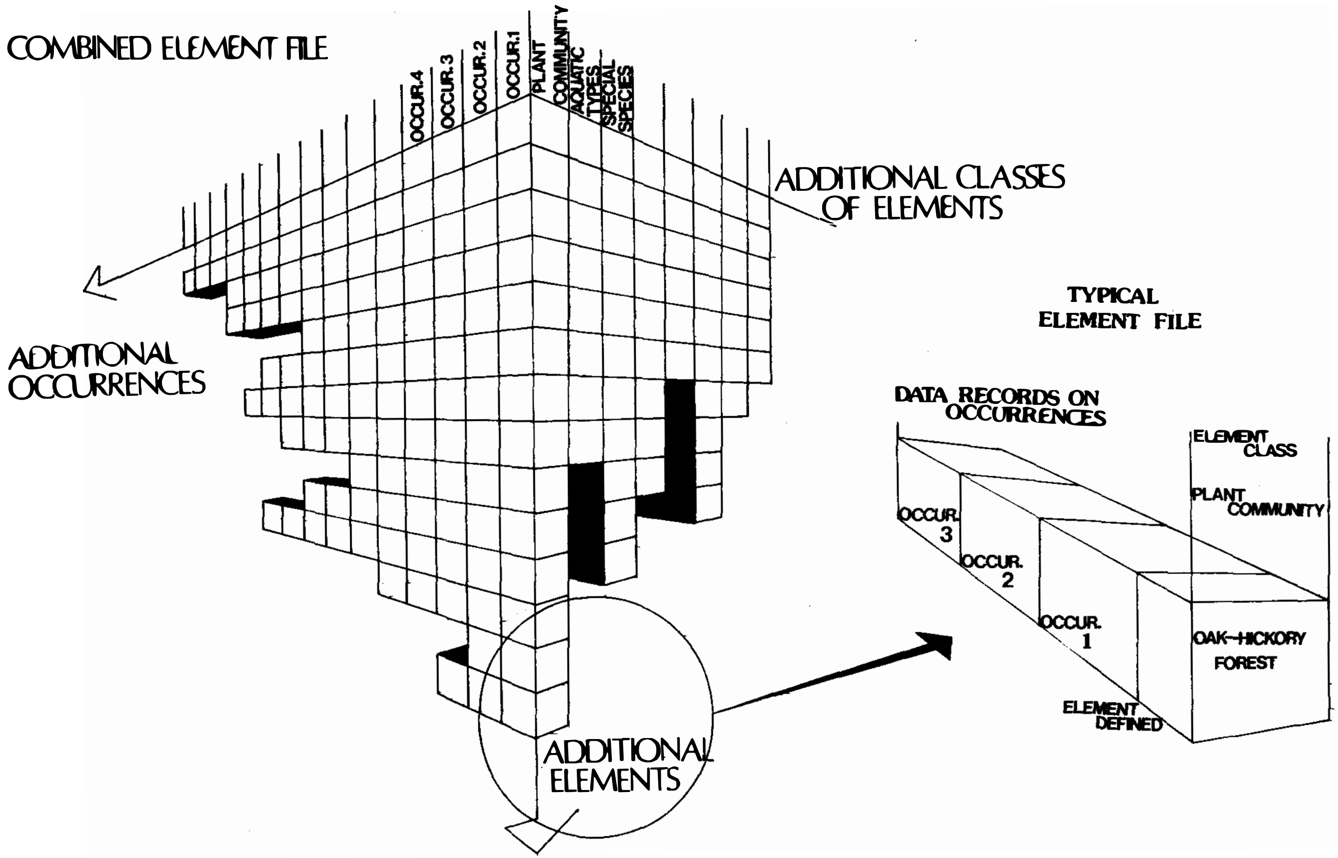

Figure 1. Natural Heritage Data Structure

large data bank, incorporating or accessing the most intensive information available (such as the Ecosystem Analysis data of the IBP or Hydrological Benchmark Information). At the same time, because of the collection sequence, information has immediate utility at every step along the way.

The Conservancy, of course, is pleased with the role it has been playing, but many individuals involved in the State Government deserve great credit for the initiative and concern they have displayed and for their continuing enthusiasm and support. It has been our feeling that only state government agencies can reliably carry out the long term cumulative efforts of data collection, recollection, modification and refinement which are required. Moreover, the states have the greatest capability to utilize this system. The Bureau of Outdoor Recreation in the Federal Department of the Interior has also played a key role, matching state and private resources from its Land and Water Conservation Fund as part of its systematic planning process. A number of private foundations, individuals, and corporations have also supported the effort, either nationally or in the individual states.

Conclusions

I believe that the idea of preserving natural diversity, in those terms, is coming of age. As the pace of land conversion accelerates and naturalness is everywhere on the retreat, the increasing scarcity of the elements of diversity is beginning to make, I hope, the kind of counterstroke that scarcity does on pricing and other economic affairs. Its value is increasing in people's minds and a willingness is being expressed to pay a price in resources and restraint of consumption. This will certainly be necessary in the near future, and in the long run, will pay off by retaining richness in the world which is probably vital and certainly beneficial.

However, we presently have no specific programs to pursue this purpose, and the existing fragmentary efforts are not sufficient. Too many of the elements of diversity could easily be destroyed without our notice, and above all, effective action will depend on amassing information in such a way as to create the underpinnings for informed action. This paper has primarily dealt with this need for information and a specific approach for getting and using it.

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Discussion

MR. CRAIG SCHAEFFER [National Park Service]: For the benefit of the individuals who may not already be aware of them, could you briefly outline some of your major recommendations in your recent study for the preservation of natural diversity?

DR. JENKINS: We think that this whole question of natural diversity is the key concept which has been neglected in considering environmental quality maintenance. Not only does natural ecological diversity of species, genotypes and communities have great intrinsic value, but it also provides a wonderful unifying mechanism for a lot of currently fragmented activities which prudence requires me not to enumerate.

However, you all know that in state government, federal government, and in private activity, we are pursuing things in such a fragmented and competitive manner that we constantly get in one another's way. Considering that we do not have much in the way of resources in this field, this seems almost criminal.

We did, at the behest of the National Park Service, the Fish and Wildlife Service, and the Bureau of Outdoor Recreation within the Department of the Interior, a six-month study of land preservation programs in this country at the federal and state level, and made recommendations concerning the creation of an integrated, systematic national system for preserving diversity. I really am not going to attempt to summarize the study except to say that there were sections on what Congress, the federal agencies, and other entities should specifically do and if you obtain a copy of the study, you can read and evaluate our recommendations in detail.

At any rate, we feel the inventory process I have described could contribute greatly to the coordination of a lot of fragmented efforts. At this point in time we believe that this can best be accomplished by an information synthesis rather than by attempts to simultaneously accomplish the administrative redirection of a lot of existing programs. The latter is always difficult and many programs may, in fact, be functioning very well in some ways and might suffer from disruption if directly altered to maximize efficient coordination.

We believe there is every justification to create a unified system and the data management approach I have been talking about here is a kind of "bottoms-up" attempt to accomplish this beginning at the state or regional level.

Guidelines for Maintaining and Enhancing Wildlife Habitat in Forest Management in the Blue Mountains of Oregon and Washington

Jack Ward Thomas
Pacific Northwest Forest and Range Experiment Station U.S. Forest Service, La Grande, Oregon

Rodney J. Miller
Wallowa-Whitman National Forest U.S. Forest Service Baker, Oregon

Hugh Black
San Bernardino National Forest U.S. Forest Service San Bernardino, California

Jon E. Rodiek
Department of Watershed Management University of Arizona, Tucson

Chris Maser
Bureau of Land Management La Grande, Oregon

Introduction

Wildlife as a Product of Land Management

Managers of forested public lands usually consider wildlife as one of many products from those lands. However, wildlife is generally a byproduct of management for other purposes. As demands have grown for increased production of wood fiber, recreation, and red meat, it has become increasingly obvious that such cliches as "good timber management is good wildlife management" will no longer suffice. The requirement of the National Environmental PolicyAct that environmental effects (including effects on all wildlife) of any federally financed project be evaluated, brought matters to a critical stage.

Need for a Working Tool

Our involvement with environmental impact statements and plans contrasting alternatives for long-term management showed that the weakest link in the process was our inability to predict effects, over time, on wildlife populations. Consequently, this weak spot has frequently been the point of contention in conflicts resulting from critical review of such plans.

We concluded that lack of knowledge—though meager in some instances—was not the biggest problem. The biggest problem was the lack of a conceptual framework to allow (1) consideration of all vertebrates in the planning process, (2) retention of the ability to emphasize management of particular species, and (3) identification of specific habitats requiring special attention in land alteration schemes.

Continued generalized criticism of ongoing timber management and land use planning will not help wildlife. Biologists must develop models to predict consequences, good or bad, of timber management decisions on wildlife. True, there is not the quantity and quality of data on every vertebrate species that we would like, yet we do have sufficient knowledge to make a good start.

We dare not tarry longer because: (1) the planning process is continuing full speed, (2) timber sales continue, (3) loaded log trucks roll into the mills by the hundreds each day, and (4) the demand for wood fiber from public lands in increasing. For example, in the Blue Mountains, 3 percent of the commercial forest land (112,000 acres or 45,360 ha) is impacted each year by timber harvest activities. With intensified forest management this will increase. The need is critical. The time is now.

Contributors

The Forest Supervisors of the Umatilla, Wallowa-Whitman, Malheur, and Ochoco National Forests in northeast Oregon asked for a set of wildlife-timber management relationships to evaluate wildlife impacts of alternative land management (largely timber management) schemes. A team of 50 specialists of various disciplines (wildlife biologists, ecologists, silviculturists, planners and foresters) were assembled from the Washington Department of Game, Oregon Department of Fish and Wildlife, USDA Forest Service, USDI Bureau of Land Management, and Oregon State University. In four meetings of 3-5 days each over a year, this team formulated the general concepts and generalized predictions concerning impacts of various timber management activities on wildlife. Our job was to refine these concepts and predictions into a more coordinated, polished package.

Assumptions

A system was developed especially for the public lands of the Blue Mountains of northeastern Oregon and Washington. However, the concepts should be adaptable to any forested area; so we present a thumbnail sketch of the system here.

The process is ongoing, and the final product will be a small book replete with details. Our intent here is to present only enough information to show how the system works and how a similar system can be developed for other areas.

To achieve integration with the ongoing planning process, we recognized these realities:

(1) Timber management is the dominant land management activity in the area.

(2) Any wildlife management of large scope will be the result, planned or unplanned, of the manipulation of forest habitats primarily for wood production.

(3) Purposeful results in terms of wildlife can be obtained through well-coordinated management of timber.

(4) Timber management is wildlife management and the job is to insure that everyone, the public and the land managers, know and understand it.

The Framework

Given these assumptions and our desire to graft onto the ongoing system, it was necessary that wildlife/timber relationships be modeled in a framework that foresters can readily relate to timber management activities. We thought the appropriate framework to be timber types, successional stages within those types, arrangement of managed stands in time and space, and the occurrence of wildlife as affected by each criterion.

Our purpose was to point out the relationships between timber management activities and wildlife occurrence and welfare. This is not a list of "do's and don'ts." Rather, it is a set of relationships that say, "if you do this, you may expect that . . . "

The relationships are divided into three sections. The first shows the relationship of all resident vertebrates to forest communities and their successional stages. There are four levels of information: the gross response of all vertebrates condensed into 16 life forms to community and successional stage of the habitat, the responses of individual species within the life form, detailed biological data on each species, and guidance to appropriate literature for each species if more detailed information is required.

The second section demonstrates how a particular species can be emphasized in such relationships. The primary species receiving such emphasis in the Blue Mountains are elk and deer. The elk is used as the example.

The third section deals with special and unique habitats or habitat components. These habitats require special treatment as they are not associated specifically with plant community or successional stage.

The Relationship of Vetebrates to Forest Community and Successional Stage

Life Forms

All vertebrates (26 amphibians and reptiles, 263 birds, 90 mammals) that were known to occur in the Blue Mountains were divided into 16 life forms (Table 1) based on a combination of requirements for reproductive sites and feeding habitat as suggested by Haapanen (1965).

Response of Life Forms to Community and Successional Stage

The models were developed so that planners could extract information at four levels of detail. To illustrate, one life form is presented—species that excavate cavities for nesting and feed on trees, shrubs, ground, or in the air. Figure 1 shows the orientation of the life form to plant communities and their successional stages. Animal response to alterations of the plant community can be

Table 1. Description of vertebrate life forms occurring in the Blue Mountains.

Life form number	Reproduces	Feeds
1	in water	in water
2	in water	on ground, in bushes and/or trees
3	on ground around water	in water, on ground, in bushes and trees
4	in cliffs, caves, rims and/or talus	on ground or in air
5	on ground without specific water, cliff, rim, or talus association	on ground
6	on ground	in bushes or trees or air
7	in bushes	on ground, in water or air
8	in bushes	in bushes, trees, or air
9	primarily in deciduous trees	in bushes, trees, or air
10	primarily in conifers	in bushes, trees, or air
11	in trees	on ground, in bushes, trees, or air
12	on very thick branches	on ground or in water
13	excavates own hole in a tree	on ground, in bushes, trees, or air
14	in a hole made by another species or naturally occurring	on ground, in water, or air
15	underground burrow	on or under ground
16	underground burrow	in water or air

determined. For example, if a stand of old growth were clearcut (reduced to the grass-forb stage of succession) the effect would be strongly negative for both the feeding and reproductive habitat of this life form. The reaction will be entirely different for other life forms, with some benefiting strongly.

Further, the effects of silvicultural treatment on life forms can be anticipated (Thomas et al. 1975). Such treatments alter the forest community in ways that can be thought of as advancing or retarding succession. For example, planting trees advances the normal state of succession, as does thinning or fertilization, in that the planted trees make the stand appear older. Conversely, fire generally has the reverse effect. If effects can be anticipated in terms of accelerating or retarding succession, the response of the life form can be seen in Figure 1.

Response of Species to Communities

Figures 2 and 3 show the next level of detail. Figure 2 shows the primary orientation of each species in the life form to the plant communities for feeding and reproduction. Also revealed, by means of the total number of species occurring in each community, is the importance of each community to the life form.

Further, the number of plant communities that each species uses for feeding and for reproduction can be used to measure the adaptability of the species. The greater the number of plant communities utilized the more adaptable the species is considered to be.

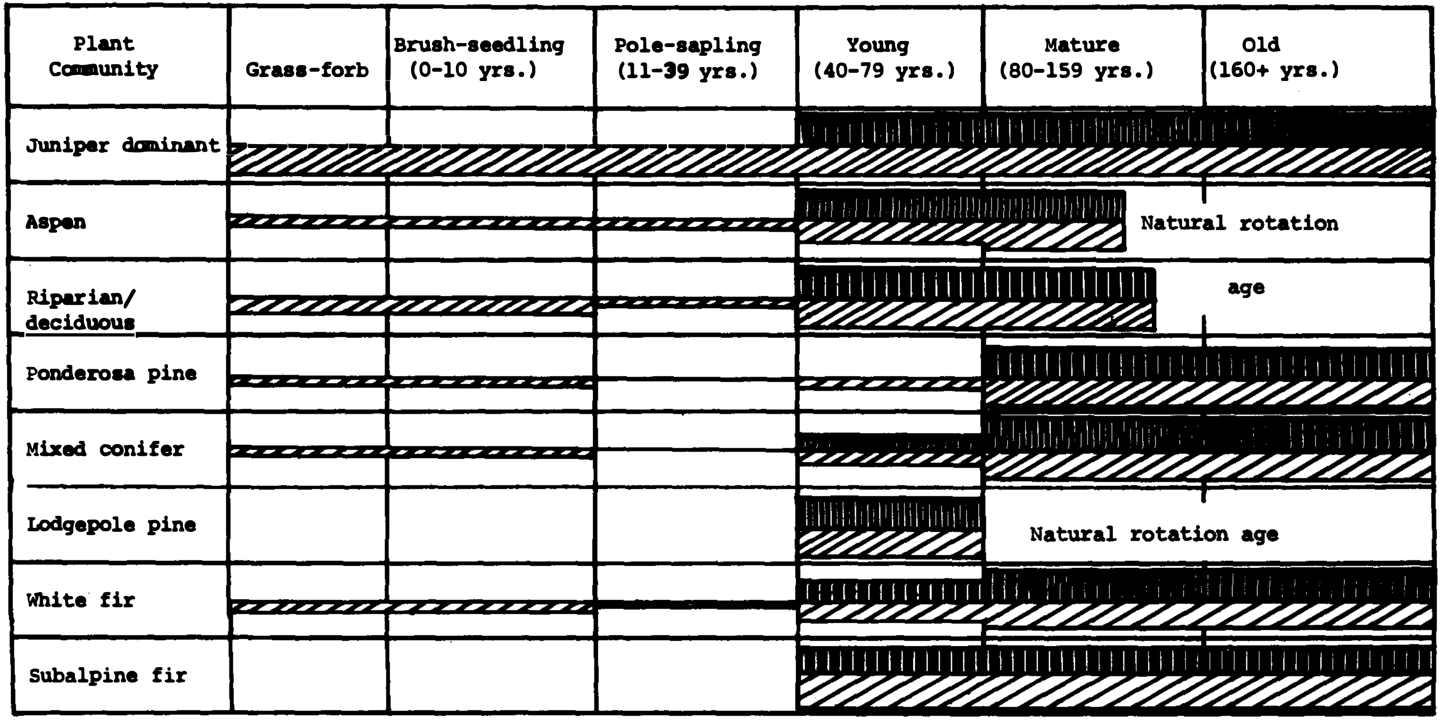

Figure 1. Life form 13 (excavates own hole, feeds in bushes, trees, or air). Relative degree of use by successional stage - width of bars indicate degree of use.

Species	Juniper dominant	Aspen	Riparian/ deciduous	Ponderosa pine	Mixed conifer	Lodgepole pine	White fir	Subalpine fir	Number of plant communities in which species occur: Reproduction	Feeding
Common flicker	X O	X O	X O	X O	X O		X O		6	6
Pileated woodpecker				X O	X C		X O		3	3
Lewis' woodpecker			X O	X O	X O				3	3
Yellow-bellied sapsucker		X O	X O	X O	X O				4	4
Williamson's sapsucker				X O	X O		X O		3	3
Hairy woodpecker				X O	X O	X O	X O	X O	5	5
Downy woodpecker		X O	X O						2	2
White headed woodpecker				X O	X O				2	2
Black-backed three-toed woodpecker					X O	X O	X O	O	3	4
Northern three-toed woodpecker						X O		X O	2	2
White-breasted nuthatch				X O	X O				2	2
Red-breasted nuthatch					X O	X O	X O		3	3
Pygmy nuthatch		O		X O	X O				2	3
Number of species using plant community: Reproduction	1	3	4	9	11	4	6	2		
Number of species using plant community: Feeding	1	4	4	9	11	4	6	3		

Figure 2. Life form 13 (excavates own hole, feeds in bushes, trees, or air). Species orientation by plant community. X - Reproduction O - Feeding.

Response of Species to Successional Stage

The orientation of each species within the life form to successional stages for feeding and reproduction is shown in Figure 3. The number of species occurring in each successional stage measures the importance of the stages to the life form. The number of successional stages used by individual species for reproduction and feeding is also a measure of adaptability. The greater the number of successional stages utilized the more adaptable the species is considered to be.

Vulnerability of Species to Habitat Change

The number of plant communities and successional stages used by each species for feeding and nesting was used to derive a vulnerability index (Fig. 4). The fewer successional stages and plant communities used, the less adaptable and more vulnerable the species to habitat manipulation. Conversely, the more stages and communities used, the more adaptable and less vulnerable the species. Reproductive habitat was considered more restrictive and was given double weight.

Detailed Information by Species

The third level of information available for each species is a summary of detailed biological data (Table 2). If a user needs still more detail, he is referred to pertinent literature sources.

This gives the planner the option of working with generalized life forms or of dealing with individual species in more detail. Immediate effects of timber sales and silvicultural activities can be evaluated across the species spectrum. Further, since succession and growth rates of forested stands are predictable, the effects of timber harvest schedules can also be forecast.

Table 2. Detailed information available on each species.

1. Name (common and scientific)
2. Life form association
3. Seasonal occurrence (reproduction and feeding)
4. Reproductive potential per year
5. Home range or territory size
6. Minimum habitat management unit
7. Occurrence by plant community (reproduction and feeding)
8. Key habitat components (riparian, water, ecotones, cliffs, talus, snags, dead and down material, etc.)
9. Key literature

The Ratio of Forage Areas to Cover—The Elk Response

The foregoing section was primarily about how to deal with all vertebrate species in the planning process. However, managers often have the goal of promoting the welfare and numbers of a particular species. In the Blue Mountains, one of the species of primary concern is Rocky Mountain elk. The complete guides include mule deer. However, this discussion will be confined to elk and convey the principles involved. Details can be found in Black et al. (1976).

Species	Grass-forb	Brush-seedling (0-10 yrs.)	Pole-sapling (11-39 yrs.)	Young (40-79 yrs.)	Mature (80-159 yrs.)	Old (160 + yrs.)	Number of successional stages in which species occur: Reproduction	Number of successional stages in which species occur: Feeding
Common flicker	O	O	O	X O	X O	X O	3	6
Pileated woodpecker					X O	X O	2	2
Lewis' woodpecker	O	O		X O	X O	X O	3	5
Yellow-bellied sapsucker				X O	X O	X O	3	3
Williamson's sapsucker					X O	X O	2	2
Hairy woodpecker				X O	X O	X O	3	3
Downy woodpecker				X O	X O	X O	3	3
White headed woodpecker					X O	X O	2	2
Black-backed three-toed woodpecker				X O	X O	X O	3	3
Northern three-toed woodpecker				X O	X O	X O	3	3
White-breasted nuthatch					X O	X O	2	2
Red-breasted nuthatch				X O	X O	X O	3	3
Pygmy nuthatch					X O	X O	2	2
Number of species using successional stage: Reproduction				8	13	13		
Number of species using successional stage: Feeding	2	2	1	8	13	13		

Figure 3. Life form 13 (excavates own hole, feeds in bushes, trees, or air). Species orientation by successional stages. X - Reproduction O - Feeding.

Species	Reproductive orientation[1/]				Feeding orientation			A/V score[2/]	A/V rating[3/]		
	No. of successional stages used	No. plant communities used	1 + 2	3/2	No. of successional stages used	No. plant communities used	5 + 6	4 + 7	Low A High V	Moderate A Moderate V	High A Low V
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	1-6	7-12	13-18
Common flicker	3	6	9	4.5	6	6	12	16.5			
Pileated woodpecker	2	3	5	2.5	2	3	5	7.5			
Lewis' woodpecker	3	3	6	3.0	5	3	8	11.0			
Yellow-bellied sapsucker	3	4	7	3.5	3	4	7	10.5			
Williamson's sapsucker	2	3	5	2.5	2	3	5	7.5			
Hairy woodpecker	3	5	8	4.0	3	5	8	12.0			
Downy woodpecker	3	2	5	2.5	3	2	5	7.5			
White headed woodpecker	2	2	4	2.0	2	2	4	6.0			
Black-backed three-toed woodpecker	3	3	6	3.0	3	4	7	10.0			
Northern three-toed woodpecker	3	2	5	2.5	3	2	5	7.5			
White-breasted nuthatch	2	2	4	2.0	2	2	4	6.0			
Red-breasted nuthatch	3	3	6	3.0	3	3	6	9.0			
Pygmy nuthatch	2	2	4	2.0	2	3	5	7.0			

1/ Reproductive orientation is weighted doubly to the feeding orientation; this is done by dividing the sum of columns 1 and 2 (= column 3) by 2. The results are shown in column 4.

2/ The adaptability/vulnerability score (A/V score) is derived by adding columns 4 and 7. The lower the score, the lower the species' adaptability and the higher its vulnerability.

3/ species of special interest listed by Research Natural Areas (Dyrness et al. 1975), National Audubon Society (1974), or U.S. Department of the Interior (1973).

Figure 4. Life form 13 (excavates own hole, feeds in bushes, trees, or air). Adaptability/vulnerability (A/V) ratings of species.

The Forage/Cover Ratio as an Integrating Factor

Classic wildlife management theory says the three components of habitat are food, cover, and water. The integrating habitat factor used here is the ratio of cover to forage areas and the juxtaposition and arrangement of cover and forage areas in time and space. Optimum habitat, particularly for summer range, is defined as amounts and arrangements of cover and forage areas that result in maximum elk use of the maximum area. Using Reynolds' (1962, 1966) data on how elk used cover and openings in relationship to their ecotone, we derived an ideal ratio of about 40 percent cover to 60 percent openings to assure maximum use of the maximum area.

Cover

Hiding Cover

Cover is divided into two types—hiding and thermal. Hiding cover provides the elk the "security blanket" that makes use of the area possible. It is defined as vegetation capable of hiding 90 percent of an elk from the view of a person at 200 feet or less. The actual distance is called sight distance and varies from stand to stand.

For optimum effect, hiding cover should be between four and eight sight distances wide (600-1,200 feet [182.88-365.76m], assuming an average sight distance of 150 feet [45.72m]). Four sight distances is the minimum width that would yield a core area where elk, which are generally gregarious, would be out of view from all directions. Eight sight distances would be the maximum width area that would not have a central core area that received less use (Reynolds 1966). Larger areas would fail the criterion of maximum use of the maximum area.

Thermal Cover

Thermal cover aids the elk in maintaining body temperature within narrow tolerable limits. Such cover can be used for protection from heat or cold, respectively, by intercepting incoming solar radiation or by preventing radiational loss from the animal to the open sky (Beall 1974, Moen 1973).

Thermal cover is defined as a stand of coniferous trees 40 feet (12.19m) or more tall, with an average crown closure exceeding 75 percent. Optimum size for thermal cover on summer or transitory range ranges from 30 to 60 acres (12.15 to 24.30 ha). Areas less than 30 acres are too small to provide enough impediment to wind movement or to accommodate a herd of elk. Areas larger than 60 acres would receive less than maximum use in the central area.

Cover on Winter Range

These foregoing general rules of thumb on elk cover are for summer and transitional range. Cover requirements on winter ranges must be considered much more carefully. The elk distributed over thousands of square miles in spring, summer, and fall are forced by snow depths and declining temperatures at higher elevations into constricted wintering areas. These ranges, because of their scarcity and intensity of use, are more sensitive to alteration of the vegetation. It is *essential* that each such range be studied in detail before decisions are made to alter the cover—particularly thermal cover—where a mistake can have its greatest consequences on elk welfare.

Optimum Cover

On summer and transitory ranges a mixture of cover types is best if we assume the optimum habitat requirement of 40 percent in all cover can be met. This mixture should approximate 20 percent in hiding cover, 10 percent in thermal cover, and 10 percent in either hiding or thermal cover.

Forage Areas

Forage is produced to some degree on all areas. Cover areas produce forage but to a lesser extent than non-cover areas. By our definition, forage areas are separate from cover areas—i.e., area that does not meet the cover definitions is a forage area. Forage areas include forest openings and stands that do not meet cover requirements.

Created openings receive as much or more use than natural openings. For maximum elk use of the maximum area, such areas should have no point farther than 600 feet (182.88 m) from cover (Reynolds 1962, 1966). This allows forage areas up to 1,200 feet (365.76 m) wide to qualify as optimum.

Land-types

The foregoing information was used to develop models useful to teams preparing long-range resource management plans for the Blue Mountains. These planning teams use a land classification scheme based on a combination of physiography, vegetative types, and plant communities (based largely on Hall 1973), parent soil material and its inherent stability, slope, aspect, percent of area forested, and elevation. There are 32 such distinct land ecoclasses in the Blue Mountains. We used the same classification to "plug into" the system. As a sample, four such ecoclasses are shown in Table 3.

Aerial oblique photographs were used to display the land-type; the expert panel considered effects of the manipulation of cover/forage ratios on elk use of the area. Each land-type had differences in the amount of forested sites, the ratio of potentially forested sites to openings, and the spacing of those areas. These factors were considered together in deriving elk use potentials for each land-type in response to changes in the cover/forage ratios.

Elk Response to Altered Forage/Cover Ratios

For illustrative purposes, the anticipated responses for the land-types described in Table 3 are described in Table 4 and illustrated in Figure 5.

Elk response was forecast as potential increase or decrease in use when the cover/forage ratio is altered (assuming all forest sites were forested and in cover). The resulting curves shown in Figure 5 represent opportunity curves for elk use as the cover/forage ratio changes.

Derivation of the data points deserves explanation. Consider the information for land-type 16 in Table 4. Column 2 shows that 90 percent of the land-type is in forest sites and is, therefore, potential cover. Column 3 indicates 40 percent of the land-type must be in cover to get the highest possible use by elk (60/40 ratio of forage/cover). Column 4 shows the potential of the land-type for increased elk use through cover removal to attain the optimum 60/40 ratio—300-percent increase. Column 5 indicates the amount of the land-type that must be retained in

Table 3. Description of selected land-types of the Blue Mountains.

Land-type[1] number	Percent slope	Aspect	Percent in forested sites	Elevation in feet (100's)	Major plant communities	Ecoclass codes - from Hall (1975)
16	0-30	All	90	50-80	Subalpine fir, white fir, lodgepole pine	CE-S3-11; CE-S4-11; CW-S8-11; CL-G2-11; CL-S5-11; CL-S4-11
15	0-100	All	80	30-65	White fir, mixed conifer, ponderosa pine	CW-S2-11; CD-S7-11; CW-G1-12; CD-G1-11, 12
10	30-80	North-south	35	20-60	Douglas-fir, white fir, bunchgrass	CD-G1-11; CD-S7-11; CW-S2-11; GB-49-13, 14; SM-19
3	30-80	All	25	20-64	Bunchgrass, mixed conifer, ponderosa pine	GB-49, 13 14; CW-G1-11, 12; CD-S7-11; CP-G1-11, 12; SM-19

[1]There are 32 recognized land-types in the Blue Mountains. Four are presented as examples.

Table 4. Elk use as related to cover: forage ratios by land-types.

(1) Land-type number	(2) % land-type in forest sites	(3) % land-type retained in cover to achieve optimum habitat	(4) % increase in elk use attainable by reducing cover to 40% of the land-type	(5) % of the land-type that must be retained in cover to produce elk use equal to all forested sites in cover	(6) %of the land-type that must be retained in cover to produce elk use equal to 66% of that when all forested sites are in cover	(7) % of the land-type that must be retained in cover to produce elk use equal to 33% of that when all forested sites are in cover	(8) Remarks
16	90	40	300	18	14	9	
15	80	40	25	32	24	16	
10	35	35	0	35	28	21	Hiding cover is of primary importance
3	25	25	0	25	20	15	Hiding cover is of critical importance

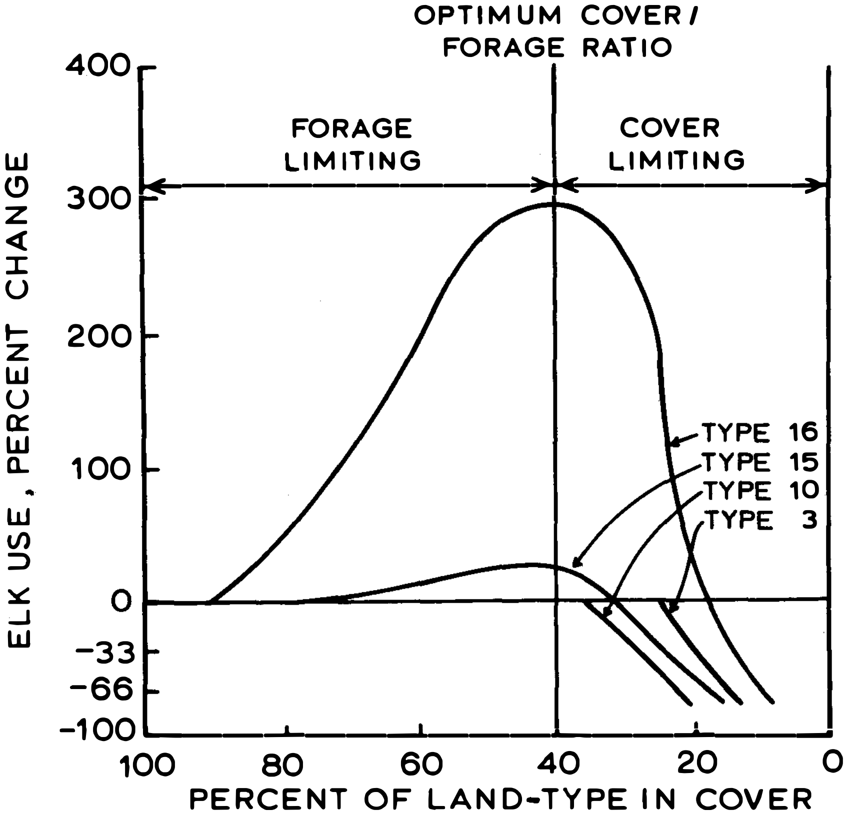

Figure 5. Potential change in elk use expected in response to possible ratios of cover to forage areas by land-type.

cover to give the same use as the unaltered site (column 2)—in this case 18 percent. Column 6 shows that the percent of the land-type in cover can be reduced to 14 percent and decrease the use level shown in Column 2 by 33 percent. Likewise, Column 7 indicates that reduction of cover to 9 percent of the land-type will produce a decline in the elk use rate of 66 percent of the unaltered site (column 2).

What if the land-type has forested sites of less than the optimum 40 percent? Consider land-type 10 in Table 4 and Figure 5. Column 2 shows 35 percent of the land-type in forested sites. Column 3 shows that all 35 percent must remain in cover to get highest elk use—i.e., no cover can be removed without damaging the already suboptimal habitat. Column 4 shows no potential for increasing elk use though cover removal. Column 5 also shows that all 35 percent of the land-type in cover must be retained in cover to maximize elk use. Columns 6 and 7 show that 28 and 21 percent of the land-type must be in cover to yield a decline in use level of 33 and 66 percent, respectively, of the unaltered site (column 2).

As previously stated, the entire curves (Fig. 5) are opportunity curves. As presented, the curves represent potential of the land-type. What if the cover has already been altered—say by fire or by timber harvest? Look at the opportunity curve for land-type 15. Assume that cover has been reduced to 60 percent by timber harvest and go to the point on the curve above the 60-percent cover level. That is the point at which elk use potential of the land-type is now, and the opportunities lie in either direction along that curve—if cover increases use will decrease, if cover is removed use will increase up to a ratio of 60-percent forage/40-percent cover and then decline. Such responses are valid only as long as the previously described arrangements and sizes of forage and cover areas are maintained.

Every time a silvicultural option is chosen, a decision about elk management has been made. So the manager must simultaneously consider elk and timber goals which complicates the decision, for it is obviously more difficult to simultaneously accomplish two things than to accomplish one. The more options available the easier it is to accomplish such goals, particularly in a world where markets, rules, goals, and knowledge are constantly changing.

Meeting Cover Requirements With Different Rotations

Fortunately, the biological needs of elk can be met in terms of forage/cover ratios, and cover *per se,* under a variety of rotation ages and management intensities. It is largely a matter of locating timber cuts and timing regeneration. For example, Figure 6 shows the stages of a managed stand on a white fir site that meets the forage and cover (hiding and thermal) requirements under 50-, 100-, and 200-year rotations. The trick is to arrange juxtaposition of the stands in time and space to yield desired forage/cover ratios.

Consider, for example, the 50-year rotation. The trees would be about 55 feet tall at 50 years (Silvicultural Handbook, R-6, USDA Forest Service). The stand would meet the 20-percent thermal cover requirement (40 feet tall with crown closure of 75 percent or more) from stand age 40 to 50, or 10 years out of the 50-year rotation. Requirements for 20-percent hiding cover are met at stand age 15 to 25. Obviously, other stands will have to be synchronized to provide proper spacing and to insure that the proper habitat is maintained over time.

The important point is that simultaneous timber-elk production goals can be met, and we believe this scheme is one way to plan just how to do that. There are obviously other management tasks to assure proper coordination—primarily schemes to minimize human disturbance and hold deleterious effects of roading, etc., to a minimum. These are included in our final product but are deleted here in the interest of space. See Anonymous (1975) for similar recommendations.

Special and Unique Habitats

Habitat types covered in this section are: riparian, snags, edges, cliffs, talus, and caves. Although the above types are widely varied, they have three common denominators: (1) individually they occupy a small percentage of the total land base, (2) they are more or less restricted in location, and (3) they concentrate the use of dependent wildlife into small areas. Each habitat has at least one species of animal that is highly adapted to it for part or all of its life cycle and cannot exist elsewhere as a self-sustaining population. With the exception of some edges and snags, these habitats cannot be artificially created. Because each of these habitats

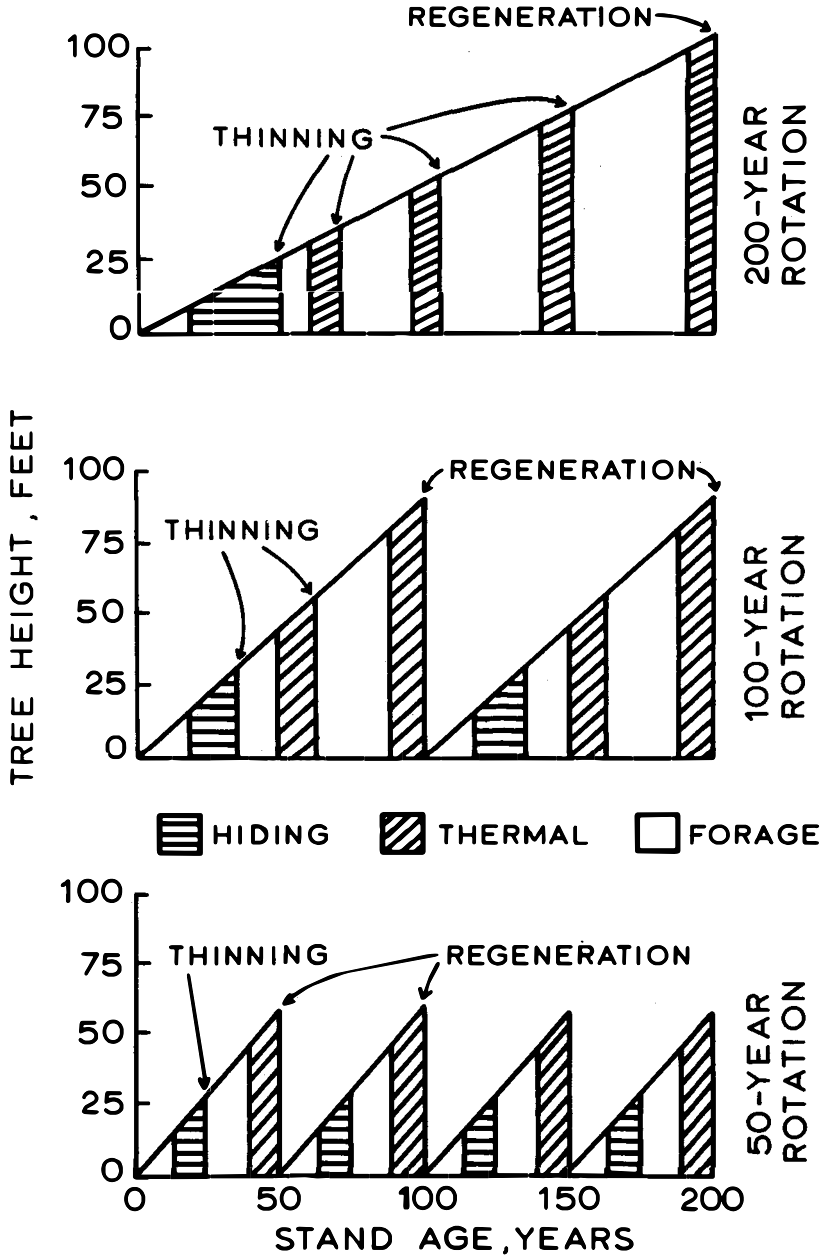

Figure 6. Occurrence of cover and forage areas under three possible rotations of a white fir stand.

is specialized in its own way, general management suggestions are given on an individual habitat basis. However, specific management decisions must be made on site-inspection basis.

The six habitat types fall into two categories- -special and unique. Special habitats (riparian, snags, edges) normally occupy or occur over a greater percentage of the total land base than do the unique habitats (cliffs, talus, caves). Furthermore, special habitats are largely a product of plant community structure and function whereas unique habitats are a product of geologic processes. One example is discussed here for each category: snags for special habitats and talus slides for unique habitats.

Snags

Snags are defined as completely or partially dead trees still standing and at least 10 feet (3.05m) tall. Snags are further divided into two categories—hard and soft. Hard snags are composed of sound wood, and soft snags are characterized by advanced decay and deterioration.

The Place of Snags in Forest Ecosystems

Snags are the primary location of the cavities that provide nesting sites and shelters used by 38 birds and 24 mammals in the Blue Mountains. The species that use these snags for nesting sites and for shelter can be categorized as shown in Figure 7.

The majority of snag-dependent wildlife species, both birds and mammals, are insectivorous and represent a major portion of the entire insectivorous forest fauna. The roles of insectivorous birds and mammals in control of forest insect pests have been intensively reviewed by Bruns (1960), Franz (1961), Herberg (1965), and Buckner (1966,1970). Beebe (1974) thoroughly reviewed relationships between insectivorous hole-nesting birds and forest management, including the bird/insect interface.

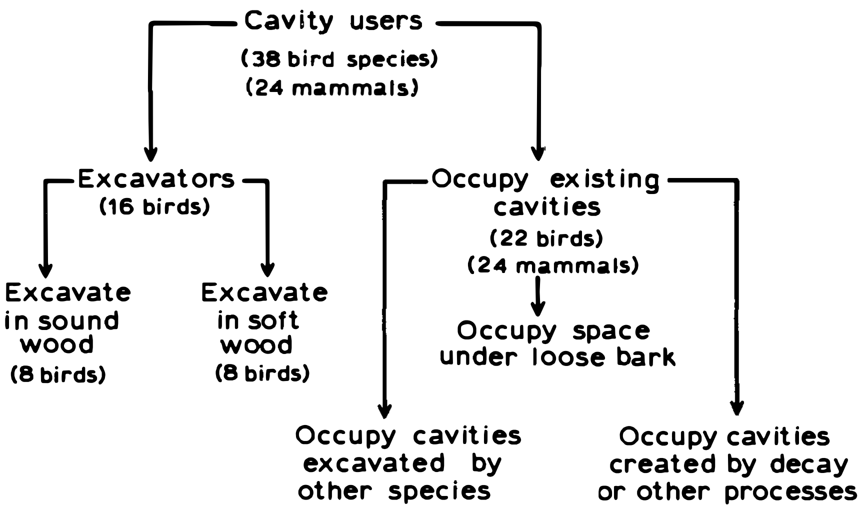

Figure 7. Characteristics of cavity users.

Several authorities have persuasively argued—see literature reviews by Thomas et al. (1975), Beebe (1974), Jackman (1974), Poznanin (1956), Bruns (1960), Franz (1961), Herberg (1965), Haapanen (1965), and Gysel (1961)—that absence of suitable nest sites for cavity-nesting birds is their usual limiting factor. There is a direct relationship between the number of snags per unit area and numbers of snag-dependent wildlife.

Management for the excavators (those that can construct their own cavities) is management for secondary cavity nesters, in approximately direct proportion.

Retention of Soft Snags

Snags undergo a succession of changes from the time a tree dies and becomes a snag until the final collapse—i.e., soft snags evolve from hard snags. Therefore, management for hard snags will eventually produce soft snags.

Soft snags provide the nesting substrate for the primary excavators that must use soft or decayed wood, as well as important feeding places for woodpeckers. They have little or no commercial value, a short life expectancy, and are dangerous to remove. Soft snags cannot be created (hard snags can be), and only a percentage of hard snags stand long enough to become soft snags. Therefore, we assumed that *all* soft snags not representing a distinct safety hazard or fire danger would be preserved.

Assumptions

If requirements of woodpeckers for hard snags are met and if existing and resulting soft snags are retained, we assumed the requirements for nesting and shelter of all snag-dependent species would be met.

Each general timber type supports a distinct combination of primary excavators and secondary cavity users. Further, each species has distinct requirements in terms of size and height of snags that they use for nesting or shelter. The result is that each type has different requirements for the number, diameter, and height of snags to provide the requirements of resident hole nesters—i.e., snag requirements should be considered on a type-by-type basis.

It would be possible to manage for various levels of these species if guidance were available on the relationships of numbers, sizes, and heights of snags to population levels of snag-dependent species.

Development of the Model

We developed a series of models, one for each general timber type:

(1) The territorial requirements of each species of sound wood excavators (woodpeckers) were derived from the literature.

(2) The potential maximum population of each species per square mile of habitat was derived by dividing the territorial requirement into 640 acres or:

$$\text{Potential maximum population in numbers of pairs} = \frac{\text{Acres in a square mile}}{\text{Territorial requirement, in acres of each species}}$$

Table 5. Hard snag requirements for woodpeckers in the ponderosa pine type(s).

		Percent of					
			100			80	
Minimum snag size (inches)	Species and groups	Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.	Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.
≥ 6	Hairy woodpecker	3,840	600	80	3,072	480	64
≥10	White headed woodpecker	2,064	323	42	1,651	258	34
	Williamson's sapsucker	4,368	683	91	3,494	546	73
	Yellow-bellied sapsucker	4,368	683	91	3,494	546	73
≥12	Common flicker	768	120	16	614	96	13
≥20	Pileated woodpecker	288	45	6	230	36	5

Suitable sites were assumed to be the primary limiting factor.

(3) Levels of possible management were derived as percentages of the potential maximum population for each species at the 100, 80, 60, 40, and 20 percent levels, by multiplying the potential maximum population by those percentages:

$$\begin{array}{l}\text{Number of pairs}\\ \text{per square mile}\\ \text{at this level}\end{array} = \left(\begin{array}{c}\text{Potential maximum}\\ \text{population in number}\\ \text{of pairs}\end{array}\right)\left(\begin{array}{c}\text{Percent of maximum}\\ \text{selected}\end{array}\right)$$

(4) The snag requirements for each pair was derived by considering that: (a) each pair excavated three holes per year—two for roosting and one for nesting—and surveys indicated that there are approximately 15 snags without currently occupied cavities for that particular excavator for each one that does have a currently occupied cavity. Then the requirement was computed as follows:

$$\begin{array}{l}\text{Snags required}\\ \text{per pair per}\\ \text{square mile}\end{array} = \left[\left(\begin{array}{c}3\\ \text{cavities}\end{array}\right)\left(\begin{array}{c}\text{15 snags}\\ \text{without}\\ \text{cavities}\end{array}\right)\left(\begin{array}{c}\text{No. of}\\ \text{nesting}\\ \text{pairs}\end{array}\right)\right] + \left[\left(\begin{array}{c}\text{3 snags per}\\ \text{nesting}\\ \text{pairs}\end{array}\right)\left(\begin{array}{c}\text{No. of}\\ \text{nesting}\\ \text{pairs}\end{array}\right)\right]$$

potential maximum population								
	60			40			20	
Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.	Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.	Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.
2,304	360	48	1,536	240	32	768	120	16
1,238	194	26	826	129	17	413	65	9
2,621	410	55	1,747	273	36	874	137	18
2,621	410	55	1,747	273	36	874	137	18
461	71	10	307	48	6	154	24	3
173	27	4	115	18	2	58	9	1

(5) The number of snags required for each species at each management level was computed by:

$$\text{Number of snags per 100 acres at a management level} = \left(\frac{\text{Number of snags per square mile}}{\text{640 acres in a square mile}} \right) (\text{100 acres})$$

Snag Requirements by Forest Type

We have derived estimates of hard snag requirements for seven forest types. Only two are displayed here, ponderosa pine in Table 5 and lodgepole pine and subalpine fir in Table 6.

Using the Model

The information displayed holds the means for consideration of a number of options and trade-offs for the user. Refer to Table 5 showing the requirements for ponderosa pine. Six woodpecker species nest in this type. The column headed "minimum snag size" is the *smallest* diameter snag that a species can use for a nest or roost cavity.

Larger snags can serve in place of smaller; the reverse is not true. For example, the decision is made to manage all six species at 100 percent of their potential nesting level. Pileated woodpeckers require 45 hard snags per 100 acres (40.5

Table 6. Hard snag requirements for woodpeckers in the lodgepole pine and

		Percent of					
		100			80		
Minimum snag size (inches)	Species and groups	Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.	Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.
≥10	Hairy woodpecker	3,840	600	80	3,072	480	64
≥12	Northern three-toed woodpecker	288	45	6	230	35	5
	Black-backed three-toed woodpecker	288	45	6	230	36	5

ha) > 20 inches (50.8 cm) DBH. Because these snags are larger than the ≥ 12 inches DBH snags required for the common flicker, they are substitutable; i.e., when the pileated woodpecker was provided for, 45 of the 120 snags for the common flicker were provided as well. So, if 45 snags ≥ 20 inches DBH and 75 ≥ 12 inches (30.48 cm) DBH are provided, 120 (45 + 75 = 120 of the 683 snags > 10 inches (25.4 cm) DBH required for the white headed woodpecker and Williamson's and yellow-bellied sapsuckers were also provided, reducing that number from 683 to 563 (683-120 = 563). When the requirements of the species within a particular DBH class (in this case ≥ 12 inches) that needs the largest number of snags are met, it satisfies the requirements of all other species within that DBH group. Further, if the needs of the ≥ 20 inches, ≥ 12 inches, and ≥ 10 inches DBH groups are satisfied, the requirements of hairy woodpeckers are met because these snags are larger than the 6 inches (15.24 cm) DBH snags and are, therefore, substitutable. So, in this example, the 45 hard snags/100 acres ≥ 20 inches DBH, 75 hard snags/100 acres ≥ 12 inches DBH and 563 hard snags/100 acres ≥ 10 inches DBH (a total of 683 hard snags/100 acres) provide the necessary nesting and roosting sites for all six woodpecker species and for the secondary cavity nesters as well.

There are two simultaneous "successions" that affect each snag—the continuous gradual process of deterioration of the snag itself and the changes in the structure of the plant community that surrounds the snag. Combination of these two factors, as well as the differing requirements of the woodpecker species in terms of DBH, nest heights, and suitable surrounding habitat, provides for the presence of all the occupying species over time.

The models show that different levels of population can be selected. It should be noted that this can be done on a species-by-species basis. For example, because the pileated woodpecker has a large territorial requirement and excavates a large cavity needed by large secondary occupiers, it might be decided to manage for 100 percent of maximum. At the same time, it could be determined to manage for, say, yellow-bellied sapsuckers (and, simultaneously, Williamson's subalpine fir type(s).

potential maximum population								
	60		40			20		
Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.	Sangs/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.	Snags/ sq. mi.	Snags/ 100 acres	Pairs/ sq. mi.
2,304	360	48	1,536	240	32	768	120	16
173	27	4	115	18	2	58	9	1
173	27	4	115	18	2	58	9	1

sapsucker and the white headed woodpecker) at the 60-percent level. This would yield a much lower total snag requirement than managing for all at the 100-percent level.

The models can be examined in yet another way. Consider a stand that has no snags or tree larger then 11 inches (27.94 cm). Although it is impossible to currently provide for pileated woodpeckers or the common flicker and their associated secondary cavity users, it is within the manager's ability to manage for the four species that use smaller snags. Further, decisions can be made to provide for larger snags at selected levels at an older stand age.

The lower the level of population (percent of potential maximum) selected the larger the risk taken in terms of maintenance of a viable population. We feel that management below the level of 40 percent of the potential maximum population is below the level required, over time, to maintain viable self-sustaining population of the species in question.

Meeting the Snag Requirement

Snags come and go throughout the life of a stand. These models are built in the hope that the snag numbers will be met over time. Consider Table 5: If the stand in question is clearcut and the previously mentioned 683 hard snags/100 acres are left to provide for 100 percent of the potential population of all size species, it should be realized that this level will be maintained only as long as the snags remain. Their natural demise will result in meeting far less than the needs for 100 percent of the potential population before replacement snags begin to occur naturally or can be created in the new stand. Management over time will be required to meet any snag level selected. It may not be feasible to meet the requirements on all forested acres at all times.

Vulnerability of Cavity Nesters

Ingenuity may be required to provide snags of sufficient size over time to insure the welfare of dependent species. As forest management intensifies, there will be a tendency toward elimination of "old-growth" stands that produce the large snags of such value to snag dwellers (Meslow and Wight 1975, Thomas et al. 1975, Jackman 1974). Purposeful planning for snags will be required (Bull 1975, Jackman 1974).

Several primary tools can be used: long rotations of either stands or selected trees, killing suitable trees, and purposeful retention of required snags.

Most species that use snags are not considered highly vulnerable in that they can occupy several plant communities and successional stages. In a "non-managed" forest they are in little danger. However, when intensive forestry tends to eliminate old-age stands, salvages dead and dying trees intensively, eliminates large numbers of snags as fire hazards, and where safety regulations call for intensive snag removal and firewood cutters are active, managing *for* snags and their attendant wildlife is necessary. Man's activities and aims make the snag users a vulnerable group.

Talus

Talus is the accumulation of broken rocks and rock fragments that occur on or at the base of slopes.

The structural components of talus include the length, depth, width, type, and size classes of the rock, and the age and stability of the talus. A large deep talus of basalt or andesite and mixed size classes is much more important for wildlife than a talus of sedimentary origin, regardless of its structural features.

Talus is a unique habitat offering protection for species, such as pika, living within its confines. Furthermore, talus is normally surrounded by an edge of herbaceous vegetation that forms the food supply for species that make their home in it. Krear (1965) found that the microclimate within a talus was more stable than above it. He also noted the ease with which animals could move about in and on the talus under the cover of snow since the snow rested primarily upon the larger rocks. Talus, as do cliffs, tends to concentrate vertebrates such as frogs, lizards, snakes, a few birds, and many small mammals. The pika or rock-rabbit occurs nowhere else.

Talus usually makes up a small percentage of any area and supports a unique faunal complex. Vegetative complexes around such areas should be stabilized as much as possible. The temptation to use such areas as a source of roadbed material should be carefully weighed. There is little that can be done in the sense of improving talus as habitat.

It should be recognized as a relatively scarce and certainly unique habitat, and alteration should be considered with extreme caution.

Summary

We hope we have demonstrated that there is enough information to make predictions about the welfare of most, if not all, vertebrates in relation to forest management decisions. Further, this information can be made available in a framework mutually useful to biologists and foresters.

Such a system can be used in: (1) preparation of environmental impact statements, (2) land use planning, (3) judging consequences of silvicultural activities, (4) as a checklist, (5) as a brief summary of habitat preferences of the vertebrates, and (6) as a key to more detailed information on each species. The information can be computerized to yield rapid prediction of impacts of proposed alterations in the forest environment or to make predictions of wildlife populations in a managed forest over time. Further, the system can be updated easily as additional data become available.

Most important, it can be done.

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Discussion

CO-CHAIRMAN BARICK: Thank you, Mr. Miller, for a very interesting approach to applying coordinated forestry and wildlife management. I would like to ask you one question about this.

Can you, for example, comment or tell us about the difficulty that you had in assigning types, whether you had a great deal of difficulty in applying it to the whole system?

MR. MILLER: No, I don't have enough time to really tell you the difficulties. We did most of our typing from aerial photographs based on soil information and vegetative information. All the other information, in turn, was just gathered by a lot of digging.

From Fire Control to Fire Management: An Ecological Basis for Policies

Bruce M. Kilgore
U. S. National Park Service
San Francisco, California

Fire has periodically burned forests and grasslands as long as such flammable vegetation has existed on earth. The Bible records numerous instances of the effect of fire on vegetation, and accounts of the use of fire by American Indians reveal ancient man's knowledge of the potential of fire as both process and tool (Stewart 1956; Mutch 1976). In 18th and 19th century America, fire in the woods was regarded as a common sight. "... whether set by Indians, settlers, loggers, or natural causes, [forest fires] were frequent and often extensive ... unless they threatened human life, livestock, or buildings, they were little regarded except as a local nuisance" (Clepper 1975).

Many of our present wildfire problems began when we attempted to ban all fires from the forests. Yet, control of wildfire was essential in the late 19th century as forest resources were being destroyed by careless logging and the catastrophic fires which followed. Two big names in wildfires were Peshtigo in Wisconsin where 1500 people died and 1.2 million acres burned in 1871 and Hinkley in Minnesota where 400 people died and an undetermined acreage burned in 1894. Such large, destructive fires started in logging slash where they gained momentum before moving into uncut forests (Davis 1959). They made the public aware of the potential damage of wildfires and set the stage for development of rigid fire control policies.

Suppression Policies and Early Challenges

Efforts to more effectively control forest fires in America began with the founding of organizations such as the American Forestry Association in 1875. In celebrating AFA's centennial, Clepper (1975) noted that, "The prevalence of forest fire was a major influence in the start of the conservation movement and the rise in public opinion that brought it about."

The policy of suppressing all fires in national parks began in Yellowstone National Park in 1886 and was implicitly incorporated in the National Parks Act of 1916 (Agee 1974). The establishment of the Forest Reserves in 1891 and the Forest Service soon thereafter resulted from public reaction to the continuing destruction of forests by "fire and depredations" (Clepper 1975). It is understandable that members of the new U.S. Forest Service, National Park Service, and other agencies such as the Forestry Branch of the Bureau of Indian Affairs dismissed the historic role of fire in the forest and established policies of total exclusion of fire.

Fire suppression policies were based on claims that fire of any kind: (1) damages mature trees and kills seedlings; (2) destroys the best forage plants and perpetuates undesirable grasses; (3) robs the soil of nature's fertilizer and promotes floods, droughts, and erosion; and (4) destroys the natural breeding places and shelter for birds and animals and often burns up nests, eggs, and young (Komarek 1973).

Some researchers did not feel these statements accurately described the role of controlled fires or low intensity natural fires. Therefore, while no one questioned the attempt to exclude destructive wildfires, some questioned exclusion of all fire. By the late 1920's, research had shed considerable light on the results of low intensity burning. These research findings were almost diametrically opposed to the position being advocated in the South by the "Dixie Crusaders," sponsored by the American Forestry Association. The federal and state land management agencies were so committed to total exclusion of fire, however, that Schiff (1962) reports there was "reluctance to promote research or release results which seemed to jeopardize success" of other agency fire projects.

Support for total suppression was so strong in the late 1920's and early 1930's that a policy of aggressive speed in control was adopted by the Forest Service in 1935. This policy provided that fires must be controlled in the first work period or, if this fails, by 10 a.m. the next day (Baker 1975a). At the same time, strong opposition was expressed toward any "let burn" or "herding" procedures.

Ecological Basis: Research in the South

Early plant ecologists, including Clements, Cowles, Hall, Ramaley, and Cooper recognized the effects of fire on vegetation (Bock 1976). But some of the earliest challenges to the concept that all fires are bad came from a group of fire scientists called by Komarek (1973) the "Dixie Pioneers." These men included a forester, a botanist, an animal husbandman, a wildlife scientist, and several Forest Service scientists from southern experiment stations. These men worked independently, yet they concluded that periodic fire plays an important and beneficial role in the life of many southern pine forests, and particularly that of longleaf pine.

The forester was Dr. H. H. Chapman of Yale University, later president of the Society of American Foresters. Dr. Chapman published more than 20 papers between 1909 and the early 1940's dealing with southern pines and their relationship to fire. His work (Chapman 1912, 1926, 1932, 1944) showed that most winter fires do not kill all longleaf pine seedlings; rather, they help establish pine stands, suppress other pine and hardwood competitors, reduce hazardous fuel accumulations, and control brown-spot disease. Chapman recommended use of fire in longleaf pine every three years. He has recently been termed the "father of controlled burning for silvicultural purposes" in America (Komarek 1973).

In 1913, Dr. Roland M. Harper, botanist for the Florida Geological Survey and later State Botanist for Alabama, published a widely circulated defense of forest fires in *Literary Digest* which spoke of the importance of fire to southern pine in forestalling hardwood succession. Along with Chapman, Harper condemned promiscuous use of fires.

S. W. Greene, an animal husbandman with the Bureau of Animal Industry at the Coastal Plains Experiment Station, McNeill, Mississippi, found that quality and quantity of grasses and legumes on burned lands were much greater than on unburned lands and that cattle grazed on burned pasture made substantially greater weight gains than animals on unburned pasture. It was Greene's 1931 article, "The Forest that Fire Made," that finally reached the public with the message that not all fire was bad. This article was part of what has been referred to as the "dynamite from outside the profession [required] to awaken us," in the words of a Forest Service employee (Schiff 1962).

At the First North American Wildlife Conference, 40 years ago, H.L. Stoddard, wildlife scientist with the U.S. Biological Survey and Director of the Cooperative Quail Study Investigation, reported on his extensive studies of bobwhite quail which showed that carefully controlled, light fire at the proper season and weather conditions can be beneficial to quail habitat (Stoddard 1936). Such fires provide ground cover that is open below but offers protection from predators above. Because quail are weak scratchers, dense tangles of wire grass and broomsedge exclude these birds from their food supply. In addition, heavy ground cover of pine needles, dead grass, and debris smothers the legumes quail require (Stoddard 1931, 1935).

Forest Service scientists from southern experiment stations also gathered data during these early years which helped clarify the role of fire. They did so despite administrative pressure against working on projects or publicizing research conclusions which would be at variance with the fire exclusion policy (Schiff 1962). One significant paper showed that frequent fires did not harm the chemical composition of forest soils in the longleaf pine region (Heyward and Barnette 1934).

In summary, the work of these southern fire scientists showed that controlled burning can be beneficial to longleaf pine, cattle, and quail. In contrast, total fire exclusion in the South soon led to considerable problems, including a tremendous increase in fuels and fire hazard. Not until 1943 did the weight of this evidence bring about adoption of a prescribed burning policy for the southern forests (Schiff 1962).

Ecological Basis: Research in the West

The 1943 shift in Forest Service policy on prescribed burning applied primarily to the South. But soon thereafter, a similar challenge was raised in the West by the combined research and experimental management efforts of two foresters with the Bureau of Indian Affairs (BIA) and a forestry professor at the University of California.

Actually light burning was advocated as early as 1909 in California, but a Society of American Foresters Committee which looked into the controversy concluded in 1923 that light burning was neither more practical nor more economical than fire exclusion (Biswell 1967). The Regional Forester for California and the Director of the California Forest Range Experiment Station during these years believed centuries of repeated fires had caused "unsatisfactory conditions in the forest" (Show and Kotok 1924). Their attitude exerted tremendous influence on the developing fire protection policies in California. Only in recent years has convincing evidence been published which verifies the ecological roles of fire in western forests (Weaver 1974; Biswell 1967; Hartesveldt 1964; Kilgore 1973b).

The Bureau of Indian Affairs in the Department of the Interior is a relatively little known bureau in forestry matters. Yet the program of forest management developed by two men in that agency has had a major influence on the evolution of fire management policy in the West. In 1943, Harold Weaver published the first of nearly 20 articles on fire and ponderosa pine in Washington, Oregon, and Arizona (Weaver 1943), and in 1950, Harry R. Kallander became actively involved in controlled burning of ponderosa pine in Arizona.

Under the early leadership of these two men, the BIA has control burned nearly 500,000 acres (202,500 ha) of forest lands on the Fort Apache Indian Reservation since 1948, with nearly 100,000 acres (40,500 ha) being reburned once or twice (Kallander, pers. comm.). Additional controlled burning has been done on the San Carlos and Hualapai Reservations in Arizona. In each case, the principal objective was to reduce wildfire hazards (Biswell et al. 1973). There has been more prescribed burning over a longer period of time on these three reservations than on any other forested area in the western United States.

Studies (Weaver 1974, Cooper 1960) have shown that periodic lightning-set fire occurred in ponderosa pine forests at intervals of about 6 to 7 years and maintained low fuel levels. The fires were, therefore, of low intensity, yet pruned back competing woody vegetation, prepared a receptive soil surface for seedfall, and thinned young trees and prevented thickets of reproduction (Biswell et al. 1973).

Ideas from his earlier prescribed burning experience in the Southeast were brought to California by Dr. H.H. Biswell, Professor of Forestry (Ecology) at the University of California, Berkeley. In 1951, he began work on prescribed burning experiments in ponderosa pine forests of the central Sierra Nevada and in the North Coast Range. Biswell concluded from his studies that this vegetation type developed in nature with frequent light fires, that fire exclusion has resulted in extreme fire hazards today, and that prescribed burning by means of light fires can reduce fuels while simulating other ecological impacts of natural burning (Biswell 1967).

In both the South and West, there was considerable resistance on the part of government agencies and private forestry and conservation groups to the acceptance of new facts on the natural role of fire. Even today this acceptance is not total in the West. However, the continued buildup of high-hazard fuels and the increasing expense of associated fire suppression are causing many previously devoted fire-control advocates to question total exclusion policies (Towell 1969; Task Force on California's Wildland Fire Problem 1972; Dodge 1972; Craig 1975).

Ecological Basis: A Brief Synthesis

Since the initial work of these early scientists, an every-increasing number of research reports on the fire ecology of various vegetation types have been published. These have been summarized in recent books, review articles, or annotated bibliographies (Kozlowski and Ahlgren 1974; Wright and Heinselman 1973; Baker 1975b; Heinselman, forthcoming). The Proceedings of the Tall Timbers Fire Ecology Conferences have also provided an important forum for exchange of ecological knowledge between scientists and managers since 1962. Additional symposia have been held in various parts of the country where scientists and managers have discussed the role of fire in the Intermountain West (Intermountain Fire Research Council 1970); the northern environment

(Slaughter et al. 1971); the Southwest and West (Southwestern Interagency Fire Council 1971); the Southeast (USDA, Forest Service 1971); North America (USDA, Forest Service 1972); and Southern California (Sierra Club 1974).

These studies and symposia dramatically reveal that fire plays different roles in different geographic areas and vegetation types. Under natural conditions, low intensity surface fires occur frequently in the longleaf pine forests of the Southeast and the ponderosa pine forests of the West. In contrast, the spruce-fir forests of Minnesota and Montana are much less flammable; but on those rare occasions when they do burn, it's often a hot crown fire. Understanding each of these roles is an essential part of the ecological basis for fire policies.

With these great differences in fire intensities and frequencies in various vegetative types, it is reasonable to expect that fire would cause a variety of impacts on such specific ecosystem components as wildlife. In reviewing the results of more than 290 studies, mostly between 1960 and 1972, Bendell (1974) concludes that it is difficult to generalize about the effects of fire on birds and mammals. While a few researchers believe wildfire is extremely destructive of wildlife, many feel direct mortality is negligible. What is far more important is impact on habitat—food, cover, and microclimate. While these species dependent on late stages of forest development may have to relocate following fire, many others are favored by conditions following fire. A surprising conclusion to many people is that most species of mammals and breeding birds simply remain in an area after fire (Bendell 1974). Either they tolerate a wide range of conditions or fires burn so unevenly that some unburned units remain. Certain common wildlife species are apparently not particularly sensitive to the fine details of their environment. Some, like moose, seem adapted to flammable habitat.

In the Sierra Nevada, and in particular the sequoia-mixed conifer forest, the National Park Service currently has a special problem. Early descriptions of the Sierra portray the original forests as open and park-like. They were apparently subject to frequent surface fires which made them practically immune to crown fires. With more effective fire suppression, such crown fire immunity was lost. This poses a special threat to the giant sequoias in national parks. Early Superintendents at both Sequoia and Yosemite National Parks recognized the problem, and in 1904 some efforts were made to reduce fuel hazards. Anti-fire critics, however, undercut these early prescribed burning attempts, and total fire suppression continued for more than half a century.

The turning point came with a disasterous wildfire in 1955 just west of Kings Canyon. Within a short time, the McGee fire had consumed more than 13,000 acres (5,265 ha) of brush and forest and threatened the Grant Grove of sequoias. Hartesveldt of San Jose State University began the first studies of prescribed burning in Sequoia and Kings Canyon in 1964 (Hartesveldt and Harvey 1967). This work combined with studies by Biswell et al. (1968), Kilgore (1973a), Kilgore and Sando (1975), Forest Service researchers at Missoula, Montana, and Riverside, California, and others led to the conclusion that fire plays seven essential roles in the Sequoia-mixed conifer forests (Kilgore 1973b). Fire (1) prepares a seedbed and favors germination and survival of sequoia seedlings; (2) recycles nutrients; (3) changes the successional pattern; (4) favors wildlife; (5) develops a mosaic of vegetation age classes and types (6) modifies impact of insects and disease; and (7) reduces hazardous fuels.

Reading fire scars on sugar pine stumps adjacent to the sequoia groves reveals that lightning strikes and fires have occurred regularly in the natural sequence of events in a sequoia community. Fires probably burned individual trees severely enough to leave a scar about every 10 to 20 years (Kilgore 1973b). In the absence of fire, however, white fir moves in, sequoia seedlings do not become established, and the sequoia forest cannot replace itself. So, recurring fire is a natural force which favors the sequoia. This is true except when too much undergrowth, because of too much fire suppression, leads to too much fire. Because of the present tremendous buildup of fuels, great care must now be taken as prescribed fire is first reintroduced into these groves. Only when such abnormally high fuels are gradually reduced can normal surface fires again be allowed to burn without danger of crown fires.

Such ecological evidence of the role of fire does not in itself determine policy. The same ecological evidence can lead to differing policies depending upon the objectives of the agency. Where the objective is to restore natural processes and conditions as in national parks, determination of the impacts of those processes under natural conditions will allow the National Park Service to use fire to approach its objective. Where the objective is to grow trees for timber or grass for grazing, as in some segments of the national forests, determination of how fire can be used as a tool to best achieve these objectives will allow the Forest Service to decide on its fire management policy for that unit of land. Both agencies have wrestled with the problem of how to make use of new scientific evidence on the ecological role of fire when modifying fire management policies.

Recent Changes in Policies

The document of greatest significance to present National Park Service fire policy was the Leopold Report on wildlife management in national parks, presented for the first time at the North American Wildlife and Natural Resource Conference in 1963. This report noted that, ". . . much of the west slope [of the Sierra] is a dog-hair thicket of young pines, white fir, incense-cedar, and mature brush—a direct function of over-protection from natural ground fires" (Leopold et al. 1963). The report suggested that, "A reasonable illusion of primitive America could be recreated, using the utmost in skill, judgment, and ecologic sensitivity." This report was largely adopted as National Park Service Policy in 1968, bringing about a major re-orientation in attitudes toward fire suppression.

Present National Park Service fire management policy divides all fires into either management fires or wildfires. It defines management fires as those of both natural origin and prescribed burns "which contribute to the attainment of the management objectives of a park through execution of predetermined prescriptions defined in detail in a portion of the approved resources management plan." As such, the policy does three things:

(1) It allows some natural (lightning-caused) fires to burn when they help reach management objectives and when they do not threaten human life or developed properties;

(2) It recognizes prescribed burning as a proper tool of wildland management in ecosystems modified by prolonged exclusion of fire or to reduce fuels along boundaries of management zones;

(3) It continues fire suppression in developed areas and for all fires not classified as management fires.

The Forest Service has been more cautious in accepting this new philosophy. While they have been prescribed burning in the national forests of the South since 1943, and burned more than 250,000 acres (101,250 ha) in 1974, it was 1970 when the Forest Service in its Northern Region first established a management direction which allows fire to play a more natural role in wilderness (Aldrich and Mutch 1975). In 1971, a major shift in Forest Service policy occurred when exceptions to the 1935 10 a.m. policy were authorized on a preplanned basis when approved by the Regional Forester and the Chief, Forest Service (Baker 1975a).

Present Fire Management Programs

In the late 1950's Everglades became the first national park to use prescribed burning, while in Sequoia and Kings Canyon natural fires were first allowed to burn in back-country areas in 1968 (Kilgore and Briggs 1972) and an integrated policy was implemented in 1969. Two or more segments of the integrated fire management program—natural fires, prescribed fires, and suppression—are now in effect in 17 national parks and monuments including Everglades, Yellowstone, Grand Teton, Sequoia, Kings Canyon, and Yosemite (Kilgore 1975, 1976). More than 4 million acres (1.62 million ha) of park wildlands are being managed so that fires play a more natural role in the ecosystems. During the last 8 years, more than 300 natural fires have covered some 40,000 acres (16,200 ha) in eight parks, while another 300 prescribed burns have covered nearly 50,000 acres (20,250 ha) in seven parks.

Natural fires are generally allowed to burn only in fairly large wilderness parks where there is sufficient land area to permit such a policy without danger to human life or property. Prescribed burns to simulate the role of natural fire may be used in carefully selected locations, including such smaller units as Wind Cave National Park, South Dakota. They are carried out under predetermined conditions of temperature, humidity, wind, and fuel moisture. Suppression continues as the primary action in most developed areas, in zones with high cultural resource value, and in many smaller National Park System areas. Additional integrated fire management programs are expected to begin soon in another dozen National Park System areas, mostly in the West.

Exceptions to the Forest Service 10 a.m. policy are now in effect in parts of the Selway-Bitterroot Wilderness in Idaho, the Gila Wilderness in New Mexico, the Teton Wilderness of Wyoming, and in multiple-use management areas of two national forests in the South whereby some fires are being allowed to burn. Fire management prescriptions have been written for each vegetative management zone of the 100-square mile (259 km^2) White Cap Fire Management Area in the Selway-Bitterroot Wilderness (Mutch 1974), and guidelines have been developed by the Forest Service for planning and inventory procedures and for developing a fire management plan (Mutch and Aldrich 1973; Aldrich and Mutch 1975). The first major test of the White Cap plan came with the 1200-acre (486 ha) Fritz Creek fire in 1973 (Mutch 1974). All indications are that despite the fact that a fire spotted outside the approved fire management area and had to be suppressed, the initial experiment was successful and is leading the way toward incorporating fire management considerations into broader land use planning (McGuire 1976).

The program known as "DESCON" (Designated Control Burn System) was approved in 1973, in which either man-caused or lightning-caused wildfires may be allowed to burn when they meet preestablished and approved prescriptions and thus accomplish certain desired land management objectives (Devet 1976). Now in use on two national forests in the South, this program is apparently planned for expansion to all Coastal Plain Forests (Mutch 1976).

Fire management programs are now also carried out on state and privately owned grasslands, shrublands, forests, and wildlife refuges for a variety of purposes including wildlife benefits (Kayll 1974). More than 300,000 acres (121,500 ha) of private hunting lands in the South have been burned annually since 1930 for quail management (Komarek, personal communication). Such state agencies as the California Department of Parks and Recreation are beginning to use prescribed fire in managing their forests.

The Future

While many changes have occurred in recent years in National Park Service and Forest Service fire management policies and programs, even greater changes can be expected in the next decade. I see five broad goals if we are to move ahead with the effective long-range fire management programs:

(1) Better understanding of fire as a process;
(2) Better understanding of fire as a tool;
(3) Greater commitment by managers to use on the land the best of what we already know;
(4) A well-trained cadre of master prescribed burners;
(5) Greater public understanding of and involvement in developing and approving our management practices.

Fire as a Process

A group of fire scientists and managers agreed on the following five high priority problem areas about which they want further information (Kickert et al. 1976): (1) How do fire frequency and intensity affect accumulation of litter and exchange of nutrients? (2) How does fire intensity affect fuel reduction, soil erosion, microbial food chains, and nutrients? (3) How do frequency and intensity affect plant succession and nutrients? (4) How does fire exclusion affect duff buildup, soil moisture, and primary productivity? and (5) How do fire frequency and intensity affect litter accumulation and soil water repellancy? Answers to parts of these questions may be available in widely dispersed literature sources. So the first step must be to "synthesize what is already known by putting together system simulation models" (Kickert et al. 1976). Through use of such computer models, it may be possible to help the manager predict short-term and long-term ecological effects of various fire management decisions (Agee 1973; Kessell 1975, 1976; van Wagtendonk 1972; and Bonnicksen 1975). In the absence of such models, information being produced may not be the most urgently needed.

A specific area needing further study is the impact of smoke from fire management programs on disease organisms such as *Fomes annosus* and white pine blister rust as well as on visibility at airports, on highways, and at scenic viewpoints. Initial studies by Parmeter and Uhrenholdt (1975) indicate that smoke inhibits many fungi and rusts and may play a greater role in the dynamics of these organisms than previously realized.

A problem related to better understanding of fire as a process is the lag time between information discovered by a researcher and receipt and use of that information by the manager. The FIREBASE program of the Forest Service is attempting to get fire ecology knowledge into accessible form; it is a computerized system which will store and retrieve wildland fire information and put it into hands of fire managers and scientists. By the middle of 1976, it should be ready for limited operational use with 3,500 items involved (Taylor 1976 and personal communication).

Fire as a Tool

Three Forest Service Fire Laboratories and several Experiment Stations, the Petawawa Forest Experiment Station in Ontario, Canada (Van Wagner 1974), and a number of National Park Service scientists (van Wagtendonk 1974) are working on a variety of basic and applied projects which can assist with use of fire as a tool. These projects deal with fire behavior, fire prevention and control, weather, smoke management, prescribed fire, and fire effects on wildland ecosystems (nutrients, streamflow, insects, animals, and birds). Information must be gathered both in controlled laboratory studies and by sophisticated monitoring of experimental burns and wildfires in Wilderness Areas and national parks. Perhaps one of the most practical applied programs is the "Fire and Multiple-Use Management, Research, Development, and Application Program" at Missoula, Montana, in which a team of land managers are working with scientists to define the role of fire in western forests, to develop methods for blending fire management with land management plans, and to apply and evaluate fire management alternatives on national forests.

Fire process ideas must be translated into answers to such practical questions as: (1) How often should an area be burned? (2) What prescription is appropriate (what temperature, humidity, wind, and fuel moisture conditions should be used to bring about a given intensity of fire)? (3) How much fuel accumulation indicates the need for another burn? and (4) What management actions can best simulate "naturalness" in parks and wilderness areas and still minimize smoke contribution to adjacent communities?

Very specific and sophisticated techniques are often needed to use fire as a tool in a particular vegetative type. As a result of long-term sequoia studies, Harvey (Hartesveldt and Harvey 1967 and personal communication) suggests that areas with no sequoia regeneration and with high fuel levels should be given high priority in our sequoia prescribed burning programs and that the base of mature sequoias be protected from heavy burning. He also concurs with Bonnicksen's (1975) suggestion that representative examples of certain vegetation units, such as patches of reproduction which occur in openings, patches of sugar pine mixed with white fir in the understory of larger trees, and multi-layered vegetation units composed of pure white fir be protected from large-scale broadcast burning in order to more closely simulate the dynamic balance that existed in the primeval sequoia-mixed conifer forest mosaic. Such specific techniques need to be built into our ever-evolving fire management plans. These plans should take advantage of the planning guidelines and inventory procedures developed by Aldrich and Mutch (1973), a document Moore (1974) called the "most complete how-to-do-it document available for ecosystem-based fire planning."

Commitment by Managers

While we will always need more research to confirm our hypotheses, and while new techniques can improve our management programs, simply waiting for more studies to give us the answer before acting is a "cop-out." Adequate knowledge is available, for example, to use fire in ponderosa pine; yet millions of acres of this species wait for our management actions. We are getting close to this situation in the sequoia-mixed conifer forest. It gets down to the crucial question, "Why aren't we putting into practice what we already know?" Philpot (1976) identified five important reasons: (1) Lack of personal commitment or acceptance of fire's role in land management; (2) Lack of administrative understanding and strong leadership; (3) Fire ecology knowledge is not in useable form; (4) Lack of expertise and technical know-how; and (5) Absence of fire ecology considerations in the basic land-use planning process. Recent fire management programs in Sequoia-Kings Canyon National Parks, California; Grand Teton National Park, Wyoming; and the Selway-Bitterroot Wilderness of Idaho demonstrate what can be accomplished by committed managers with research backing (McLaughlin 1973; Kilgore 1975; Daniels 1974).

Perhaps one of the most exciting developments in fire management reflecting administrative understanding and leadership is the recently approved large, interagency wilderness fire management program for one-half million acres (202,500 ha) of the Teton Wilderness and 1.7 million acres (688,500 ha) of Yellowstone National Park. This program will be operational in the summer of 1976. It will be the first time that fire on National Park System lands can be allowed to cross the boundary onto National Forest System lands, by plan, and fires from the Teton Wilderness to cross into Yellowstone. Decision charts are included in an excellent Forest Service plan which take into account such things as public safety, weather, number of other fires burning at the time, spread potential, size of fire, air quality and smoke dispersal, and cooperation with the managers of Yellowstone and Grand Teton National Parks. If all goes well with this program, presumably it will grow with the addition of the Shoshone National Forest and perhaps other interagency cooperative management efforts aimed at better managing the resource and better serving the American public.

Master Prescribed Burners

One of the most important products of the fire management program in the next decade must be trained specialists who will be experts in the use of fire. Lack of technical expertise seems to be a major problem in most areas, with the possible exception of the South and the Fort Apache Indian Reservation in Arizona. As Vogl (1973) points out, in our past emphasis on fire control, we have almost forgotten both the technique of prescribed burning and the legendary men who practiced it. We cannot afford to forget the skills of men like Herbert Stoddard, the Komarek brothers (who "could burn circles around a parked car without blistering the paint"), Harold Biswell, Harold Weaver, Harry Schimke, and Harry Kallander. As these men retire, and several already have, Vogl is concerned that in most parts of the country, few other master prescribed burners are being trained as specialists who really know controlled burning both as an acquired skill and a scientific technique. He fears the know-how that needs to be passed from generation to generation may be lost.

Neither the National Park Service nor the U.S. Forest Service, nor any other responsible land managing agency in the U.S. today can afford this loss. The importance of training was recognized when a complete issue of *Fire Management* was devoted to this subject recently, including the importance of continuing education for fire management professionals and coordination of agency training courses (USDA Forest Service 1974). But we must also find some way to pass along the practical field knowledge and skill from one generation to another.

Perhaps we can establish field training workshops and demonstration sessions whereby young resource management specialists from all agencies, having sound academic backgrounds and fire suppression experience, can also learn the very specialized skills and techniques of fire management—including prescribed burning—from men with extensive practical experience. The Forest Service's Eastside Prescribed Fire Workshop in Oregon is an example of such a program.

One specific suggestion is a small team of interagency, interdisciplinary fire professionals to give a traveling seminar on a 3-month detail basis to fire management practitioners in all agencies. We must make certain a cadre of specialists learn these skills well, for fire is a powerful force which must be carefully respected at all times (Barrows 1974). I see no area in the country better able to serve as a starting point for these training workshops than the Coastal Plain Region of the South—on the national forests or at the Tall Timbers Research Station in Tallahassee, Florida.

Perhaps as a first example of this type of program, the Pacific Northwest Region of the Forest Service detailed nine of its fire management personnel to the Southern Region this spring to work with Southern personnel on prescribed burns in the South. These men needed to gain expertise in the use of fire for later application in the ponderosa pine forests of the Northwest. The Eastern Region also sent eight men down on the same training detail. The sophisticated techniques developed in the South over long years of practical application can help train others for their mission, even though the conditions under ponderosa pine or other types will require major modifications of the southern burning techniques.

As another approach, Dr. Harold Biswell conducts occasional field seminars in California which involve demonstrations of appropriate use of fire. There has been only minimal effort, however, to use these as training sessions for agency management personnel. Some courses are developing at universities and colleges to fill this need in part; Jack Barrows' fire science program at Colorado State University is a prime example. But even more emphasis on field experience is essential. Ongoing fire management programs in such park and wilderness areas as Everglades, Florida; Sequoia and Kings Canyon and Yosemite, California; Grand Canyon, Arizona; and the Selway-Bitterroot Wilderness of Idaho, should definitely be worked into the demonstration section of such a program.

Except for fire suppression efforts, the concept of big fire management programs, with lots of equipment and personnel used on each fire, must be changed. The expert burners I have talked with say, "give me relatively few knowledgeable men with hand tools and one drip torch, and I can burn as much in a day as ought to be ignited anyway! You can't afford to be impatient with fire." These experts *do not want* large numbers of personnel nor great amounts of sophisticated equipment. During initial applications, they want to burn relatively small areas where carefully planned natural fuelbreaks allow them to have control. If more people are there, they should be observers, and not required back-up. As programs evolve, larger acreages can be handled, once abnormal fuels are reduced, special techniques are developed, and a careful planning job is done.

Not long ago in one of our western parks, I saw what can happen when too many personnel not trained in prescribed burning are involved. In that case, the idea was to use a prescribed burn as a training exercise for 100 to 125 people from a variety of agencies. Several crews of 8 to 10 men each were assigned different sectors to burn. These people were highly qualified in fire suppression work, but their background in prescribed burning was minimal. Not having been adequately briefed in the overall purpose of the exercise, some crew leaders became impatient to finish their sector. Thus the particular type of backing fire required under the topography, fuel, and weather conditions at that time was not skillfully used. Too much fire was put into the forest, and certain sites burned overly hot and did not achieve the desired objective. We learned from that mistake, and we'll continue to learn if such judgmental errors are used constructively to improve our training programs and to refine our prescriptions.

We cannot afford the luxury of impatience in dealing with so powerful a natural process as fire. To learn the right conditions for burning requires appropriate theoretical training and practical experience. Such experience must provide a working knowledge of fire behavior under the variety of fuel, weather, and topographic parameters in which a resource manager will be operating. And most importantly, he must gain an attitude of deep respect (1) for fire, (2) for the natural resource itself, and (3) for our land management objectives which allow him to use the best judgment and appropriate restraint in making decisions about fire prescriptions and programs.

Public Involvement

We all realize the public relations problem faced by a fire management program, following decades of effective conditioning that "all fires are bad." But there are indications with both National Park Service and Forest Service programs that hard work and skillful communications can get across the new, more complicated message (Kilgore 1972; Stankey 1975). An "inform and involve plan" is included as part of each Forest Service fire management plan. Agency public affairs and information-education personnel can be key elements of this effort to involve the public in these important land management decisions.

Conclusion

The transition from total fire control to scientific fire management is a major shift in philosophy and attitude toward the land as well as a change in an action program. It requires subtle "weaving of a fundamental understanding of fire as an ecosystem process into the day-to-day fabric of resource management" (Mutch 1976). The ecological basis for this change in policies has been developed by fire scientists and managers in the South, the West, and other parts of the country and the world, but the gut-level acceptance of the policy change is still evolving. Better understanding of fire as both a process and tool is needed (Mutch 1976) along with greater commitment by managers and greater involvement of the public in important land management decisions.

In our enthusiasm for fire management programs, we must avoid any bandwagon approach to the use of fire. While there is some element of risk in reasonable fire management, we will lose both credibility with, and support of, knowledgeable fire control experts as well as support of the public if we do not use the best possible professional skills and judgment in our use of fire in the forest.

Fire's role as a process is basic to the operation of many ecosystems in national parks and Wilderness Areas. With this firm knowledge and insight, we can begin to use fire as a tool to best simulate its natural role in these areas. Eventually, forest and wildlife specialists, livestock interests, and all the American public may agree on appropriate fire management programs which will prove to be best for the natural resources of America, upon which we all depend.

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Discussion

CO-CHAIRMAN BARICK: I feel I can relate to the philosophy that you articulated, Dr. Kilgore, because the agency for which I work has been practicing burning for the past 25 years on game ranges in North Carolina, and I am sure there are other people here who have had similar experiences.

Are there any questions from anybody in the audience?

MR. WALTER SHEPPE [University of Akron]: I can understand the burning program that you described but, on the other hand, it is not at all clear to me how you quite define your objectives and choose your techniques, especially when your real objective is maintaining natural conditions in the Park Service area. I would think this is much more difficult.

I would like to know whether you have involved any park lands or the Park Service in your burning program.

DR. KILGORE: In answer to your first question, we need to learn more about the relationship between fire and natural conditions and what role fire has played in both parks and wilderness areas. That would help us select the best techniques to achieve near natural conditions.

On the other hand, I don't think we can wait until we have a "perfect operation" to start our integrated fire management program. Our managers feel we must move ahead now with the best available information and the best tools we have. Then we will continue to modify our techniques, in a sense by trial and error, but always handling things conservatively.

Insofar as using prescribed fire on park land, the main comment we have received from both conservation groups and knowledgeable park visitors is "why didn't you start this long ago?"

MR. KEN WILSON [North Carolina]: I would like to comment further on what my good friend, Frank, said.

Most of our burning, while I was supervisor of some management areas in North Carolina, was on the 60,000-acre Sand Hills Wildlife Management Area. As I recall, we burned 10,000 acres a year and we burned them every 3 years.

We laid out transects, on which we measured what we hoped would burn and, as we were very much interested in the management of the bobwhite quail, turkey and, of course, deer, we governed our burning on this criteria.

Populations of many of these animals, after burning, increased almost 100 percent, at least in some cases. Also the vegetation that came after the burn was more palatable to deer who would often graze it to a much greater degree.

There is no doubt in my mind that Frank Barick was the man that pushed this. He did not have a lot of friends who understood it in the first place but he had enough internal fortitude to push it.

I must say that conditions in the one area that I mentioned are now acceptable. Also, there are other parts of North Carolina where the Forest Service is operating on the same basis. They are doing their own burning and getting some good results.

DR. KILGORE: One other point that I made in my paper is that we should not look at fire just as a tool but also as a process. In the South, for example, where they have been burning for quail management and a number of other purposes, they are finding a lot of interesting and beneficial side effects. In some areas, for example, where fires have been used for a number of years, populations of wild orchids are developing where they had not been found for years, and certain species of woodpeckers are increasing in numbers.

MR. PAUL LATIM: I was wondering what the consequences of nondegradation is in relation to air quality. You have been talking about activity especially in wilderness areas of the West.

We have put together a number of statements in draft form and, to my knowledge, none of them have made it out of our agency as yet. We are trying to address this type management and your talk has encouraged me and others to come to professional meetings and try to explain to others what we see. At present, for example, we have prescribed regulations which can help us designate smoke from wild fires that will damage the resource.

MR. WILLIAM ROGERS [Naval Air Station, Maryland]: In the West, in contrast to the South, you are burning on some very steep slopes. What problems have arisen in the form of erosion and stream sedimentation as a result of your burning?

DR. KILGORE: We have measured this carefully, ourselves, and have also used USGS researchers to monitor this type of problem, both as to water quality and erosion. We have found no particular problem with the light burning we have been using in sequoia-mixed conifer and red fir forests.

We have monitored erosion on particular plots of sequoia-mixed conifer forests, and we have found minimal change there after surface fires have burned.

Even if you burn most of the surface fuels, you have some litter from the unharmed overstory back on the ground within a matter of weeks or a month later. Therefore, we are not talking about bare soil following a devastating fire.

MR. WILSON: That controlled burning on our areas has saved tens of thousands of acres in the immediate area from burning flat to the ground. It is a case now, however, where people just do not think and it takes a lot of education to make them change.

DR. KILGORE: With reference to erosion, I think it involves a kind of trade-off. Perhaps state and U.S. Forest Service managers and scientists will come up with something else for the Southern California chaparral. But right now my best bet is that chaparral is going to periodically be burning 100,000 years from now (as it does today) regardless of what else we do. While some managers are looking for slow burning plants and grasses to replace chaparral, many people feel the roots of the chaparral are the nuts and bolts that hold the whole thing together, and if you get rid of chaparral, you are going to have more serious erosion problems.

MR. CHESTER McCONNELL [Wildlife Management Institute]: Since the idea of fire and smoke as a pollutant has been brought up, I thought it might be interesting to see what your comments are on the research at Tall Timbers which shows that smoke from the natural burning fires is beneficial to their environment simply because our environment was developed as a result of numerous fires in our past history and they have evidence to prove that smoke from natural fires is actually beneficial to the environment.

DR. KILGORE: I know of various studies being done along that line. However, I am not an expert on that. While we have heard much about the negative impacts of the quantity and quality of smoke found in auto exhaust, there are a number of benefits of wood smoke that are now coming to the forefront. I simply mentioned the work at the University of California with disease organisms and smoke. I would urge researchers to get out in the field and help us determine just what roles wood smoke does play in our forests and other ecosystems.

Agriculture and Wildlife: Opportunities and Conflict

Robert W. Long[1]
Assistant Secretary for
Conservation, Research and Education
U.S. Department of Agriculture,
Washington, D.C.

Farmers and ranchers share many goals with members of the wildlife community—because they are *part* of that community.

Many of them share with you memberships in wildlife or environmental groups. More than half of them are members of local conservation districts, which were among the earliest and most active environmental groups.

In fact, most Americans share with you an expanding desire to be associated, in some satisfying way, with nature's magnificence—with the great out-of-doors. They try to satisfy this desire by hiking, camping, bird-watching, jogging, hunting, fishing, moving to the country, and in many other ways.

These experiences with nature are essential to what we often describe as "the full, good life." They help people regenerate their values and add more meaning to their life—breadth to their culture.

Farmers and ranchers, of necessity, satisfy this need, in part, by providing renewable resources—food, fiber, and timber—for America and other nations. The national interest requires it. It is their way of making a living. Yet, if it didn't give them a lasting sense of well-being, most of them would find another occupation.

I want to suggest that farmers' primary responsibility for agricultural production sometimes gets in the way of the well-being of wildlife . . . that it sometimes greatly adds to the wildlife habitats . . . and that sometimes, or in some locations, it has a minimal effect one way or the other.

I want to suggest that the mushrooming rush of people into the nation's timberlands and wide open spaces has an impact on wildlife habitats.

I want to suggest that together we should try to find a better way to reach agreement on the management and use of out-of-doors resources. Together we need to decide, with interested or involved groups, how varied human needs to communicate with nature may best be met.

I want to suggest that farmers, the Department of Agriculture (USDA), the wildlife community, and all agencies of government closely associated with wildlife need to find better ways of maximizing areas of harmony and minimizing areas of conflict.

You will find most farmers anxious to supplement their contribution to wildlife habitats, when this can be done in relative harmony with their responsibility to meet the needs of all people.

While we have made some headway in working together, a renewed effort should be made.

[1]In the absence of Secretary Long, this paper was presented by Ronello M. Davis, Administrator, U.S. Soil Conservation Service, Washington, D.C.

Protecting wildlife and its habitats can sometimes be an elusive goal when planning to meet community needs or to increase production of food and fiber to meet pressing domestic and international requirements. It can also be an elusive goal in water resource development.

Overall, farmers and ranchers may have a greater opportunity than any other group in America to influence fish and wildlife habitats. Farmers own the bulk of the privately-held land in the United States—60 percent of the nation's 2.3 billion acres (.93 billion ha).

The U.S. Department of Agriculture (USDA) itself has a great opportunity as well through its programs that aid farmers and ranchers in managing their land and water resources.

USDA's Forest Service directly manages nearly 10 percent of the nation's land area—the National Forests and Grasslands. It also cooperates with State and local governments in providing assistance to private forest landowners, and conducts an extensive forestry research program. The Forest Service carries out these programs, involving one-third of the nation's land, to serve both wildlife and man.

Food, always a basic consideration, recently has become of even greater concern. Only energy approaches it as a top priority item on the agenda of world economic affairs. Programs that used to curtail U.S. agricultural production have been replaced with programs that encourage food production.

Hunger and malnutrition in "Third World" nations hound the conscience of mankind. It is estimated that 500 million people suffer from chronic malnutrition. This whittles away at the pillars of international stability. Yet the global expansion in population continues. At this rate, shortly after the turn of the century, there will be twice as many people on the planet Earth—8 billion instead of today's 4 billion. Even the United States is expected to experience an increase of 50 million people by the turn of the century.

Likewise, our forests face heavy added pressures. I have alluded to one such pressure—their recreational use by people. Another is the escalating demand for timber and other wood products which is expected to accompany the population explosion and increasing levels of affluence in developed nations.

The Question: Can farmers around the world increase food production fast enough to feed twice as many people by 2005 or 2010? Can they increase production as much in the next 25 years as they did during the last 8,000 years of recorded history? Also, will it be possible to meet the timber needs of the next quarter century and thereafter?

These are sober reflections. They point to potential widespread global poverty, misery, and certainly to malnutrition. They point to the grave possibility that the situation may worsen. They cast heavy shadows upon some of the aesthetic ambitions of American life. These are the threads of realism.

Yet farmers and wildlife interests are not willing to fully surrender to these forces. Nor is there need to. Together I believe we have the capacity, the determination and the good sense to arrive at understandings, compromise, and balanced judgments, so as to meet the total needs of Americans—and their communities.

Fortunately, food, timber, and most of the other ingredients of wildlife habitats are renewable resources, both qualitatively and quantitatively. Soil capability is also renewable, even though the rebuilding process is slow and expensive.

Renewable resources are becoming ever more important for many reasons. One reason is that we must rely upon them to meet the needs of society as supplies of essential nonrenewable resources become scarce and expensive. The only exception to this basic truth is the potential for the development of substitutes supplied by our continuing research efforts.

It is appropriate, therefore, in this setting that we should talk about the needs and opportunities to provide and improve fish and wildlife habitats.

Here are several specific areas where conflicts may be reduced and where mutual goals may be strengthened:

First: In farming fence-rows, reducing windbreaks, and minimizing idle acres, operators have reduced wildlife covers—particularly in the nation's highly productive agricultural regions. Often fields are too large and open for some animals to take advantage of the abundant supplies of food often available there.

Yet these areas of intensive cropping are offset by vast acreages in other regions that have been allowed to return to grass, brush, and woodlands.

Farmers in all areas are involved in a concerted effort to install and use additional land use and conservation practices and patterns that, generally speaking, add to wildlife cover. These include terraces, contour cultivation, strip-cropping, sod waterways, the establishment of crop rotations and the improvement of meadows, pastures, and woodlots, plus the planting of trees.

These are practices that not only add to habitats on the area involved, but reduce erosion runoff of soil and residual fertilizer, thereby protecting the habitats of fish and other aquatic life.

We need to mutually answer the question: How can these processes be speeded?

Wildlife people could help by supporting efforts to expand desirable practices and patterns through education, motivation, and public support for programs offering technical assistance and incentives.

Second: The long, massive movement of farm and other rural prople to urban areas, in search of employment and a better life, has been reversed. The turnaround came in the early 1970's. More people are now moving to rural areas than are moving away from them. Industry is placing plants, laboratories, and offices in small towns and the countryside around them. We expect this trend to continue. This phenomenon will dramatically affect wildlife habitats in major regions of our country.

Rural communities, however, are just beginning to use this reverse growth to enable them to more fully meet the needs of residents. They are trying to use this growth creatively—to make land use and developmental decisions that add to the quality of local life.

There are complex problems which need to be addressed and I hope you are going to be willing participants because here is an excellent opportunity for wildlife interests to work with local leaders, helping them to meet the total needs of the community, including wildlife considerations.

Third: Another excellent chance for you to enhance the cause of wildlife habitats is by supporting agricultural research, education, and technical assistance programs. By supporting these programs, plus supporting the use of safe and essential chemicals, each designed to increase production per acre and per unit of livestock, wildlife workers help keep huge acreages of land in uses suitable as habitat that otherwide would have to be used for crop production.

These are the modern ingredients of the agricultural revolution.

It is that revolution—hybrid corn, chemicals and hundreds of other innovations—that has made it possible for this nation to meet domestic and export needs for food and fiber by using perhaps one-half as much cropland as would otherwise have been used. That revolution thus has permitted huge acreages to remain in uses most compatible and best managed as habitats for many species of wildlife.

Fourth: Farm ponds, and the areas surrounding them, make an important contribution to fish and wildlife habitats. Farmers have installed 2 million ponds in recent years. There is need for many more such ponds, perhaps nearly twice as many. There is room for better pond management. We are all challenged, together, to find ways to see that these are needs met. And you are in a position to play a powerful role in that process.

And fifth: The Forest Service manages the nation's 187 million acres (75.73 million ha) of national forests, in part, to improve and preserve wildlife and fish habitats. The agency has worked closely with authorities in these fields to maximize wildlife contributions. The Forest Service wants to continue and to expand its relationship with the wildlife community, in the interest of better service. Also, the Resources Planning Act recommended program provides the vehicle to fund and implement wildlife and other resource programs to meet future demands. RPA puts all the cards on the table, in full view of the American public. Concerned citizens will be able to judge the commitment of the Administration and Congress to renewable resources.

These are but a few of many areas where farmers, your government, and the wildlife community may work together to increase and improve wildlife habitats.

Associated with such mutually desirable activities, however, is the necessity that we solve relationship problems between the two groups. Some segments of the wildlife community are highly critical of practices often associated with today's agriculture.

Many ranchers and farmers likewise have developed antagonism toward those who condone the idea that coyotes should be permitted to kill lambs; that nothing should be done to prevent millions of blackbirds from consuming farm crops; and that pesticides and other chemicals be barred from farm use even though they have not been shown to be truly harmful to human health.

No matter how well intentioned these viewpoints may be, they have often caused farmers to place anyone connected with wildlife and environmental causes in a category of extremists as people who demand unreasonable and unworkable solutions. And wildlife people often have their own pet names for the farmer and rancher.

I think all sides need to be careful about actions affecting the others. I think we need a way to resolve issues before positions are firmly polarized. Certainly, we need to work together more than we have in the past.

Together we need to find land use systems, management techniques, and economic incentives that can be balanced with the needs of those who need food, both here and abroad, with those who would enjoy wild animals, with those who would make a living on *the land, and with those who would enrich their life with out-of-doors experiences.* We need to understand the viewpoints and problems of each other. We need to work together, wherever possible, to mold policy decisions for our mutual advantage and to implement those decisions.

There is an inclination at this stage in our national life to rely upon laws, regulations and compulsion to achieve goals. Compulsion and regulations, especially as they relate to future land use, are obnoxious to farmers. Farmers' response to regimentation is understandably hostile. They'd rather solve problems voluntarily—by coming to an agreement with others eye-to-eye. They prefer to manage each field, with the advice of professionals, according to conditions found on that field, and the economics involved—not by submitting to some bureaucrat's standardized remedy dreamed up in Washington or in a state capital.

The problem of relationships is a part of a broader, overall problem in many segments of American life.

Long, costly lawsuits are being used today to delay or block hundreds of projects that are essential to this nation's progress. Groups are often attempting to win their case by involving themselves in a mass media shouting match. Others deluge legislative, administrative and regulatory bodies with one side of an argument. Still others, as I said, attempt to achieve goals by regulation and compulsion rather than by using slower, but more effective approaches such as education and cooperation. I urge our conservation groups *to beware of an attorney's solution to problems*. Litigation is a last resort—let us all try to resolve our differences by other means.

Surely there is a better way to determine how the interests of all Americans in the use of natural and national resources may best be served. Surely there is a better way to help administrators and others decide what is right, fair, and equitable for all citizens. Surely there's a better way than methods in current use, including large legal standoffs, of deciding:

—the type and location of electrical generating facilities important to America's future;
—the solution to problems related to essential surface mining;
—and the way to manage and use public and private lands, including wildlife habitats, so as to meet the total public interest.

The same argument may be made for finding a better way to resolve disagreements over methods of harvesting timber, modifying stream channels, alterning wetlands, and building facilities for storing, moving and spreading water.

I have come to you with a rural viewpoint—not that of a wildlife expert. From this vantage point, I have tried to say:

—that the interests of farmers, the community and wildlife groups are often identical; that most Americans seek a relationship with nature's great out-of-doors; that sometimes those interests are in conflict; that we should encourage the areas of common interest and minimize the points of conflict.

—that many farm practices help some species of wildlife and harm others—that there is opportunity to increase positive contributions.

—and that while farmers, of necessity, give food production a top priority, they are generally sympathetic to wildlife causes except when their economic well-being is threatened.

I have also tried to say that there's surely a better way to resolve areas of conflict than the use of the courts, battling it out with news releases, or swamping legislators and administrators with tons of one-sided arguments; that education and voluntary action often get better results than do regulations and compulsion.

Now, with your indulgence, I want to share with you a practical problem:

Federal expenditures have reached such momentous proportions that unless the escalation is checked, regular federal functions will suffer gravely. In fact, they are already suffering.

The massive drain on the Federal Treasury is spearheaded by payments to individuals. Our national compassion has exceeded our common sense. Federal outlays for health and income security programs have jumped from $27.5 billion in 1965 to an estimated $151.8 billion during the current fiscal year. These programs are largely responsible for pushing the federal budget from $100 billion 15 years ago to near the $400 billion mark in the upcoming year.

Four hundred billion dollars is an incredible sum of money. If every farm in America were sold at early 1975 prices, these farms would bring a total of $371 billion—enough to run the Federal Government for about 11 months.

Because of these enormous financial stresses on the Federal Government, we have fewer professionals aiding farmers in developing conservation plans than we had 10 years ago. Fewer scientists are manning our agricultural research laboratories; and fewer professionals are protecting and managing our national forests. Likewise, we have been forced to reduce or eliminate many programs aimed at creating, preserving, or improving wildlife and fish habitats. These cutbacks include an assortment of cost-sharing programs, easement programs, incentives and demonstration efforts, including forestry incentives, marshlands and pothole programs, long-term habitat agreements, and programs aimed at opening private lands to public access.

Much more than the well-being of fish and wildlife is at stake. The fiscal integrity of the country—indeed the future of the system that has meant so much to us—is at stake. It is time that all Americans put the ingredients of national expenditures into perspective, examine spending priorities, and insist that the federal establishment live within its income.

Until we are willing to work just as hard for a balanced federal budget as we work for specific appropriations, we are placing our legislators in difficult and untenable positions.

All of us need to face this challenge. As Abraham Lincoln once said, "We shall nobly save, or meanly lose the last best hope of earth."

Discussion

CO-CHAIRMAN BARICK: Thank you so much, Mr. Davis.

These are interesting comments and they concern me, Mr. Davis, and possibly others in the audience, because they involve the philosophy that the United States has the obligation, to feed the rest of the world. I wonder whether we can afford to do this and if we attempt to go in this direction, what will the total impact be on our other resources?

We see vast acreage being depleted. We see destruction of wetlands, which has put a strangle hold on wildlife, in at least the Southeast. Therefore, it seems to me that we do need to develop other kinds of philosophy with regard to our responsibilities.

By attempting to satisfy the world's hunger, we are damaging our wildlife habitat. Therefore, it seems to me that we need to develop some other philosophies in this direction. I would like to hear your comments on that if I may.

MR. DAVIS: I will try to answer your question on my own.

I don't believe that Mr. Long said in his paper, nor am I saying, that we have an obligation to feed the rest of the world. I don't believe we could if we really wanted to do it. I am talking about the total mass of the world's population.

Certainly this country needs to make some contribution. We always have and always will. We need agricultural production for other nations in the world. It contributed $22 billion last year to the balance of payments and thus had an effect on the value of the American dollar.

When we think of our ability to feed the rest of the world, then some of the things you alluded to might happen. For example, we do need to provide other countries of the world technical assistance to enable them to help themselves more than to provide them with free food.

In my travels to foreign coutnries, I have found that after the food got on the docks, it really did not get to the poor people who needed it. The Department of Agriculture today has a lot of people involved in providing technical assistance to foreign and underdeveloped countries. Our prime pitch has been in that direction and I also believe this is true of some other organization more than it was in past years.

DR. KEITH HARMON [Wildlife Management Institute]: I would like to ask you to clarify one point. I am not asking you to speak for Mr. Long, of course. However, one of the points he made in his paper was that we need to improve our working relationships in order to provide a better and stronger policy, particularly as it might relate to wildlife habitat in private lands.

In the face of this statement, I am wondering why the 1973 Agriculture and Consumer Protection Act, specifically Title X of that law, provided for the establishment of a National Advisory Board to advise the Secretary of Agriculture on some things, such as the Water Bank Program, Upland Nesting Cover and other aspects of the program, which might improve fish and wildlife habitat. Now that we are in the third year of our four-year program, that board has never been screened by the Secretary of Agriculture.

Another example was that Title X of the same act provided the Secretary of Agriculture with authority to take perpetual easements in flood plains, shore lines and aquatic areas of the United States, yet the Department of Agriculture has refused to implement that authority. Therefore, what we keep hearing about begins to have a hollow ring, especially when authorities are already in existence that the Department of Agriculture has either shown lack of enthusiasm for or had complete disregard for the law thereof. I am wondering how we can improve this working relationship in the face of these kinds of examples?

MR. DAVIS: I don't know if I can answer all of your inquiries. I know, however, exactly what you are alluding to and this fellow you are looking at right here has been trying to get back of that same act that you spoke of—has been trying to get it implemented. However, it has not been seen as efficient by the Administration to request funding for those particular sections.

The Department, in the first year which I believe would have been fiscal year 1974, did request some funding but it was not left in there by the Congress. Congress handed the argument back to the Administration—since they are not funding programs that are presently underway, the Congress is not, in turn, going to fund new ones. Therefore, we are at a standoff between the Legislative and the Executive Branch at this time.

I do not propose that an agency administrator, such as myself, can resolve that particular conflict; but what you cite is a very real example, where the Congress has provided for programs, but they were never funded or no funding has been requested for them. This does not speak well for cooperation beween the two branches.

CHAIRMAN NELSON: I would like to raise a point, Mel, of the Soil Conservation Service itself. As I understand it, our basic approach in soil conservation efforts has been one of providing free services and cost sharing to landowners in an attempt to prevent soil erosion, for example. I am concerned that in my section of the country at least, southern Minnesota, this is not working adequately. I cite as evidence the severe losses to erosion as described in the State SCS Conservation Need Inventories over the past years, as well as various other publications, which say, for example, that two-thirds of our land is in need of conservation treatment of one form or another. I believe this involves largely erosion control, but then witness too, the severe snow and dirt storms that we have had in recent years on the plains areas. Therefore, on that basis, my question is—do you feel that the current voluntary approach for erosion control is working adequately and, if not, what type of regulation or other approach do you feel would be appropriate?

MR. DAVIS: We have had many successes and many failures with the current voluntary approach to conservation. The Great Plains Conservation Program is the greatest one that I can bring to mind where we have made some study. That program, of course, involves technical assistance and cost sharing, based on complete conservation plans.

The last study in relation to that ratio was four to one. In one of four places where we did an arbitrary spot check, there was a significant amount of erosion taking place as opposed to the noncooperative or noncompliance areas in that particular program.

What will take its place? Well maybe it is going to involve some sort of regulation, if I can use that term, to really solve the problem. I think we have to recognize that this great conservation movement got started back in the 1930's during which people had witnessed all of these dust storms and some of the land being taken away. On that basis, they were more apt to cooperate than they are now.

Today we have another generation of people, both working in the agencies and actively farming the land. I would expect that perhaps the "Clean Water Act" Amendments of 1972, Section 208 are going to have greater impact on the future direction of conservation programs, voluntary or mandatory, in this country, than anything else.

I am sure that our neighbors adjacent to dust storm areas today are going to be bringing up air pollution as a result of dusting and these factors are going to back down into some sort of regulatory standard setting procedure and, of course, a force to some conservation back-up on the land.

MR. CHESTER McCONNELL [Wildlife Management Institute]: I just want to go over one or two things.

You said wildlife people could help improve farm management practice for wildlife and farming and you said you were in a position to help. You are also one of the top administrators and sometimes we feel as though the system has finally whipped us down to nothing. We have tried for years and years, we have come to your people in the Deparment of Agriculture, to as high a level as we can reach, to get some of these things acted upon and ask as to how we can get some input into these programs. In turn, they would outline a method of approach and we would follow it completely. I have reference to, for example, the 1973 Agricultural Act. But nothing results from these things and we see it getting even worse as the years go by.

Do you have a solution here today? Can you say "here is the way you can do it?" I am at a loss.

MR. DAVIS: I understand your plight and I really cannot pinpoint everything.

There are some areas in which we could team up. When I say "we", I have to be careful now, because I am part of the Executive Branch of government, to get certain sections of the Act implemented. It happened that way, to a degree, with such things as the Water Bank, even though that has limited application. It happened that way, to a degree, with Forestry Programs. However, I think what we have to do is to sit down and talk about these things.

I also have to make this comment and, of course, I am not being critical, but I know that my agency, the Soil Conservation Service, has caught a lot of hell over the years. Since I have been Administrator in that agency for one year and, believe it or not, it has been a crowded year, there has been nobody from any wildlife interest or association that has come to my office to discuss any of these items with me.

We need to open up our lines of communication. That is one of the reasons I am here this afternoon and will be tonight—to make myself available so that you people can see what I look like. I think both of us have some steps to take in this direction. I don't propose that I have any pat answers to what you bring up but I believe, collectively, we can get some things done working with you and through other established agencies and organizations who lobby for or against various components of programs.

CO-CHAIRMAN BARICK: It seems to me, Mr. Davis, that much of the benefits that have accrued to wildlife and wildlife conservation through conservation farming, have been those practices which have had other benefits as well—practices which probably did not have as their primary purpose the improvement of wildlife habitat but independently or accidentally did have wildlife benefits as well as help to conserve soil or in some other way benefit the land owner. Maybe what we need to do is to find more practices like that, practices which have a dual function and which will both improve agriculture production as well as improve wildlife habitat.

MR. RON KLATASKE [Central Regional Representative, National Audubon Society]: In addition to my professional interest in wildlife management, I have been involved in farming for the full extent of my life and I maintain close association with farm organizations, farmers and farm groups.

You indicated in the paper that there was a groundswell of antagonism between conservationists and farmers in this country. I do not personally see it, although it is there to some extent. Sometimes I am greatly disappointed because it seems that certain officials within the Department of Agriculture have felt this antagonism and this, I think, falls directly into conflict with the theme of your paper, which calls for cooperation.

I greatly endorse the conservation concept and I certainly do hope that in the future we will be able to move much more in this particular direction. There are several problems that we do need to overcome, however.

You have alluded to the fact that conservation is sometimes presenting only one side of a viewpoint. You did not mention, however, that agricultural interests sometimes do this, including the Department of Agriculture.

After extensive review of the Department of Agriculture's major program for conservation on American farms in the country, called the Agricultural Conservation Program, after review of the practices that are taking place in the field and the draft environmental impact statement which was sent out in December, I find very little resemblance between the two and I believe that the impact statement does tend to mislead the reader and conceal, I might emphasize, the negative aspects and adverse impacts of some of these practices. I believe that this attempt to conceal these is misleading the public and leading us in a direction of conflict—not necessarily a conflict between the American farmer and conservationists, but a conflict between the Department of Agriculture, which is responsible for this little booklet, and the conservationists.

You also suggest that the conservationists should not resort to legal action and there were several hundred projects now being held up by lawsuits. I am wondering how we can avoid legal action in issues such as this, especially when the Department of Agriculture refuses to comply with the Natural Environmental Policy Act on programs like this, and to strive to work with us to improve programs.

This program has a great amount of potential for environment and conservation improvement practices on American farms and ranches, but that potential is far from being realized. In fact, it is questionable whether the adverse impacts are greater than the beneficial aspects. Could you respond to that, please?

MR. DAVIS: First of all, we are talking about the environmental impact statement prepared by the Agricultural Stabilization and Conservation Service for the ACP program, which has been known as a cost-share program throughout this country.

That draft statement was prepared, and submitted for comment as is required in all of them. We, of course, are not administering that particular program and did not prepare that statement. SCS only provides technical assistance to ASCS.

ASCS operates in a little different ball game than do most of our technical and professional agencies in the Department. Therefore, I would not like to get into a discussion of that particular impact statement because what you said may be entirely true. As I say, I have not received it and so I cannot comment on it from a factual base. We might discuss that a little later, after this meeting.

In relation to legal action, here I think is an area in which these things have happened. I am not saying that our agency was not guilty in some cases, or other agencies of the Department were not guilty, but what Mr. Long was alluding to was to be sure there were proper avenues of discussion and, through this, we maybe can avoid as much legal action as possible.

I think, for example, in recent years there has been more of an effort to point out more wildlife benefits than in past years. Hopefully, today we are doing a much better job of that than a decade ago. I believe that was your last point.

CHAIRMAN NELSON: Before introducing the next paper, I would just like to say that the theme of this paper was one of cooperation and it is a logical route for all of us to make every effort to travel, especailly as some of us realize that wildlife is very often secondary and given less consideration, therefore, merely at the drop of a hat.

Habitat Programs and Recreation Opportunities on Private Agricultural Land: Opportunities and Constraints

William J. Horvath
The National Association of Conservation Districts, Stevens Point, Wisconsin

There are approximately 2.26 billion acres (.92 billion ha) in the United States, of which 60 percent is privately owned. Of this privately owned land, 47 percent is used by 3 million farmers to produce our nation's food and fiber.

It is on these privately owned lands, and particularly those in agriculture, that we find our greatest opportunity for wildlife habitat development and recreational opportunities.

Habitat Programs on Private Agricultural Land: Opportunities and Constraints

Seventy-five percent of wildlife is raised on agriculturally-oriented farmland, whether it be quail in the South or pheasants in the Dakotas. It is here that our greatest opportunity exists to change, modify or otherwise manipulate our habitat.

While agricultural practices can be destructive, properly instituted conservation plans have added greater numbers of game birds, game mammals, furbearers, and game fish than were here at the turn of the century. Many of these increases can be attributed to a widespread use of strip cropping, contour farming, crop rotation, minimum tillage, grass waterways and other conservation practices which soil and water conservation districts and USDA have promoted since the dust bowl days of the 1930's.

In addition to that, over 1.7 million farm ponds, reservoirs and watershed structures have been built, providing opportunities for game fish production as well as for many kinds of waterfowl. Many of the water areas are physically located in areas of the country which otherwise have few permanently established water bodies.

While this country is daily consuming some 3,000 acres (1,215 ha) of land for highways, shopping centers and other activities associated with an urbanizing society, there remains great opportunities through existing governmental mechanisms to increase wildlife habitat. Surely our technical expertise is not lacking. What is lacking is a continuing commitment from the public sector to assist these private individuals and to provide the proper financing to get the job done.

Nevertheless, America's 3,000 conservation districts, working with the USDA and state wildlife agencies, have accumulated an enviable record in private property habitat development, involving over 2.3 million district cooperators and nearly 800 million acres (324 million ha).

Here are a few of the facts about this cooperative effort on the land as of June 30, 1975:

Contour farming	49,246,947 acres (19,945,013.5 ha)
Hedgerow planting	25,097 miles (40,381 km)
Field border	49,213 miles (79,183.7 km)
Wildlife wetland habitat management	7,070,970 acres (2,863,742.8 ha)
Wildlife upland habitat management	76,685,435 acres (31,057,601.2 ha)

While the professional habitat manager can quarrel over the loss of habitat through its destruction by drainage and land clearing, one cannot quarrel with the beneficial aspects of the district concept of conservation planning. The basic conservation plan is the single biggest opportunity for converting present agricultural land to wildlife habitat and retaining that land in habitat, since it provides direct access by conservation agencies to landowners through signed agreements.

Over 1.8 million conservation plans have been prepared involving 615 million acres (249.07 million ha). What is significant is the fact that the U.S. Soil Conservation Service (the district's prime source of technical assistance) is now placing greater emphasis on the basic conservation plan. We know this is where we will reap the greatest long term gains for resource management.

Regardless of our successes, there are several constraints we face in developing wildlife habitat on private property.

High Prices for Farm Commodities

Many farm producers have been under severe economic strains in recent years due to run-away inflation. Agricultural producers cannot pass on their costs to consumers as other business concerns do. With higher prices, additional land has been brought into production that should never have been put to the plow. This has resulted in degradation of our soil resources as well as loss of critical wildlife habitat.

Lack of Technical Assistance

This is a major element in carrying out habitat preservation and development programs. It becomes an academic exercise when district cooperators have to wait long periods for technical assistance to carry out their plans. Freezes on federal personnel and reduction in the work force has shrunk the Soil Conservation Service nearly 3,000 in recent years to a low of just over 13,000. At the same time, our number of new cooperators who want technical assistance steadily increases. We literally have hundreds of thousands of conservation plans which have not been completed because we can't give proper follow-up to their request. This is a sad state of affairs when such a large block of our wildlife land could be beneficially affected. Almost every conservation plan I have seen has wildlife benefits built into it. It's a matter, then, of implementation requiring technical assistance.

While district-employed personnel have increased to the point where there are now 7,000 stationed in district offices, most of these people have not had the technical training required for conservation farm planning. Capability to develop the plan with the landowner and to follow up to see that the plan is being carried out is severely restricted. We feel that state agencies responsible for wildlife management ought to pay greater attention to management on private property and offer their technical expertise to these landowners.

Decreased Cost Sharing

From a high point of over $500,000,000, ACP cost sharing has decreased to $175,000,000. No one can argue that some of the practices were production-oriented. However, the ability of land to produce and protection of that ability to produce is directly correlated to wildlife productivity. Give the producer the ability to produce on less land, and he will take that option.

But there are many practices such as tree and wildlife planting that hardly can be called production-oriented. Even if they were, they would have immediate benefits to wildlife. Many of the programs our national association supports—the Great Plains Program, the Water Bank Program, and Long Term Contracting, as well as ACP—have been slated year after year for abolition rather than extension or expansion. We believe that the public can best be served with a continuing program of incentives and technical assistance. Congress has recognized this and has over-ridden attempts by the Administration to abolish these programs.

The Trespass Problem

This is a very real constraint with the mobility the public enjoys. With the recent advent of off-road and all-terrain vehicles, the problem has increased. Coupled with this mobility is the fact that 95 percent of our people no longer reside on the farm . . . . the last bastion of private property rights. Vandalism and lack of respect for these rights is a very real threat to closing a great deal of private property and enjoyment of our wildlife resources. The threat of a lawsuit due to injury of an invited guest may exceed the benefits a landowner might receive. Trespass laws generally are not conducive to making it easier for the landowner even though permissible access might be in the interest of the wildlife-seeking public. The "taking it to court" syndrome and large rewards have resulted in a reluctance by many landowners to open their land to the public.

The Evolution of our Public Policy.

This policy, often implemented in the form of state and federal programs, has more and more relied on public purchase in fee simple. There is every reason to believe public policy will continue in this direction, since there is a backlog of $25 billion in expenditures by state and local agencies for public recreation facilities. At the federal level, there are three bills pending to create new national parks, three to establish new national riverways, twenty-seven relating to national wild and scenic rivers, nineteen trail bills, and twelve wilderness bills.

This is clear evidence that our public policy is "fee simple" oriented and probably will continue in this direction in the future until an evolution occurs which puts a deed in a restrictive condition (i.e. development rights, mandatory continuation of existing practices, etc.). We are at present a good ways from uniform application of these concepts. When it does occur, purchasing of public rights or interests for wildlife habitat will be more palatable and acceptable.

Recreation on Private Agricultural Land: Opportunities and Constraints

The leisure boom which began in the 1960's has pushed over $100 billion into the economy annually—more than our expenditures for national defense. And this will continue to climb.

This upsurge in outdoor recreation is already straining facilities in our state and national parks, and in part is the reason for the many bills in Congress calling for additions to our National Parks, recreation and wilderness areas, and wild rivers.

Harking back to a point made earlier, the lands held in the United States (particularly those held by agricultural interests) provide the bulk of possible expansion of recreation in the private sector. About one billion acres of rural land with potential recreational use could be converted to recreation and rural living without seriously encroaching on essential food-producing areas.

Our district records indicate that by June of 1975, 75,213 landowners had established their first commercial enterprise, with a total of 2.5 million acres (1.01 million ha) being converted primarily to recreation. Our records also show several hundred thousand more have expanded or converted in the past decade, involving some 13 million acres (5.26 million ha). In 1975, 1445 individuals expanded their facilities with another 819 beginning operations for the first time.

Constraints

The position of our national association is that outdoor recreation is a marketable product of privately-owned lands that should be regarded as an alternate land usage, along with the production of food and fiber in the multiple-use operation of farms and ranches. Yet there are many constraints on the private sector. Following are a few.

Lack of Data

In 1973, our national association asked the Bureau of Outdoor Recreation (BOR) and SCS to assist us in making a national inventory of private and semi-private recreation facilities. County-by-county, we will have inventoried 38 types of facilities. It is our firm belief that the private sector shoud provide the bulk of facilities while the federal, state and local governments provide facilities that have a wide range of public appeal such as unique recreation areas, national and state parks, etc.

The intent of this inventory is to provide a benchmark of the private sector's contribution, the first time such data will be available. As others have found, the recreation business is highly segmented, and there is no uniform set of statistics dealing with the myriad of private facilities. When completed this summer, it will be helpful to resource managers as well as governmental officials who must make financial resources available for expansion of public recreation systems. This inventory, in part, will answer many of the questions on the private sector and should help in everything from promotion to regulation.

Lack of Attention

NACD was sadly disappointed in *The Recreation Imperative,* the much touted National Recreation Plan, for it was almost devoid of recommendations for dealing with the private sector. Many of the State Comprehensive Outdoor Recreation Plans (SCORPS) do not have a good grip on the private sector, either. Yet, two-thirds of our land is in private ownership—much of it farmland or woodland capable of producing a multitude of recreational uses. In short, planning for the public sector must be related to the private sector contribution in order to determine expenditure of public funds.

Lack of Research

While considerable research and marketing analysis has been done by specific recreation industries, additional research is needed to adequately determine the needs and preferences of people seeking outdoor recreation opportunities. Without that analysis, setting major goals for use of the recreation dollar is a futile effort. As a major constraint, this problem can only be solved by our public research institutions funded to take an unbiased look at the role of the public sector as it relates to the private sector.

Lack of Technical Assistance.

Another major constraint in some elements of the private sector has been inadequate technical assistance for these private entrepreneurs to maximize benefits derived from the use of their resources. There is a wide range of considerations to take into account when deliberating on whether to go into a particular enterprise .... soils, potential market, management of the resource, financial capability, and the like. Many of the recreational programs start out in a small way, an inch-by-inch process whereby a farmer might eventually convert his entire operation. But there are many which are converted in one sweep, thus setting the stage for mismanagement of natural resources as well as financial resources. Without some kind of guidance from technically-trained agencies, we may well wind up with some situations resulting in recreational slums. None of us want that.

What does all this mean to one interested in habitat programs and recreational opportunities? It simply means we are caught in the middle.

We're caught in the middle because we are in a game of world politics involving 4 billion people today and 6.4 billion by the year 2000 if our population experts are correct. That's going to place additional pressure on our land base used for agriculture, and continued pressure for exports. One only has to look back to the last few years to see how quickly agriculture adapts to demands, and as a result, can put millions of acres back into production that had been left to other uses during times of surplus.

We're caught in the middle because we are a dynamic society that is constantly changing. Demographers barely had their statistics together to interpret for highway builders, city planners, consulting firms, and other interests who need to plan for economic and social growth, when reversals started. Births dropped off, the economy went sour and for the first time in decades, areas of the country (mainly rural) were starting to grow.

Resource managers are getting deeply concerned about the 20's, 40's and 80's being sold not to developers but to the young families who want to live out there on the land doing nothing with it in particular. They are concerned because all opportunity for systems management, be it habitat, forest or general land resources, is diminishing. This has a terrific impact not only on wildlife but on planning for land use and the building of recreation facilities.

Another aspect dealing with the dynamics of society has been its reassessment of values which has occurred in the last few years.

The traditional concept of game management and habitat management for game is under attack. Habitat management traditionally dealt with concepts of mortality, principles of production, preserving and sometimes improving habitat conditions for wildlife. The advent of the Environmental Impact Statement and the ecologically-conscient citizen just doesn't let that happen any more—nothing is done in a vacuum. The whole range of ecological considerations and environmental impacts of users must be taken into consideration. Single purpose management for a particular species is a thing of the past. This puts an awesome burden on today's resource managers who find it difficult to manage oneec, let alone a whole host of associated fauna and flora.

This gets us back to the private landowner. If the landowner decides to manipulate his habitat or develop his agricultural land for recreation, he is at a distinct advantage since the range of ecological and environmental considerations are not yet required as with a public agency. Our greatest opportunity, therefore, lies with this entrepreneur—encouraging him through incentives, through technical assistance, and through persuasion to adjust his operation to provide maximum benefits to society. This approach is less costly, less time consuming and is dollar effective.

We ought to recognize this last huge expanse of acreage for what it is . . . . . our last opportunity to work with a limited number of people who have the title to it. They, if approached in the right manner, will be responsible citizens who will be willing to provide wildlife habitat and develop the recreational facilities required for present-day society.

Discussion

CO-CHAIRMAN BARICK: Thank you, Mr. Horvath.

There is a lot in what you have said and there is one thing that I would like to point out.

Insofar as demands for technical services or financial support, rather, in relation to these NACD Programs, various type of government programs, I think, generally, these programs have had a rather dismal record.

I know, for example, in talking with our biologist in North Carolina, they feel that those practices have been established, they are approved, on the books, available in the individual counties but when it comes to the individual landowner selecting which posture and practice he is going to use, invariably he selected those that will have some effect on his production of commercial crops and the other practices are simply ignored.

Insofar as rendering technical assistance is concerned, we have quite a record in North Carolina. We assist some five to six thousand individual farmers per year and what we find now is that we can provide assistance to only those farmers who have an innate interest in wildlife management, hunting and fishing, on their own; not necessarily from the standpoint of making money, but they themselves like to hunt and fish. Therefore, it seems to me that much of the solution to this problem of continuing to provide wildlife habitat improvement on private land, is to sustain the interest of the individual in the out-of-doors and in natural resources. So that, of course, is where we are putting our emphasis. Would you care to comment on that?

MR. HORVATH: Two things.

First, the National Association of Conservation Districts has been fighting for a long time to get a long-term contract program established across the country. We agree with you on principle, that the only way we can keep a man's interest is to provide him with a complete package, perhaps with financing, over a number of years, and continue technical assistance, thus maintaining that man's interest over a period of time.

I have worked in some districts in Pennsylvania, where the district officials have sat down and reviewed a man's cooperative agreement form, and they always had the wildlife manager and whoever else there might be involved there at the same time. What this did was simply alert that particular agency of the man's need and they worked together in the planning process so that wildlife, and forestry would blend in with the man's desire. This gave other resource agencies, not just the Soil Conservation Service, access to landowners.

One of our big faults in the country is that we are not using that access point as a reference point for all public agencies to work toward and thus we do not get the planning process done.

DR. HARMON [Wildlife Management Institute]: Bill, I don't want to say anything to embarrass you because I know some of the figures you use. I am well aware of them and they are pretty generally used nationwide.

You stated that 7 million acres of wetland habitat and about 7.6 million acres of wildlife habitat, more precisely upland wildlife habitat, was now under management on private lands.

I know where the figures come from, which is a running total from year to year. But then I became interested in this for a number of reasons and discovered the figures are really misleading.

The point I am getting at is that in order to have a spirit of cooperation and to make changes and to find out what we need to do, we have to know precisely where we are. These figures have to tell us precisely where we are because, although they are generally thought of as an indication of how much of a particular wildlife habitat we have on a particular piece of land, or nationwide in this respect, the policies that permit the development of the report say that in addition to what the Soil Conservation Service does under their own programs for the landowner, anything else that is within the Soil Conservation District, regardless of who does it, private landowner state fish and wildlife agency, will also be included in that report.

It is conceivable that we have made a few spot checks and, under the report, it is also conceivable that the entire natural wildlife refuge system could be in there. It is not unthinkable that it would be in there. Therefore, figures are misleading in terms of where we are in terms of private land and wildlife habitat.

The point I want to get to in raising this issue is not to embarrass you with figures, but that we have developed a possibility of a 13-state survey to look into this thing in order to get a better feel for the situation so we could make recommendations for program changes either by law or administrative policy, or to view, for example, the farm lands that are drawn up for the landowner that are considered the property of the Soil Conservation District and are not accessible to people who would like to look into programs and go through a program review to establish what the problems are.

Do you see the possibility for NACD to enter into this type of thing and make these records available so that we can find out where we are, where we start from and what we need to do?

There is about $190 million going into these records which are virtually closed off. Now, it seems to me that here would be an area of cooperation where everybody involved could start looking at this type of thing and see where we stand.

MR. HORVATH: I agree with you.

I know these figures come from the Soil Conservation Service. I know we don't have any other figures available. Therefore, what I gave you was really the only source that I have.

The other point I make is that I can understand the request for the kind of information you are saying you want access to. However, I think the access point has to be at the local conservation district level. If the point is made that other public agencies want to work with landowners, I think the districts are quick to respond. That has been my experience—to allow them to have access to the conservation plan.

However, you are talking about it for a different reason. It is strictly a district by district approach and the NACD really has no control over that. I would not know how to go about asking for that. It depends on who would ask for the information and how we go about getting it.

MR. RON KLATASKE [National Audubon Society]: In following up on that credibility aspect in relation to some of the figures used in your paper, you mentioned that 25,000 miles of hedgerows had been planted under the program. I am wondering how many miles of hedgerows are still in existence, especially over the last two decades, when we have lost many thousands of miles of Great Plains hedgerows? Does this just recount all the miles that have been planted over the last 30 to 40 years or does it include the current figure?

MR. HORVATH: Well, under the ACP Program in 1974, we planted a total of eight miles of hedgerows within the entire state. Yes, it is very conceivable that hundreds of miles, possibly a few thousand, were removed during that year. A survey of two counties in Kansas, for example, indicated that during the last 15 years, approximately one-third of the hedgerows had been removed.

This brings up another problem—that is, what can we do to put some long-term direction into the Agricultural Conservation Program?

For example, during the 1950's and 1960's, many hundreds of thousands of acres were restored to native grasslands or planted to other grasses on the Great Plains. Yet, since 1972, a vast percentage, possibly most of that land, has been plowed up again and put into production.

What can we do to assure that the American taxpayer's funds are going to have some long-term beneficial impact for conservation? Well, we are doing something about that. As I indicated, we are constantly pushing for long-term agreements. I think this will help restore some of this and provide some stability to that program.

The second thing we are doing, nationwide, as you know, is that we have been working, since early 1970 and 1973, with the EPA and the Soil Conservation Service and others in helping states develop pollution control programs.

One of the aspects of that control program is a land regulatory function,which simply says "you will have to maintain some kind of conservation practices on the land." That, in one aspect, will, by regulation require mandatory establishment of conservation practices.

We are doing this in some areas at this moment. There are 14 states now which have adopted some kind of program for this purpose and it is being discussed in many more of the state legislatures right now. The only thing that is going to force the issue is a two-way planning process.

MR. RON KLATASKE [National Audubon Society]: I have just one more point. I wonder what we can do to restore some balance in terms of enhancement of the conservation features of land to the program.

In 1974, under the ACP program in Kansas, 13 acres were planted under the Wildlife Habitat Improvement Practice and yet more than 17,000 acres were involved in the irrigation systems improvement program.

How can we get some balance back into this program so that conservation organizations like the National Audobon Society and the Wildlife Management Institute and government wildlife and environmental agencies, can come to your support and seek additional funds for the ACP program?

MR. HORVATH: Well, if you think that is a problem with your organization, let me relate the problem we have. Up until last year, conservation districts did not have a voice in development of a county program, as to what those ACP practices were going to be. Our state soil conservation agency that supervises them, did not have a voice either. Therefore, we sat down with representatives of the Soil Conservation Service and ASCS at the level of Mr. Davis, and we said we would like some changes and they were accomplished.

Last year, Mr. Davis said they really had a voice in it. The memorandum that deals with that still stands and has not as yet been revised. Therefore, we have had our internal problems in relation to soil and conservation fields, of trying to work with the ACP Development Committee.

I would say that this is probably the strongest input point for other organizations—at that county development committee meeting. You should find out where they are and if you have enough people, you should attend to try to influence the way the committee is going to spend the money. I think you are going to have to work at that level.

MR. KLATASKE: We have 150 counties in Kansas. I think all of those have their own county committees and, further, being involved with five states, I find it difficult to attend all of the county program meetings.

However, that is really not my point. My point is that there are federal funds and that we need some federal and state direction in how these funds are spent.

MR. HORVATH: If I had an hour here, perhaps I could go into some of the political processes of Congress, which you are all familiar with. However, the problem is with the way those funds are appropriated and under what conditions.

Somebody in Congress in my state said, "We will go back to the 1970 approach for allocation of funds." That is a political process we have to get at.

MR. McCONNELL [Wildlife Management Institute]: You mentioned, I believe, that the ACP was pushing for long-term contracts. What were you talking about there?

MR. HORVATH: We want to see ACP cost-sharing funds used for a long-term provision to provide funding and technical assistance and guarantee that the farmer can carry out a complete conservation program for his land, whatever it calls for.

MR. McCONNELL: However, the 1973 Agricultural Act provides for a long-term contracts of 3, 10, or 15 years, so that is already in existence.

MR. HORVATH: I understand that, but the point is we have a political problem in talking to the agency that handles those funds. We have not had the movement of funds we need in that area and that is in the political process, something we cannot solve by ourselves.

Providing Habitat for Migratory Birds Through Private Efforts

Dale E. Whitesell
Ducks Unlimited, Inc., Chicago, Illinois

> Civilization marches inexorably on. Agriculture claims vast areas of land heretofore the habitat of wildfowl. The prairie provinces of Canada and the northwestern states have been, and are extensively reclaimed for farming. Waterfowl are driven away from their natural ranges in quest of food and shelter.
>
> No single factor retards the natural increase of waterfowl so much as reduction in breeding grounds caused largely by drainage and water diversion for irrigation. As settlements spread, lakes, sloughs, swamps, marshes and other wet areas, which formerly furnished ample food and nesting areas for waterfowl were claimed, usually for agriculture. Grain production on this continent, chiefly responsible, has grown in excess of profitable marketability.
>
> Drainage of wet areas is not only detrimental to wildfowl in the immediate locality, but frequently affects adjacent areas adversely by lowering the water table, reducing desireable plant growth and increasing fire hazards.
>
> Unfortunately, drainage has been most intense in regions especially adapted to, and frequented by waterfowl.
>
> Clamor to preserve these remaining wetlands, to stop grazing, hay cutting or prevent fires on them will be of little avail if the land happens to be in private ownership and *if such wet preservation is burdensome to* its owner. If he drains his land for an anticipated profit, who can blame him? Having no income from the wetlands, he may get tired of seeing the tax collector come around. (More Game Birds in America Foundation 1931).

Although the words I have just read could easily have been written yesterday, they were in fact written almost 50 years ago. The writer seemed to have an almost prophetic view of the future of wetlands in North America. The writer did not stop with a definition of the problem . . . he proposed some solutions. The following is some of what he said:

> *An international agency,* to be created to increase migratory waterfowl production and to disburse,
>
> *Ample funds,* to be raised by a cent-a-shell tax, supplemented by such governmental appropriations as may be obtained, to promote production expeditiously and with the highest efficiency by acquiring,
>
> *Breeding grounds,* preferably by purchase, wherever they exist or can be restored in the United States and Canada—hundreds of thousands of acres—to be efficiently supervised by,
>
> *Game bird management forces,* to (1) control water levels and provide ample supplies of food and cover, (2) control natural enemies where necessary, (3) prevent fires, stop unauthorized grazing, and suppress shooting on these breeding grounds.
>
> *Refuges,* to be established by the Agency for use of wildlife on northern and southern flights, coordinated with a system of,
>
> *Concentration areas* for winter use.

I submit that a careful analysis of these proposed solutions, conceived almost a half-century ago, will show that they sowed the seeds that eventually blossomed into the establishment of the Pittman-Robertson Act, a greatly expanded role for the U. S. Fish & Wildlife Service, the Refuge System, and the Canadian, U. S., and Mexican Ducks Unlimited organizations. In short, it was a devastatingly accurate definition of the problem, accompanied by a master plan for resolving it, that was adapted ultimately almost in it entirety, although in varying forms.

Who were the prophetic people that made these proposals? They were the organizers of the More Game Birds in America Foundation—the forerunners and founders of Ducks Unlimited, Inc. The More Game Birds Foundation described itself thusly:

> . . . a non-profit organization, national in scope, sponsored by some of the leading businessmen in the United States. Among its supporters, growing steadily in numbers, are the sportsmen of little and big means. These men are giving liberally of their time and money in an endeavor to work out a satisfactory solution of our game bird problem.
>
> The founders are appalled at the economic waste which has resulted from the depletion of one of our great natural resources—game birds. They believe that by applying *sound business methods* to the problem, and by learning from the experience of other countries which have been faced with an identical problem and solved it satisfactorily, that a substantial and permanent increase in game birds in this country can be obtained. This will create, and assure for the future, greater opportunities for recreation, sport, and enjoyment of the great outdoors; a new and great industry supporting thousands; and increases in rural land value and a new source of income for our farmers.

So, back in 1931, when this continent was in the grips of a devastating drought and a ruinous economic depression, it was the *private* sector that was actively developing a plan for saving our wetlands . . . complete with a plan for funding it. As you know, I am here to talk about providing habitat for migratory birds through private efforts. However, realizing that a good many of the "public" or governmental programs for providing habitat were first put forth by the private sector, and were funded by taxes on individual sportsmen, requested by themselves, and other users of the resource, I must admit that I find it difficult to neatly separate private effort from public. I am reminded of the old saying that government can't give you a thing until it first takes it away from you . . . because government is you.

Today, we have even greater cause to be concerned about the future of our continent's wetlands. One hundred twenty-seven million acres (51,435,000 ha) of wetlands once existed in the contiguous U.S. A 1964 inventory indicated that 2.7 million acres (1.09 million ha) of the most productive wetland types remained in the prairie pothole regions of the Dakotas and Minnesota. Surveys between 1964 and 1968 in the same area indicated a loss of nearly 2 percent annually (U. S. Fish and Wildlife Service 1975).

According to a 1970 USDI study, 73 percent of the Nation's estuaries have been moderately or severely degraded. During the 1960's an average of 200,000 acres (81,000 ha) of bottomland hardwoods were cleared annually in the lower Mississippi River region. There are other statistics, equally disturbing, that could be quoted. Suffice it to say, our North American wetlands are at the crossroads—and the momentum is not in favor of their survival.

Let's examine for a moment, the programs of those groups and organizations that are dedicated to the preservation of those wetlands. The National Wildlife Refuge System encompasses approximately 1,611,000 acres (652,455 ha) of waterfowl production areas. State Conservation Agencies control approximately 4.5 million acres (1.82 million ha) of land and water "having major value to waterfowl." Privately owned waterfowl hunting clubs—some 11,000 of them in the U.S.—control a minimum of 5.2 million acres (2.1 million ha) of land. An additional 400,000 acres (162,000 ha) of wetlands are owned or leased in the U.S. by private conservation organizations (U.S. Fish and Wildlife Service 1975).

Ducks Unlimited, an effort funded by U.S. sportsmen, has control of 2.2. million acres (.89 million ha) of wetlands habitat in Canada, where over 70 percent of the waterfowl on the North American continent originate (U.S. Fish and Wildlife Service 1975).

In view of these statistics, I submit that it will be private effort—or lack of it—that will spell the future of our wetland resources. I further submit that the deciding factor as to whether or not that effort is forthcoming is the *incentive* that we are able to provide for investments of time and money in these wetland areas.

According to the U.S. Fish and Wildlife Service, the following would occur if just the hunting incentive were removed:

> Approximately 7 million acres (2.83 million ha) of wetland habitat is currently maintained by private waterfowl hunting clubs and Ducks Unlimited. This habitat is preserved and managed for migratory birds. These organizations are supported primarily by hunters and termination of migratory bird hunting would result in a major reduction if not a total stoppage of these habitat maintenance activities.
>
> Private landowners could be expected to convert at least a portion of the 5.2 million acres [2.1 million ha] of lands currently devoted to migratory bird habitat to such uses as water-oriented recreation, housing, industrial development or crop production. A significant portion of the 2.2 million acres [.89 million ha] of nesting habitat in Canada managed by Ducks Unlimited would in all probability be converted to other uses.
>
> Migratory bird habitat managed by States would be managed for other wildlife such as small game and big game species.
>
> The sale of duck stamps which annually results in the Federal acquisition and protection of 115,600 acres [46,818 ha] of waterfowl habitat (1970-74 av.) would cease.
>
> State wetland acquisition and preservation programs are strongly influenced by the numbers of waterfowl, hunter interest and hunting regulations each year. For example, during a drought period in the late 1950's and early 1960's when the continental waterfowl populations were low and regulations restrictive, only 11 states were acquiring waterfowl habitat. This compares to 35 states that purchased nearly seven times as much habitat in 1959 following several years of comparatively high waterfowl populations. Termination of migratory bird hunting would result in nearly a total halt of these conservation efforts (U.S. Fish and Wildlife Service 1975).

I refer again to those conservation pioneers, the More Game Birds in America Foundation, who in their visionary proposals for preserving our wetlands, endeavored to apply "sound business practices" to the problem. One concept they as businessmen understood, was that there is no such thing as a free lunch. It would, perhaps, be ideal if we lived in a world where everyone recognized the importance of our wildlife resources and agreed on the right of every human being to a "quality" experience in the field, whether hunting or otherwise enjoying the resource. But that is not the world we live in. Those of us who do want adequate wildlife populations understand that we must first have adequate habitat. We must further understand that provision of the habitat—by private means or otherwise—costs money. Therefore, something must be given in return for that money. There is no such thing as a free lunch; there is no such thing as a free hunt.

What do I propose be given? As I said earlier, proper incentives. Most important among these, where waterfowl is concerned, is the incentive of a reasonable hunting opportunity. On this point, I refer you back to the remarks of the U. S. Fish and Wildlife Service, concerning the possibility of eliminating the waterfowl hunting season. Some of the other incentives the U. S. might offer the private habitat owner are:

- Ability to have his own hunting areas in exchange for the production of his wetlands.
- Ability to get a vastly lowered tax bill, or one paid for him by others, if his wetlands remain in production.
- In return for the ability to control water levels, the farmer or donor receives drought and flood protection, water for irrigation, stock water, and other agribusiness benefits that benefit him while his wetlands remain in waterfowl production.
- Ability to make money in one of many ways, to name a few:
  (A) Fish as a cash crop, or for personal or business recreation.
  (B) Increased fur harvest.
  (C) Private hunting, or business hunting use, plus a variety of other uses.

Incentive is the key ingredient if we are to retain our private wetlands in America. Deriving the exact one, or combination or incentives, should be carefully examined.

In closing, I should like to bring one other thought into this discussion. The More Game Birds in America Foundation made another observation a half-century ago. They said this:

"To establish breeding grounds, refuges and winter concentration areas for migratory waterfowl without setting up a completely effective system of management is to squander money and invite disaster . . . In short, we will be right back where we started, and all advantages gained by the creation of breeding grounds, refuges and concentration areas will be dissipated."

I fear that that exact situation, particularly in the case of publicly held wetlands, exists today. While Duck Stamp funds can be used for wetland *acquisition*, where will the money come from for the development and management of these areas? Is there room for some thinking here about an incentive that would result in massive infusions of private dollars into the development and management of government refuges?

I would merely reiterate my belief that the future of wetland habitat on the North American continent is in private hands. It should be our mission to properly motivate these hands.

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Discussion

CO-CHAIRMAN BARICK: Thank you, Mr. Whitsell, for focusing on some of the facts of life with regard to waterfowl management.

I was particularly intrigued by your pointing out that, should there be a termination of hunting, it could have a serious impact on the support of the private sector and on habitat maintenance and acquisition.

Does anyone have any questions or comments of Mr. Whitsell?

MR. WILSON [North Carolina]: This was an excellent paper and thank God for Ducks Unlimited.

There were also many years when I said "Thank God for the Soil Conservation Service." When I was given the assignment of making a wetlands survey of the coastal lands of North Carolina, I thought back to when Dr. Hugh Bennett first introduced soil conservation—where land was saved from eroding into gulleys, but at the present time the SCS has their eyes on channelization.

Now, Mr. Davis, I don't mean to attack you, sir, but it would seem to me, at least from the 1950's, when you made your survey, there has been tremendous damage done to our wetlands, not only by the Soil Conservation Service but by the Corps of Engineers. I have in mind the Great Dismal Swamp which, I believe, private people and maybe even the United States Government is going to buy. There were vast channelization areas in there and that lowered the water level in some areas from 20 to 40 inches and, in turn, ruined wonderful waterfowl habitat in that area.

In relation to what has happened and what has taken place to this date, I just cannot understand why one agency, ours, was trying to save these lands and others were destroying them. Perhaps it was that these others just were not recognizing the problem. It just seems to me we are disorganized somewhere. Therefore, would you like to comment on what I have said?

MR. DAVIS: Of course, I appreciate what you say. Many aspects of this have been under discussion for a long period of time and there is controversy and conflict between agriculture and wildlife, as I indicated in the paper I presented.

My other comment is that we know what is going on, even today, but, in relation to our policies, we have not provided technical assistance on anything other than Type 1 and Type 2 wetlands as described in Circular 39.

We are seeing, I believe, on the coast of North Carolina, more drainage activity going on than what we were assisting with in some of those areas. We see this as a trend of the times, but I would hope that you, us and others can have some influence on these things.

My people tell me that now in North Carolina, there is more activity under our restricted policy than there was before. I don't know if that is true because I have not been on the coast recently, but I did have a group go in and take a look at some of this.

CHAIRMAN NELSON: Thank you, gentlemen, for being with us. Our various speakers have given graciously of their time to inform us with respect to these various topics. I also wish to thank those who have provided the discussion.

This concludes our presentation and discussion. We are now adjourned.

Meeting Demands for Resource Management Information and Services

Chariman:
RUTH C. CLUSEN
President
League of Women Voters of the United States
Washington, D.C.

Cochairman:
JAMES G. TEER
Head, Department of Wildlife and Fisheries Sciences
Texas A & M University
College Station

Trends and Future Problems in North American Outdoor Recreation

John S. Marsh
Department of Geography, Trent University, Peterborough, Ontario

This paper aims to consider some aspects of the future of outdoor recreation in North America. It is divided into four sections. The first section examines the changing basis of recreational demand. Section two deals with the changing supply base available for the satisfaction of outdoor recreation demand. The third section presents evidence of some recent trends in participation in selected outdoor recreation activities and future recreation preferences. The final section considers the implications of some current trends, future recreation possibilities, and some likely problems. Given the lack of data, and the nature of forecasting, the paper deals with recreation on a variety of scales and reflects methodologies from the scientific to the speculative.

The Changing Basis of Recreational Demand

The trends and patterns of outdoor recreation in North America can best be explained by reference to the basic forces of supply and demand (Clawson and Knetsch 1966). On the demand side, on a theoretical national basis, population size, age and ethnic structure, and distribution will be important influences on recreation patterns (Beaman 1974). Other factors include the amount and distribution of leisure time, the amount of disposable income and economic conditions, individual mobility, and attitudes to work and leisure.

Both in Canada and the United States, a continued if gradual rise in population is usually forecast. It has been predicted that the population of Canada will grow from 21.6 million persons in 1971 to between 28.7 and 31.4 million in 2001 (Canada 1974). For the United States it has been predicted that the population will grow from 203.2 million persons in 1970 to between 290.9 and 361.9 million in 2000 (U.S. Bureau of the Census 1965). Regardless of whether one accepts the high or low forecasts, this suggests on a simplistic basis, that Canada will experience a minimum increase in recreational demand of 33 percent, and the United States an increase of at least 43 percent over this 30 year period. A policy in either country regarding population growth, an optimum population, or immigration will clearly have an important impact on recreation demand and planning. It is to be hoped that recreation planners will have some say in the development of any such policies.

Not only will population be increasing, but, as the post World War II baby boom matures, it will be aging. In Canada, it is predicted that the percentage of people over 65 years will grow from 8.1 percent in 1971 to between 10.3 percent and 13.1 percent in 2001 (Statistics Canada 1974). Obviously, we should already be paying much more attention to the provision of recreation for persons in this age group, as well as catering to the increasing numbers of younger people.

Critical to the provision of recreation facilities for a growing population of changing structure is an understanding of the future spatial distribution of that population. Most forecasts suggest that both Canada and the United States will witness continued urbanization. In Canada, in 1971, 16.4 million persons were classified as urban and 5.2 million as rural (Statistics Canada 1974). By the year 2001, it is expected that the Oshawa-Toronto-Hamilton area will have grown from 3.3 million persons to between 5.6 and 6.1 million (LePage 1975). Vancouver and Montreal will be the other major growth areas, with the three megalopoli accounting for about 80 percent of Canada's population in 2001.

In the United States, a similar pattern of urbanization has long been apparent. By 1960 only 5 percent of the United States population resided outside commuter zones. The terms Boswash, Chippits and Sansan, signifying the three major megalopoli, have now become commonplace (Kahn, Wiener 1967). A population exceeding 60 million in both the Atlantic Seaboard and Great Lakes urban regions, and 40 million in California, has been forecast for the year 2000 (Pickard 1967).

As travel is a key element in many recreation activities, an understanding of the future mobility of the population is crucial to developing a satisfactory pattern of services. In the past, Americans and Canadians have become more mobile every year, with the car being the dominant mode of recreational travel. Vacations have often been described in terms of mileage and the widespread pattern of recreation facilities has developed in response to high, cheap, individual mobility. Evidence regarding the impact of higher gasoline prices on recreation travel is presently inconclusive. It has been noted that "since 1971 summer travel by Canadians to destinations in Canada in terms of person-trips has increased at an average annual rate of 13.1 percent (Statistics Canada 1975). The auto remained the dominant mode of recreational travel from 1971 to 1974, accounting for 84 percent of all person-trips, despite inflation, energy costs, speed limits and economic constraints. It is interesting to note, however, that the study of participation in seventeen outdoor activities in Canada for the years 1969 and 1972 showed a 14-15 percent decrease in driving for pleasure by residents of the metropolitan areas of Montreal, Toronto and Vancouver (Rousseau 1973).

The future amount of leisure time and attitudes toward it will also have an impact on the level of recreation demand. A recent study of recreation behavior in Ontario showed that lack of time was the major constraint inhibiting increased participation in recreation (Ontario 1974). In the United States the work week fell from 50 hours in 1920 to 40 hours by 1965, and may have declined somewhat since then (Clawson, Knetsch 1966). However, a labour study in Canada revealed that the average work week of 40.4 hours in 1972 was hardly declining, workers apparently preferring higher pay or longer vacations to a shorter work week (Canadian Labor Dept. 1973).

Perhaps of more significance, therefore, in future will be the changing distribution of leisure time. The working week may not decrease but people may opt for more long week-ends and longer vacations. People with larger segments of leisure time and more vacations will perhaps travel further and more frequently to the countryside and abroad. Profound changes in recreation demand would result from changes in the school year and statutory holidays, which presently markedly influence recreation behavior.

In the post World War II period we have witnessed a decline of the work ethic (Strom 1975; Davis 1970). Far from feeling that "the devil finds work for idle hands" we are now tending to regard leisure as a civil right. Such a right is certainly endorsed by government through legislated work hours and holidays, and by psychologists and health workers (Brightbill 1960). On the other hand, economic problems, a concern for rising unemployment costs and falling productivity, combined with the more traditional reverence of work may abate the trend towards a new respectability for leisure.

Another key factor, changing recreation demand, is the women's liberation movement. The increased employment of women in the work force may reduce their leisure time but increase their disposable income for recreation. Changes in attitude may also be leading to greater participation in traditionally male recreation activities.

As most recreation involves expenditure, the future amount of disposable income will obviously influence recreation trends and patterns. Present economic constraints, coupled with factors like rising energy costs are curtailing some recreation activities, such as air travel. However, it is unclear how elastic is the demand for recreation services amongst people who have moved towards regarding recreation as a right. A current feature of recreation spending that has future implications is the expenditure of more money now rather than later, on travel for example, as a result of perceived escalating prices (Sigurdson 1976).

To summarise, I would suggest that the future overall demand for recreation will be particularly dependent, in terms of quantity and type, upon population growth and structure and public and governmental attitudes to leisure; and in terms of location, on the urbanization trend and changes in mobility.

The Changing Basis of Supply

On the supply side of the recreation equation, we now recognise the finite nature of resource-based recreation opportunities, in terms of area and carrying capacity. We have yet to achieve the optimum utilization of such areas through the efficient distribution of visitors in space and time and we are relatively ignorant of the degree to which recreation resources can be developed to increase use without deterioration. Furthermore, we have yet to fully explore the potential and substitutability of artificial environments for recreation. The tendency has been, until recently, to cope with increasing demand for outdoor recreation by supplying more acreage.

In Canada, recreational land administered by federal, provincial and municipal governments has increased over the years. The national park system expanded considerably until 1930 and then again with new initiatives in the late 1960's (Table 1). However, the final scope of the system is now officially recognized and much of the expansion necessary to achieve this will not be in accessible areas, and will not be with recreation as a prime motive (Canada 1971). Thus, much of the increasing demand for national park and wilderness landscapes will be focused on existing national parks.

Table 1. Growth of National Parks in Canada[a]

Date	Total no.
1885	1
1900	4
1930	14
1960	18
1975	28

[a]Adapted from Canada, Government of. 1972 Special places. National and Historic Parks Branch, Ottawa.

The Ontario Provincial Park system has also grown in response to recreation pressure (Table 2). However, the abrupt expansion, from 3 to 10 million acres, in the late 1960's, has now levelled off (Ontario Ministry of Natural Resources 1975a). It should be noted that much of this expansion is also in areas remote from major population centers.

Table 2. Growth of Provincial Parks in Ontario[a]

Year	Parks	Acreage
1960	72	3.4 million
1962	81	3.5
1964	88	3.7
1966	92	3.8
1968	96	3.8
1970	108	10.2
1972	115	10.4
1974	117	10.5

[a]Adapted from Ontario Ministry of Natural Resources. 1975. *1974 Statistical report, Ontario Provincial Parks*, Toronto.

In the United States, the largest area of federal land available for recreation is administered by the Forest Service. The acreage of national forests expanded rapidly until 1910 but has grown relatively little since then. The national park system experienced a steadier growth until 1950, but again has grown little in the last decade. In terms of area, we appear to be reaching a limit that will be hard to exceed. While some new areas may be set aside, in many cases this will really mean the institutionalizing and guaranteeing of areas already used for recreation.

In both countries, however, there is still a tendency to see the north as an expanding recreational frontier that will satisfy the growing recreation demands of southerners (Butters 1972). While Alaska and northern Canada do have some potential for recreation it is severely limited by physical, climatic, cost and accessibility factors (Lotz 1972). Recreation use is increasing in the north and new facilities and recreation areas are being established, but they will by no means satisfy the growing continental demand for recreation opportunities.

The marine fringe of North America is also seen as a place for expanded recreation (Schultz 1967; Miller 1967). Again, there is potential for expanded use, and the projects of the Japanese in this respect warrant our attention (Marsh 1970). However, the nature of the marine environment, especially in Canada, precludes its large scale use for outdoor recreation (Marsh 1971).

In both countries the supply of urban recreation space and facilities is also being increased. In Canada, cities such as Toronto, Calgary and Edmonton have made determined efforts to acquire more open space, often involving new cost-sharing arrangements. The trend towards a re-evaluation of waterfront and defunct railway lands within cities, such as Toronto and Vancouver, is encouraging. There has also been the expansion of artificial and sometimes novel recreation environments ranging from stadiums to Ontario Place in Toronto, and the Triforium attraction in Los Angeles.

The middle part of the recreation supply spectrum, the settled countryside, is also now receiving greater attention as a place for expanding recreation opportunities. The European experience in utilising the countryside for recreation certainly merits attention here (The Countryside in 1970, 1965). In Canada, the federal-provincial Agreements for Recreation and Conservation program launched in 1974 is an example of a new initiative in developing countryside recreation (Canadian Department of Indian and Northern Affairs 1975).

Having detailed some of the changes in the recreation supply base and some areas of future potential, I would like to comment briefly on some factors likely to limit expansion.

First, we must recognise that expansion of recreation areas in one place may be counteracted by losses elsewhere. Presently, for example, while St. Lawrence Islands National Park is being expanded, there is the possibility of part of Wood Buffalo National Park being returned to the native people for their use, which may include mining.

Second, we may find existing recreation land is deteriorating through overuse or pollution, hence while the acreage remains constant its ability to satisfy demand falls. In assessing the supply base, therefore, we must continually monitor its character and quality.

Third, in a world facing increasing pressure on resources, even in countries where recreation is regarded as a civil right, it will be difficult to acquire and retain land that has potential for mining, lumbering, farming, housing, reservoir and communications development. In Canada, it is increasingly difficult to acquire land for national parks without accepting some infractions of parks policy. There is also outright opposition to national park development; the case of the proposed Ship Harbour Park in Nova Scotia being an example. National priorities and cost will often preclude the expansion of recreation areas and these factors may be especially the case in urban regions where additional recreation space will be needed most.

Fourth, our ability to acquire more recreational land will depend very much, in view of the costs involved and alternative uses sacrificed, on the policies and financial assistance of governments. While governments have gone a long way, since the Outdoor Recreation Resources Review Commission of 1962, towards giving recreation higher priority, in times of economic constraint it is hard to imagine that recreation will have budgetary precedence over housing, education, health provision, communications and defence. Furthermore, as Clawson and Knetsch note (p. 300), "decisions to allocate or to refuse funds for a public activity are made by political processes." Public attitudes, and the degree to which recreation provision can be made an election issue, will thus be crucial factors influencing the supply base.

Finally, I would suggest that Parkinson's Law may prevail in the recreation supply field, as elsewhere. This suggests that increasing recreation supply is likely to increase recreation demand or, to invert a proverb, that "invention is the mother of necessity." We must always ask, therefore, if the provision of a new facility will merely aggravate demand, and place undesirable stresses on other parts of the recreation system, such as highways. More research on this topic, and in the determination of latent demand for various activities, seems essential if forecasts of the future required supply base are to be accurate.

While no precise quantification of the recreation supply and demand equation has been attempted it seems reasonable to anticipate growing but changing recreation demand and slow, limited, costly growth in the supply of resource-based recreation areas. As this is a non-operational conclusion, that affords few specific guidelines for planning and management, a closer examination of some recent recreation trends now follows.

Recent Recreation Trends

As a starting point for an examination of trends in outdoor recreation I referred to the Canadian Outdoor Recreation Demand Survey. One publication details participation in a variety of outdoor activities based on surveys in 1967, 1969, and 1972 (Rousseau 1973). Of the eight activities for which data are comparable, seven show an increase in incidence of participation, with three (power boating, canoeing and snowmobiling) showing a continual increase, and one (hunting) showing continual decline (Table 3).

A breakdown of participation in the eight activities by age shows decreasing participation with age. As we anticipate an aging population we might also anticipate a decline in per capita demand for these activities, other factors remaining constant. However, this will probably be offset by a general rise in the population as indicated.

That participation in tent and trailer camping is increasing is supported by recent observations of the author and other information presented below.

Some data is also available on trends in attendance at various public recreation areas such as the Ontario Provincial Parks (Ontario Ministry of Natural Resources 1975). Visitation to these parks rose from 5.7 million in 1960 to 11 million in 1974 but reached a peak of 13.7 million in 1971, and thereafter declined each year. The lack of a decline in campers and camper days from 1971 to 1974 appears to support my earlier contention about such activity.

Table 3. Percentage of Canadians 18 years and over who did participate in 8 outdoor recreation activities in 1967, 1969 and 1972[a].

Activity	1967	1969	1972
Tent-camping	14	12	19
Trailer-camping	7	6	10
Hunting	14	13	11
Power boating	15	19	23
Canoeing	5	8	10
Snow skiing	6	7	7
Snowmobiling	7	14	18
Picnics/cookouts away from home	42	54	54

[a]Adapted from Rousseau, S. 1973. Trends in participation in outdoor recreation activities. CORD Technical Note 22. Parks Canada, Ottawa.

The common belief that wilderness use is increasing is supported by data on interior camping in Algonquin and Quetico parks. In the former there were 23,765 interior campers in 1962 and 66,524 in 1974. In the latter park, which is largely used by United States residents, the number of interior campers increased from 15,000 in 1962 to 35,932 in 1974.

Data on the ownership of recreation facilities and equipment may also be indicative of recreation trends. Despite increasing costs of cottage land, and a limited availability of sites, the appeal of cottage ownership appears to have been maintained in recent years. Since 1960, in Ontario, there has been an average 3.7 percent increase in hydro-serviced cottages 95,196 in 1960 to 153,392 in 1973 (Ontario Ministry of Industry and Tourism 1975).

Changes in the ownership of boats from 1971 to 1974 suggest that canoeing is expanding very fast. In 1971 there were 66,000 Ontario households with canoes, but by 1974 the number was 102,000, indicating a 22 percent annual growth rate (Ontario 1975). Ontario household ownership of overnight camping equipment has also increased, by 12 percent annually, over this period. Ownership of trailers actually increased 100 percent from 1971 to 1974 in Ontario, thus confirming the trend to self contained accommodation I mentioned earlier (Ontario Ministry of Industry and Tourism 1975).

Another approach to forecasting recreation demand is to ask people what activities they would like to indulge in more frequently and in what new activities they would like to participate. A recent Ontario survey indicated that, of those activities already undertaken, swimming, fishing, camping, golfing and travelling ranked highest as the ones in which more participation was desired (Ontario Ministry of Industry and Tourism 1974). Of activities not yet undertaken, flying/skydiving, waterskiing, skin/scuba diving, sailing and downhill skiing were ranked highest as the ones in which participation was desired.

Future Implications, Possibilities and Problems

As indicated, data on actual trends in recreation demand are severely limited and rarely amenable to valid extrapolation. Accordingly, I am obliged to venture away from the scientific approach to the future to the more speculative, but hopefully this will provide some insight into future recreation patterns and problems.

First, let me consider the recreation implications of an energy conserving society. As travel is a key element in many recreation activities an understanding of the future mobility of the population is crucial to the development of a satisfactory pattern of facilities.

Given rising travel costs, one might anticipate that people will travel shorter distances, but on the other hand people may travel the same distance but less frequently. Alternatively people may reduce their travel costs by using smaller cars or public transportation. If gas prices continue to rise, even public transport may prove too expensive for some and travel will decline. The degree of people's willingness to make budget cuts to allow them to maintain their traditional recreational travel patterns is unclear, but may be quite strong, especially if they have invested in a cottage or have relatives at a particular destination. If people's recreational travel field is curtailed this will place a greater demand on those places that are more readily accessible from the city, and within the city. Urban growth will emphasize this process.

Assuming intensified urbanization but no reduction in mobility, I would suggest two patterns of behavior may emerge. First, the city dweller may wish to "escape" to the countryside, parks and wilderness in ever increasing numbers. Second, I suggest that as people become more urbanized and if cities become more attractive, they may lose interest in the countryside and seek satisfaction within the city. I have witnessed a tendency for people who move to big cities to leave them less than they anticipated. If the desire to leave the city is curtailed by cost and congestion then the attraction of city recreation will be emphasised.

One can perhaps envisage a city population well satisfied with passive recreation, such as sport and entertainment, bolstered by alcohol and drugs, along the lines suggested by Huxley (1932). The wilderness that people fought so hard to preserve might then lie largely unused.

Disneyland and Ontario Place indicate something of the potential for satisfying recreation demand in highly artificial environments. Maybe electronic communication will render travel obsolete, and simulated environments will be created in one's home thus eliminating the inconvenience of travel (Berry 1970).

I should now like to discuss the trend towards the planning and regulation of recreation. Definitions of recreation frequently include the words 'freedom' and 'choice.' Recreation is apparently sought after because unlike work, sleep and household chores it affords greater opportunities for choice, for experiencing a sense of freedom, for indulging in activities spontaneously. If such attributes are essential to recreation quality then we must ensure that they are not sacrificed in the future.

I contend that in a world of increasing pressure on resources, it is felt necessary to plan and regulate behavior to achieve optimum use of resources. This tendency is clearly apparent in Canada, being recognized in many sectors including recreation. In Ontario, a Ministry of Recreation and Culture was recently created. The management techniques in the new Algonquin Provincial Park master plan are indicative of a perceived need to regulate behavior (Ontario Ministry of Natural Resources 1975; Marsh 1975). The size of canoe groups is to be limited and quotas will be established on certain routes. On parts of the

Appalachian Trail clothing and equipment must be approved by the rangers. In the national parks you must register to go backpacking, climbing and canoeing. Increasingly, certification is developed for sports, and certificates are required for participation, for example, to get air tanks filled for scuba diving.

We are also witnessing the standardization of our recreation services and facilities; indeed the concept of standards is basic to much recreation planning (U.S. Bureau of Outdoor Recreation 1967). Kenya's national park signs look just like Canadian ones and the American picnic table is becoming a universal recreation artifact. Standardization and regulation may save money and increase efficiency, but will a high quality recreation experience that calls for freedom, spontaneity, choice, variety and challenge result? Surely we need some areas, apart from outer space and the oceans, where man can escape the regulated, homogenized, predictable and secure environment of everyday life.

Recent research using the Delphi technique may throw more light on the future of the wilderness recreation environment (Shafer et al. 1974). Some 405 experts in ecology, natural resources management, and environmental pollution predicted the timing of various events and the median date was calculated for each.

According to these experts, by 1980 computers will be used to advise recreationists where to go for recreation; by 1985, recreationists will accept restrictive management procedures to maintain and preserve vegetation, water quality and wildlife; and cable TV will be available at most campgrounds. By 1990 there will be acceptance of wear-resistant footpaths, electronic guide systems, and fences to allow increased use without environmental damage. The year 2000 will see remote sensing devices to monitor park use, and air transport, underground rapid transit, tramways and cable cars used in large parks. Certification of wilderness users and permits to control all resource-based recreation will be required. In 2050 the last wilderness will be designated but after that date some land will be withdrawn from wilderness status. Robots will be used for park maintenance and public information programs, one-man low-speed helicopters will be commonly used for transportation within wilderness areas, and the first park will be established on the moon. If we don't like such a future we might remember that first, experts have been wrong, and second, the choice is ours.

Certain trends today encourage me to speculate on the future of history, or more precisely, restored or simulated artifacts, as a recreational resource (Marsh 1975b). We are caught, in these insecure times, in a wave of nostalgia, and there is a wide variety of evidence of increasing interest in historical events, places, artifacts and rituals. Preservation of the past for educational, cultural and recreational reasons is being encouraged by numerous individuals and agencies. In Canada, the federal Historic Sites Branch has conducted a country-wide survey of buildings to identify those worthy of preservation. Towns, like Port Hope, Ontario, are preserving whole blocks of buildings from the last century, and in some places, like Heritage Park, Calgary, old buildings are assembled on a new site to create a historic town. Individual structures like London Bridge, on Lake Havasu in Arizona, have become foci for recreation. Ghost towns like Barkerville, British Columbia and Virginia City, Nevada may also become gold mines based on tourist expenditure.

Such activity poses many problems. What should be preserved and how? Are preservation and recreation compatible? Is authenticity important or is simulation acceptable?

Our pursuit of the past is now leading us beyond the mere preservation of artifacts towards the preservation of cultures, life styles and crafts. There is a tendency to populate historic buildings with people in period costume, engaging in historic activities. Where such places operate year around, full-time employees can conceivably spend much of their time living in another time period; they have entered a kind of time machine.

In some places the visitor is encouraged to become a fellow time traveller. In Ireland, visitors can indulge in medieval banquets, while in England a group known as the Sealed Knot re-enact Civil War battles, that attract crowds of participants and spectators (Bradley 1972).

There are signs that many people will wish to go back in the future either as participants or spectators. Nostalgia, preservation, and re-enactment appear to be growth industries in North America, with many recreational implications.

Conclusion

In this paper I examined recent changes in the basic factors governing recreation demand, identified some trends based on current data, and discussed some implications, possibilities and problems relating to the next hundred years.

For reasons of conciseness it was necessary to omit much supporting evidence and data but some sources of information are indicated in the references.

I will conclude by suggesting that recreation and natural-resource planners and managers should anticipate a continued growth in recreation demand in North America, the emergence of new activities and a concentration of demand in the urban region. Critical problems regarding the role of government in recreation and the dilemma of regulating and standardizing recreation for efficiency, while at the same time maintaining freedom, choice and spontaneity in the recreational experience remain to be solved. While we should persevere with data collection on existing activities, trend analysis and extrapolation, we should beware of surprise technologies and activities and should encourage speculation that will allow us to identify choices of recreational futures.

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Discussion

CHAIRMAN CLUSEN: In a sense I represent the public view in this and I would like to ask a question which is raised by your last remark.

I cannot conceive of how a Canadian, in this time and place, can talk about pressures on recreation without making recognition of the fact that two major international and global events are going to happen this year which will put a great strain upon Canadian and, indeed, North American recreational opportunities.

One, of course, is the Olympics, which I am not as concerned about but I think almost nobody in the United States knows that there will be a major United Nations Conference in Vancouver in late May and early June which deals with habitat—where people live and how they handle living in areas without spoiling them and vice versa. This is to be discussed in a conference in Stockholm at some later date.

DR. MARSH: If I could respond in particular to the second because that is the one that concerns me the most, and so far I have not seen any satisfactory resolution of this problem.

It seems to me that a lot of people are avoiding public recreation areas because the regulations are intolerable to them. This is apparently true in some of the Canadian National Parks which people are avoiding because they do not want to be protected and regulated in the way that others feel is necessary in these parks.

At the same time, when I argue against regulation people always respond, "Well, what happens when you have thousands and thousands of people destroying the environment because we don't have some sort of regulation?"

It seems to me that the problem has to be tackled sooner than at the recreation site; before a person gets to where he is indulging in the recreation. This requires the educating of people against overrunning various recreation areas—in other words, one tries a policy urging voluntary restraint. Unfortunately I think any sort of educational program takes a long time. Furthermore, I am not convined that this sort of voluntary restraint can be brought about within even one generation. So I would appreciate any feedback from people who feel that regulation is necessary but undesirable. I would like to hear from anyone who has any other solutions.

MR. TONY PETERLE [Department of Zoology, Ohio State University]: About 1950 or 1951, we surveyed approximately 4,000 hunting-license buyers in Ohio, and we completed a resurvey of 600 of those people who are 14 years older. We surveyed 1,000 nonhunters and new hunters.

With data collected throughout the 14-year period—and I might say I agree with you on some of the points in the evidence you have chosen—it is indicated they are changing their recreational options as they became 14 years older.They hunt less, fish less, and kill less. They are less willing to fish than they were 14 years ago.

They are still going to the same hills to participate in the same sport—to hunt—and the hunters in this sense, as far as I am concerned, are becoming less sympathetic to the sport in terms of being conservation-oriented as a result of being 14 years older.

Incidentally, the nonhunters participate more in golf than the hunters.

MR. WILLIAM GODFREY [Boise, Idaho]: I serve on the Idaho Fish and Game Commission. Where does all this leave Idaho?

Perhaps the best way to say it is that as we plan and develop for Idaho, it evidently is a lot different than what you do in Ohio and a lot different than what you do in Petersborough.

Did Ohio manage its status quo in the 1950's or 1960's?

What I see here, as you folks move toward your electronic apparatus, is resistance and rigidity towards that sort of thing in the environment we have. Those who want to get back to that sort of thing will migrate.

CHAIRMAN CLUSEN: I'm afraid they will migrate faster.

MR. GODFREY: What do you see in the future for the mountain states? Let's talk about Montana and the Alberta area. Let's move North into your country, Canada. Let's talk about the primitive areas of Idaho. What do you see happening in there?

DR. MARSH: I think it is very difficult to pin some of these trends down to a particular place, and in many ways I tried not to. Presumably if I had talked about Ontario all the time, some would have found it irrelevant in the general situation, or elsewhere.

I have been primarily interested in the mountain areas of the Canada. I have done most of my work in the Rockies. What I see happening there is continual growth of recreation demand at a few specific points, and an overloading of some of these points.

An interesting development in the last few years is the growing attention to the front range of the Rocky Mountains in Canada, which previously everyone has driven past on the way to Banff. They ignored what was largely a wilderness. I think this new interest has largely come about as a result of the growth of Calgary and Edmonton. It is a reflection of the urban demand in that particular area.

What is happening now is an attempt to plan the use of the front range effectively, having a multiple use plan with development of a number of very highly-capitalized resorts for skiing and for some other recreation, and the development of a wide range of family-oriented facilities, while at the same time managing for timber production and other land uses.

I think a lot of the pressure that is on that area, however, is going to come from tourists. The interesting thing is whether the energy crisis will curtail the number of people traveling as far as that particular place. Obviously at present in the summer the people are coming from great distances.

Although they are from the western states, they are traveling a great distance by car to get to Banff and Lake Louise. From the attendance figures at the national parks last year there is some basis for believing that people will not travel that distance in the future, but will withdraw to recreation areas nearer home. However, the trend is not too clear. We will need a few more years and perhaps higher gasoline prices to see if this is going to be a long-term result. Certainly there are people who will remain interested in enjoying recreation in the West, in the mountains, and areas like those around Lake Superior.

I might comment on something else you said. I also think we will get a reaction to the electronic city. There are certainly large numbers of young people forming a "back-to-the-land" movement. In the past some people have left the land, and there has been a tendency for some marginal farmland to become available for recreation. However, this trend may be reversed if people are going to start back to the land.

MR. GODFREY: I would like to ask one other question, or comment on one other thing that was of interest to me. This concerns the idea of standardization.

That suggests to me that there will be some agency, or entity saying what recreation has priority and what does not have priority. You could talk about simple conflicts—a river for the use of canoes; a river for the use of fishing.

When you mentioned "standardization" what did you really mean?

DR. MARSH: I think standardization can mean several things. First, it can mean the tendency for a lot of recreation facilities to look the same as the result of certain design standards being applied. In other words, you decide that a certain type of picnic table is the most efficient, and therefore it becomes utilized in all parts of the country. I think this is happening somewhat.

There is a vast literature on what is a good sign; what constitutes a good picnic table. Agencies across the country pick up on this, hence parks and resorts all begin.

As we send people abroad to give advice to the developing countries, you will see the same sort of recreation facilities being supplied over there. So the resultant lack of variety is something that concerns me. It also concerns me that the designs may not even be the best. For example, the North American teapot that appears in all restaurants has become a universal attribute of all restaurants without being the best. That is one aspect of standardization, a lack of variety.

Secondly, I see the standards approach to management spreading out from the city where we have standards of so many acres of park; so many square feet of tot lots; and swimming pools per thousand of population. This tendency to manage on those standards is spreading out quickly towards the wilderness.

In Ontario we are developing a provincial parks set of standards—with no real idea, for example, of how many acres of wilderness each person should be able to get to or how many lakes. It is assumed that everyone is the same across the country, and that their needs are the same. I think this is rather ridiculous.

I feel that people who live in Toronto, for example, have access to a fantastic range of urban amenities. It may be that the price of having those is not having as many rural amenities. Should such a person be accorded the same rural amenities as someone in the Yukon?

It is interesting that we do not say that people in the Yukon are entitled to the same sort of standard urban amenities.

I think standardization is advocated with the idea of efficiency. However, it may not provide us with the best things for recreation across the country.

CO-CHAIRMAN TEER: It occurs to me that the recreationists direct their activities towards physical environment and physical recreation appealing to a certain sense.

The question I have is, why haven't recreationists—or perhaps they have—directed their attention to environment, such things as scholarship, or such activities as investigations or explorations of microhabitats, even to sciences?

DR. MARSH: I am not exactly sure that I understand your question, but one of the ideas I have had about the scale on which people operate in their recreation environment is very closely tied in with the car. The speed of travel, and the use of the car force one to look at the landscape at a certain scale, and the micro-environments cannot be perceived when you are traveling 60 miles an hour.

I came across some interesting evidence of different reactions to environment resulting from the different speed of travel when I was doing research on the Rocky Mountains in Canada. If one looks at the perceptions, the diaries, and the accounts of people who traveled through that area on the train in the 1880's and 1890's, they report on things in very much greater detail than those who go through today.

If one talks to people traveling through there at 60 miles an hour, they are seeing everything on a more generalized basis, and missing a lot of the micro features, unless they get out of the car to walk and move at a slow pace.

The tendency to speed up, while indulging in recreation, obviously makes us look on a macro scale and that probably is a misfortune.

CO-CHAIRMAN TEER: Thank you.

I think you partially answered this inquiry, but what I am saying is why is it not recreation—for a person with a microscope, exploring a new world, let us say, of the leaf?

DR. MARSH: I think that is a very fine idea, and I think it is coming about. Some more interesting evidence on this is the type of nature photography that has gone on in the last few years compared with what one found earlier. If you look at some of the Sierra Club publications of the last years, there is much greater attention to details of such things as leaves and rocks than there was, perhaps in the 1920's and 1930's, when we looked at things on a grandiose scale from a common viewpoint.

I think agencies like the National Park Service, with their interpretation programs, are directing people to look at things on a more microscale. We have a tendency toward very short tours in the city, pointing out the micro features of a particular building. I think this is a movement in the direction of what you would like to see.

CHAIRMAN CLUSEN: Thank you, Dr. Marsh.

I am going to repeat what I said before, because I may never have another platform from which to say it. I think that environmentalists, wildlife managers, and conservationists, are ignoring, at their own peril, what is happening in the world. I will again call your attention to the UN Conference in Vancouver, which is going to deal with settlement. I have been on the U.S. Preparatory Committee and I know what they are talking about.

They are talking about land use, recreation, and global land use. If the environmentalists and the conservationists and the wildlife people do not have input to this now, there will be no time to turn the tide back after it has happened. I have a feeling that most of the American public, and most of the professions do not even know that it is even happening.

Perceptions of Animals in American Society

Stephen R. Kellert
Behavioral Sciences Study Center, Yale University School of Medicine, New Haven, Connecticut

This paper will summarize the results of a study on American attitudes toward animals which has been conducted over the past three years.[1] One of the primary goals of this study was to devise a typology of attitudes toward animals which hopefully would provide a better understanding of people's motivations for involvement in animal-related activities such as hunting, pet ownership, bird watching, animal welfare, scientific study, and so on. The other major goal of the study was to determine the distribution of these attitudes within the general American population. Thus two separate stages were implied in carrying out the investigation: first, formulating a typology of basic attitudes toward animals and, second, determining their apportionment among major population groups (for example, age, sex and education) and among major animal activity groups (for example, hunters, humanitarians and wildlifers).[2]

Methodology

The initial investigation—aimed at developing a typology of attitudes toward animals—focused on the views of people specifically interested in animals in some significant way. Studying a select, atypical group (composed only of persons involved with animals) in order to generate understandings relevant to a broader population was considered the most appropriate method at this stage for revealing fundamental aspects of contemporary human-animal relationships.

Although restricted, the population to be investigated still offered a wide variety of people for study, including animal artists, bird watchers, breeders, conservationists, ecologists, farmers, horsemen, humanitarians, hunters, pet owners, preservationists, scientists, vegetarians, veterinarians, writers and zoo personnel. Names of possible subjects were obtained through consultation with over 30 animal-related organizations. More than 700 persons were recommended, and 65 were eventually interviewed. There were 16 women and 49 men, averaging 45 years of age, and representing every section of the country. Each of the 65 was interviewed for approximately one hour. The first half of the

[1]This study was contracted by the Fish and Wildlife Service of the U.S. Department of the Interior. Special thanks are extended to Dr. Robert I. Smith, Paul Breer, Steven Schwager and Carolyn Kellert.

[2]Space restrictions prevent detailed presentation of the methodology and results of these two studies. A complete description of the first study can be found in a Fish and Wildlife Service report entitled "From Kinship to Mastery," by the author. The national study methods and results will be available at the end of June, also in a report to the Fish and Wildlife Service.

interview was open-ended and covered development of interest and present involvement with animals. The second half included only close-ended questions on a variety of animal, environmental and social issues.

Based on the typology of attitudes toward animals developed through the initial investigation, the follow-up study focused on the views and behaviors of the general American public. A close-ended, structured questionnaire was administered to 553 randomly selected Americans in 45-minute personal interviews which covered five areas—attitudes toward animals and the natural world, attitudes toward man's social world, a knowledge-of-animals quiz, respondents' animal-related activities, and basic social characteristics. The questionnaire was designed and pretested by the author. The final list of 79 attitude questions was gleaned from over 1000 considered, including more than 240 pretested. The sample selection and personal interviews were carried out by the Gallup Organization, using a "quota" rather than a "probability" random sampling method. The quota method randomly selects geographical areas (e.g., city blocks, rural neighborhoods) instead of individuals. Although less efficient and reliable than the probability method, the quota technique was considered most appropriate in view of the study's exploratory nature and the comparative costs involved.

The results of this two-stage investigation are presented in the following two sections of this paper. The first section defines and describes nine basic attitudes toward animals as well as their intercorrelations and their approximate frequency of occurrence in the American population. The second section presents findings on the distributions of these attitudes among various social-demographic and animal-activity groups.

A Typology of Attitudes[3] Toward Animals

Nine basic attitudes toward animals were identified and labelled as the naturalistic, ecologistic, humanistic, moralistic, scientistic, aesthetic, utilitarian, dominionistic and negativistic attitudes.

The Naturalistic Attitude

Although the naturalistic attitude is associated with an interest in all animals, its most outstanding characteristic is a profound attraction to wildlife and to the outdoors in general. The naturalistically oriented have affectionate feelings for pets but tend to regard them as inferior to wild animals. A primary satisfaction is in direct, personal contact with wilderness; and, in this regard, wildlife is valued particularly for the opportunities it provides for activity in the natural environment. An occasional manifestation of this attitude is an atavistic reward derived from experiencing wilderness as an escape from the perceived pressures and deficiences of modern industrial life.

The Ecologistic Attitude

The ecologistic attitude is also primarily oriented toward wildlife and natural settings, but typically is more intellectual and detached. This attitude views the

[3]Space does not permit a thorough discussion of the concept of attitude. It is broadly defined here as a distinguishable patterning of related ideas (cognitive notions), feelings (emotional-affective notions), and beliefs (cultural value notions).

natural environment predominantly as a system of interdependent parts. Rather than focusing on individual animals, wild or domesticated, the major emphasis and affection is for species of animals in their natural habitats. The perspective is often marked by considerable knowledge of animals, although this interest tends to concentrate more on behavioral relations of animal species than on their physical or biological properties.

While adhering to the notion that man is just another animal species, as ultimately dependent on the natural environment as any other, the ecologistic attitude tends to be concerned with protecting the environment primarily for the sake of humankind. Associated with this view is an interest in modifying modern society's impact on the natural world, although typically by compromising between the values of practical human advantage and protection of natural habitats.

The Humanistic Attitude

The humanistic attitude is distinguished by strong personal affection for individual animals, typically pets rather than wildlife. The pet animal is viewed as a friend, a companion, a member of the family. The love of the humanistically oriented person for animals can often be compared to that felt for human beings. Although not specifically interested in wildlife, the humanistically oriented often extend their empathy for pet animals to a general concern for the well-being of all animals, wildlife included. This concern for animal welfare originates less in any general ethical philosophy or in any particular concern for animal species than in an identification with the experience of individual animals extended from pets to wildlife.

The Moralistic Attitude

The most striking feature of the moralistic attitude is its great concern for the welfare of animals, both wild and domesticated. Rather than deriving from strong affection for individual animals (the humanistic point of view) or from consideration for animal species (the ecologistic attitude), the moralistic attitude is typically more philosophical. It is based on ethical principles opposing the exploitation and the infliction of any harm, suffering or death on animals. The moralistically oriented object to activities involving the killing of animals (e.g., hunting, trapping), and they also oppose many practices involving exploitation of animals (e.g., rodeos, cage zoos, horse racing). There is a tendency to perceive a kinship, a sense of equality, between humans and animals.

The Scientistic Attitude

The scientistic point of view is characterized by an objective, intellectualized, somewhat circumscribed perspective of animals. Animals are regarded more as physical objects for study than as subjects of affection or moral concern. There is typically little personal attraction to pets, wildlife or the natural environment among the scientistically oriented. Animals are usually perceived as the means for acquiring specific knowledge (mainly physiological, biological and taxonomic), and as offering opportunities for problem-solving. The affective relationship is one of emotional detachment, with curiosity often constituting the primary motivation for interest in animals.

The Aesthetic Attitude

The aesthetic attitude also tends to be associated with emotional detachment, but with a central interest in the beauty or symbolic properties of animals. Although many people possess a feeling for the physical attractions of animals, the aesthetically oriented base their interest almost exclusively on this artistic appeal. As an example, the aesthetically oriented tend to be attracted to animal sporting activities involving considerable artistic display such as animal showmanship, fox hunting and bullfighting. For the most part, they remain aloof from the living animal, enjoying it more as an object of beauty (in paintings, sculpture, movies) or of symbolic significance (in poetry, children's stories, cartoons).

The Utilitarian Attitude

The primary characteristic of the utilitarian attitude is the perception of animals in terms of their practical or profitable qualities—largely for their material benefit to humans. The utilitarian attitude is not necessarily marked by a lack of affection or interest in animals, although such feelings are usually subordinated to the more predominant interest in the usefulness of animals. While many utilitarian-oriented persons own pets, for example, most believe they should be trained for specific tasks and not kept just as companions or friends. Persons with a utilitarian attitude tend to be indifferent to issues of animal welfare which do not affect the animal's performance or practical value

The Dominionistic Attitude

A sense of superiority and a desire to master animals are defining features of the dominionistic attitude. Animals are mainly regarded from the perspective of providing opportunities for dominance and control, and expressions of prowess and skill in competition with animals are typically emphasized. Considerable attachment to animals may accompany the dominionistic attitude, but usually in the context of dominating them as, for example, in rodeos, trophy hunting and obedience training.

The Negativistic Attitude

A number of quite distinctive attitudes are included within the negativistic category, with the common feature being a desire to avoid animals. Typical of the negativistic attitude are such feelings as indifference, dislike, fear and superstition. This viewpoint is quite often marked by a fundamental sense of separation and alienation from the natural world. For many negativistically oriented persons, an utter gulf in emotion and spirit distinguishes animals from humans. The negativistic attitude is obviously very much people-centered, involving little, if any, sense of empathy or kinship with animals and the nonhuman world.[4]

The nine attitudes have been presented as ideal types and should be regarded as conceptual constructs of general human tendencies rather than specific descriptions of actual behavior. Most people typically possess more than one attitude toward animals, feeling and behaving a certain way in one situation while manifesting a different attitude under other circumstances. Additionally, when

[4]The author has not attempted to imply that any attitude is intrinsically superior or inferior to any other, but has sought merely to describe the qualities characteristic of each.

individuals express a particular attitude, rarely do they exhibit every characteristic of this attitude. In other words, not only do people have multiple attitudinal orientations, but they also vary considerably in the intensity of their commitments. In general, however, it is possible to identify in most individuals predominant characteristics of a primary attitude toward animals, with elements of secondary and tertiary attitudes present as well.[5]

Related to the expression of multiple but hierarchical attitudes in individuals is the question of which animal attitudes tend to cluster with one another. Based on impressions and on a correlation matrix computed in the national study, the most typical affiliations and antagonisms of the nine attitudes are presented in the chart below. (Key identifying terms for each attitude are also presented as a crude summary index.)

Attitude	Key Identifying Terms	Highly Correlated with	Most Antagonistic toward
Naturalistic	Wildlife exposure, contact with nature	Ecologistic, humanistic	Negativistic
Ecologistic	Ecosystem, species interdependence	Naturalistic, scientistic	Negativistic
Humanistic	Pets, love for animals	Moralistic	Negativistic
Moralistic	Ethical concern for Animal welfare	Humanistic	Utilitarian, dominionistic, scientistic, aesthetic, negativistic
Scientistic	Curiosity, study, knowledge	Ecologistic	None
Aesthetic	Artistic character and display	Naturalistic	Negativistic
Utilitarian	Practicality, usefulness	Dominionistic	Moralistic
Dominionistic	Mastery, superiority	Utilitarian, negativistic	Moralistic
Negativistic	Avoidance, dislike, indifference, fear	Dominionistic, utilitarian	Moralistic, humanistic, naturalistic

[5]The validity of Classifying people on seven of the nine attitudes was partially tested during the course of the first study through statistical examination of the subjects' responses to the close-ended questions. (The dominionistic and negativistic attitudes were not considered in the first study.) Because assignment of subjects to attitude categories was based on responses to the open-ended section of the interview, it was possible to examine responses to the close-ended questions without this analysis being tautological. The results of this statistical analysis—referred to as the multiple discriminant function analysis—roughly affirmed (1) the correct classification of nearly all respondents and (2) the general distinctiveness of all the attitudes from one another (with the partial exception of the ecologistic attitude).

The relative popularity of the attitudes can be examined in terms of both their prevalence (total number of cases in the population) and their incidence (rate of new cases within a given time period). Prevalence figures provide a good idea of absolute frequency, while incidence suggests historical changes and trends. Tentative prevalence statistics from the national study suggest that the humanistic, the utilitarian, and the "indifference" component of the negativistic attitude are the most common attitudes among Americans, while the most uncommon seem to be the scientistic, the aesthetic and the ecologistic. Considering incidence during the past 10 years, the impression is that the utilitarian attitude is decreasing in popularity along with the negativistic, while the naturalistic, humanistic and ecologistic viewpoints appear to be substantially increasing. National study data comparing different age, educational and urban-rural groups generally corroborates this change, although considerably more analysis is needed before a trend can be definitely substantiated.

Distribution of the Attitudes in the General American Population

The remainder of the paper deals with the distribution of the nine attitudes within major social-demographic and animal-activity groups in the general American population. Unfortunately, these findings must be largely confined to six attitude types, as indices of the aesthetic, scientistic and, to a lesser degree, ecologistic attitudes were not particularly reliable or valid. Problems with these three attitudes probably relate to their relative infrequency in the population exacerbated by a sample size of 553. Interpretation of the findings was largely based upon three overlapping though different criteria: individual attitude cross-tabulations, attitude scale cross-tabulations, and regression analysis (analysis of variance and multiple regression). Attitude scales were created largely by examining the results of a statistical technique referred to as cluster analysis.

The national study findings must be regarded as preliminary and tentative. This was largely an exploratory study based on a limited sample size and involving rather large numbers of often complex variables. These are not exact relationships but tentative approximations of the underlying situation. Additionally, it should be emphasized that these findings are gross generalizations of large population groups. Individual person differences cannot be inferred from such results, only the statistical likelihood that a particular attitude may occur in a particular group. Further analysis may reveal the presence of unconsidered "X" factors that largely account for found relationships between attitudes and groups of people.

Findings on the distribution of the attitude types within 11 social-demographic groups are briefly reviewed below. For convenience, the 11 variables have been divided into four major groups: basic ascriptive variables (age, sex, race); socioeconomic variables (education, occupation, income); geographic variables (childhood residence, present residence, section of the country); and familial variables (marital status, number of children).

Basic Ascriptive Variables

Age. By far the most significant age differences were between persons 18 to 29 (people under 18 were not sampled) and those 65 and older. The 65 and older population was significantly less naturalistic and somewhat less moralistic than those 18 to 29. Furthermore, the elderly population was significantly more utilitarian and negativistically oriented.

Regarding naturalistic differences, the 65+ group was far less interested in wildlife, wilderness and spending time in the outdoors. Age differences were, in fact, the largest found on the naturalistic dimension. Moralistic differences between age groups were not as great but did reveal 18 to 29 people to be considerably more interested in problems of animal welfare and significantly more opposed to hunting than older people. The 18 to 29 group also expressed a more ecologistic attitude, though differences here were not great. Exemplary of the prominent utilitarian attitude of elderly persons, in contrast to those 18 to 29, was support for such activities as predator control, commercial activity at the expense of wildlife, and a preference for work animals over pets. Differences on the negativistic dimension were revealed in considerably less affection and desire for personal contact with animals among the 65 and older population.

Sex. Significant differences were found between males and females on at least seven of the nine attitudes (moralistic, humanistic, naturalistic, utilitarian, dominionistic, scientistic and ecologistic). Sex and education, in fact, were consistently the two most important social differentiators of people's attitudes toward animals and the natural world.

Sex differences were especially impressive on the moralistic and humanistic dimensions. Females were far more concerned with protecting animals from suffering, and much more inclined to express strong loving feelings toward pet animals. Naturalistic differences between the sexes were manifest in the much greater desire among males for direct contact with wildlife and the outdoors. Males were also significantly more utilitarian and expressed more acceptance of such activities as killing animals for meat, predator control, and harvesting wildlife for fur. On the dominionistic dimension, females were less interested either in mastering animals for sporting purposes or in training them to perform specific tasks. Finally, although the scientistic and ecologistic attitudes were somewhat poorly measured, males generally scored higher on these dimensions, especially regarding knowledge of animals.

Race. Racial differences between blacks and whites were quite striking on the negativistic, naturalistic and moralistic attitudes. Additionally, noteworthy differences on the dominionistic attitude were revealed by black males. These differences remained significant after all other demographic variables had been taken into account, but small sample sizes for blacks render the findings somewhat tentative at this time.

The more negativistic attitude of blacks was manifested by less animal interest and affection as well as more fear of animals, wildlife in particular. Naturalistic differences were expressed in greater wildlife interest and desire for personal contact with wilderness settings among whites. Not surprisingly, given the negativistic differences, blacks were generally less interested in moralistic issues of animal welfare and exploitation. Black males (although not black females) were significantly more dominionistic, generally admiring expressions of superior physical strength over animals.

Socioeconomic Status

Education. As indicated, education and sex were the most consistent social differentiators of people's views toward animals. Educational differences were most striking when comparing persons with a less than eighth grade education to those with some or completed college. The most significant educational findings were on the negativistic, utilitarian and dominionistic attitudes, while important differences were also recorded on the ecologistic and naturalistic dimensions.

Negativistic differences between educational groups were particularly remarkable—in fact, the single biggest distinction on any attitude dimension by any demographic variable. People with low education manifested far more fear, lack of affection, and disinterest in animals. Although these feelings were most apparent with regard to wildlife, they were also evident in views toward domesticated animals (e.g., expressing fear of stray dogs, perceiving cats as vicious and supporting extermination of all pests). Higher educational groups—especially the college-educated—tended to be less utilitarian toward animals. In contrast, the less than eighth grade group expressed much greater support for such utilitarian activities as trapping, hunting for meat, and the value of conquering and taming the wilderness. Dominionistic differences were reflected in a more authoritarian relation to animals among lower educational groups. Concern with wildlife and wilderness among the college educated accounted for their higher naturalistic scores. This interest in wildlife, along with a more extensive knowledge of animals, was the basis for the somewhat increased ecologistic orientation among college-educated people. Relatively insignificant differences were found among educational groups on the moralistic attitude. Apparently concern for animal welfare and the environment is more likely to be manifested in an ecologistic than a moralistic attitude among higher educational groups.

Occupation. Although a number of interesting occupational differences were revealed in the item and scale analyses, many of these differences were minimized in the multiple regression analyses when the influence of other factors was considered. Nevertheless, some potentially significant findings were revealed among occupational groups on the utilitarian, moralistic, dominionistic, naturalistic and negativistic attitudes.

Farmers, as expected, were by far the most utilitarian group. This pattern was revealed in strong support for such activities as the use of steel leg-hold traps (one of the few occupational groups to support this practice), predator control (the only occupational category to unanimously support this activity), pest extermination (also 100% support), and agreement with the notion that animals exist largely for the benefit of man. The one occupational category consistently contrasting with the views of farmers were students who generally expressed a highly moralistic attitude. Students not only opposed many of the above mentioned activities but also objected to rodeos, trophy and sport (though not meat) hunting, and the killing of wild animals for their fur. Students contrasted markedly with farmers and also unskilled workers who were much more dominionistically oriented. Students, as well as professionals, business executives and skilled workers, scored high on the naturalistic attitude. A discernible though not strong negativistic attitude was found among unskilled and clerical workers, especially regarding feelings of indifference and fear of animals.

Income. Perhaps the most significant finding on the income variable was its relative unimportance. On few attitudes did income differences prove noteworthy. Insofar as predicting views toward animals and the natural world, income appears to have only marginal relevance, in sharp contrast to the other socioeconomic indicators (education and occupation).

There was a moderate tendency to find lower income groups with a more negativistic attitude toward animals. Higher income people tended to be slightly more naturalistic and less utilitarian in their outlook than lower income persons.

Geographical Variables

Childhood residence. The most outstanding finding on this urban-rural dimension was the much greater dominionistic orientation of those reared in rural areas of less than 2000 population. In general, rural childhood background was related to a greater sense of superiority and a lack of affinity with animals. Additionally, rural dwellers were significantly more utilitarian-oriented than city residents and supported such practices as hunting for meat, the use of steel traps and the killing of wild animals for their fur. Those raised in cities of 1 million plus were more moralistic, objecting to these practices as well as to rodeos and predator control. Not surprisingly, noncity-dwellers were more naturalistically oriented; what was unexpected was that the strongest naturalistic attitude was found in persons from towns of 10,000 to 50,000 population. One could surmise that those raised in small towns not only had the opportunity for outdoor and wildlife exposure but also the noncommercial involvement to allow this type of appreciative interest.

Present residence. Findings on population of present residence followed the same pattern as childhood residence and therefore do not require much further discussion. Perhaps the most interesting finding was that, although childhood and present residence results were similar, the former was consistently stronger. This finding supports the developmental hypothesis that childhood environment is most important in the formation of attitudes toward animals.

Section of the country. Differences in this variable were not great although they were consistent across a number of indicators. The Rocky Mountain, South Central and West Central States seemed to be the most dominionistic and utilitarian in their attitudes. A general perspective of human superiority and of the practical use of animals was common in these areas. Additionally, the Rocky Mountain States projected the greatest naturalistic interest. In terms of affection for pet animals, the Mid-Atlantic States were generally more humanistically oriented, contrasting with the South Central and South Eastern States which were more negativistically oriented toward both wildlife and domesticated animals.

Familial Variables

Marital status. Differences among marital status groups did not usually remain significant when other variables were taken into account. This was particularly the case for widows on the negativistic dimension, and for single persons on the naturalistic, where variations were mostly a function of age. One rather significant difference on this variable was between single and married persons on the utilitarian dimension. Married persons generally revealed pragmatic perceptions of animals, whereas single persons more frequently objected to utilitarian exploitation (for example, predator control and the raising of fur-bearing animals). Single persons scored consistently higher on the humanistic dimension, partially supporting the "human-substitute" hypothesis that unmarried people often own pets as a way of compensating for the absence of other people.

Number of children. Differences on this variable were not impressive. Two tendencies were for families of five and more children to be more utilitarian, and for persons without children to be more humanistic. The latter finding further supports the human-substitute theory as one motivation for having pets.

Summary of the Demographic Findings

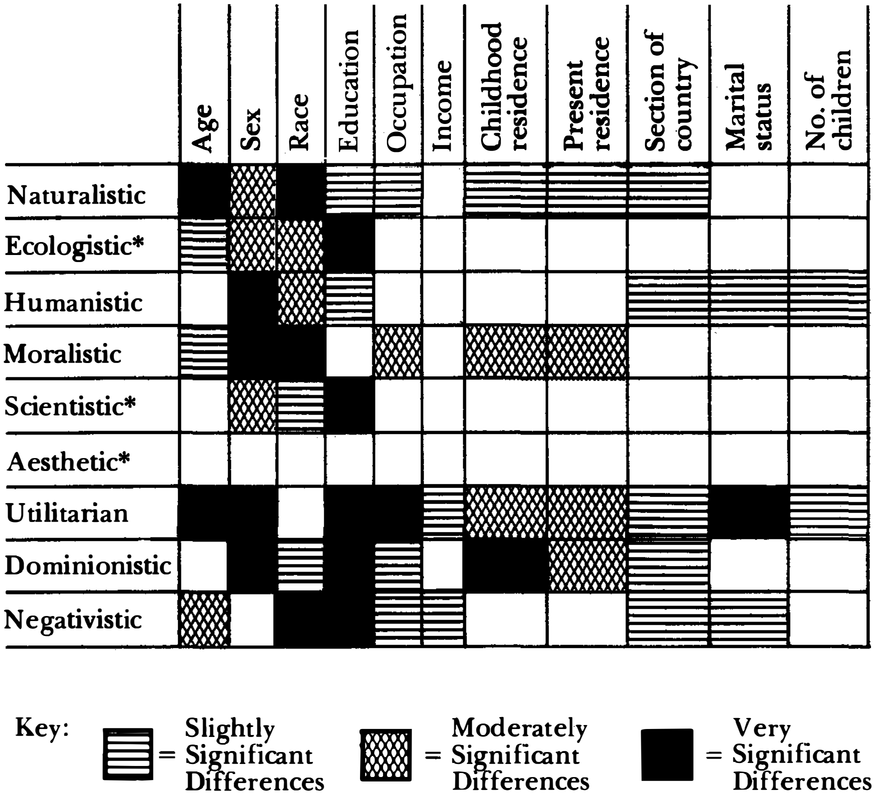
As previously indicated, three types of data were considered in assessing the significance of relationships between social-demographic and attitudinal variables—individual item cross-tabulations, scale score cross-tabulations, and multivariate analysis (multiple regression and analysis of variance). Figure 1 roughly summarizes the assessed significance of these findings for all the demographic variables described (without indicating the direction of these relationships.).

Relation of Animal Activities to Attitudes Toward Animals

A number of behavioral relations to animals were partially built into the attitude scales, and thus some of the following findings will not be surprising and may be somewhat tautological. Nevertheless, there are some illuminating results in relation to both activities and attitudes.

Hunters were categorized according to their primary reason for hunting—for close contact with nature, for meat or for sport. *Nature hunters* were predictably the most naturalistically oriented, expressing great interest in wildlife, getting out in the woods, and seeing wilderness left unspoiled and unexploited. Nature hunters also scored quite high on the humanistic and ecologistic variables, indicating their basic affection and concern for animals and the natural environment. *Meat hunters*, in contrast, were not particularly naturalistically oriented. As anticipated, they scored highest on the utilitarian dimension. *Sport hunters*, somewhat unexpectedly, manifested a rather strong negativistic attitude toward animals. Apparently interest and affection for animals is not typical of those who report sporting enjoyment as their primary reason for hunting. Sport hunters were very dominionistically oriented, suggesting that displays of skill, expressions of prowess, competition, and mastery over the animal were important motivations in this activity. Finally, it is relevant to note that, whereas sport hunters were among the lowest scoring groups on the knowledge of animals quiz, nature hunters scored higher than any other social demographic or animal activity group.

Differences in predominant attitudes of the three hunting groups underscore the value of distinguishing between attitudes toward and activities with animals although sometimes particular attitudes may be closely associated with particular activities. In a similar example, regarding opposition to hunting, at least three relevant attitudes can be cited—the moralistic, the humanistic and the ecologis-



* Scale and item indices fair to poor in national study.

Figure 1. Summary of Social Demographic Findings by Attitudes

tic. The first would object to hunting on the grounds that killing in the pursuit of pleasure is inherently wrong. The humanistically oriented identify with the experience of the individual animal and typically object out of sympathy with its suffering. Finally, the ecologistically oriented, although not always opposed to hunting, voice strenuous objections when a species is endangered.

Two other activity groups fundamentally interested in wildlife and the outdoors were backpackers and bird watchers. *Backpackers*, as expected, manifested strong naturalistic attitudes although less than nature hunters. Additionally, backpackers were both very humanistically and moralistically oriented, expressing (quite unlike the nature hunters) a fair degree of opposition to hunting and to the harvesting of wildlife for fur. *Bird watchers* were both very naturalistically and ecologistically oriented, manifesting strong interest and concern for the condition of wildlife and the natural environment.

Two groups interested in domesticated animals were pet owners and rodeo enthusiasts. *Pet owners* were divided into two groups—those who own pets primarily for companionship and those who own pets mainly for work, protection or sport (combined together because of small sample sizes). The *companion pet owner* was, of course, very humanistically oriented. This activity group was also one of the most moralistically oriented, opposing such activities as raising animals for fur, predator control, and, to a lesser degree, sport hunting. *Work, protection, sport pet owners*, in dramatic contrast, were among the most negativistically oriented groups examined in the study. They manifested strong dominionistic and utilitarian attitudes also. Apparently, pet ownership in this group was almost exclusively motivated by practical considerations and did not involve much personal affection for pet animals.

Rodeo enthusiasts manifested a relatively unusual combination of dominionistic and humanistic attitudes. Although supporting the value of dominating and mastering animals, they still revealed strong affection for pet animals. Additionally, rodeo enthusiasts were rather utilitarian-oriented, believing in the virtue of work animals, predator control, wilderness exploitation, and the killing of wildlife for fur.

Vegetarians and zoo enthusiasts were among the most moralistically oriented groups. *Zoo enthusiasts*, for example, strongly objected to rodeos, killing animals for fur, and utilitarian exploitation of animals in general. This group also revealed strong humanistic attitudes and, somewhat surprisingly, were not particularly naturalistic or ecologistic in their attitude toward animals. *Vegetarians* were even more moralistically oriented, expressing opposition to a wide range of activities including hunting, trapping, predator control, neutering of dogs, and much medical investigation involving the killing of animals. Additionally, they were one of the few moralistically oriented groups which were not also strongly humanistic, embodying a general philosophical concern for animal welfare divorced from any personal affection for animals.

Two of the more utilitarian-oriented groups were animal farmers and trappers. *Animal farmers*, in addition to their utilitarian outlook, were also quite dominionistically oriented. *Trappers* were among the most negativistic of all groups studied, revealing a general disinterest and lack of affection for animals. Additionally, trappers were highly dominionistic, supporting such activities as cock fighting, training animals through strong physical force, and trophy hunting.

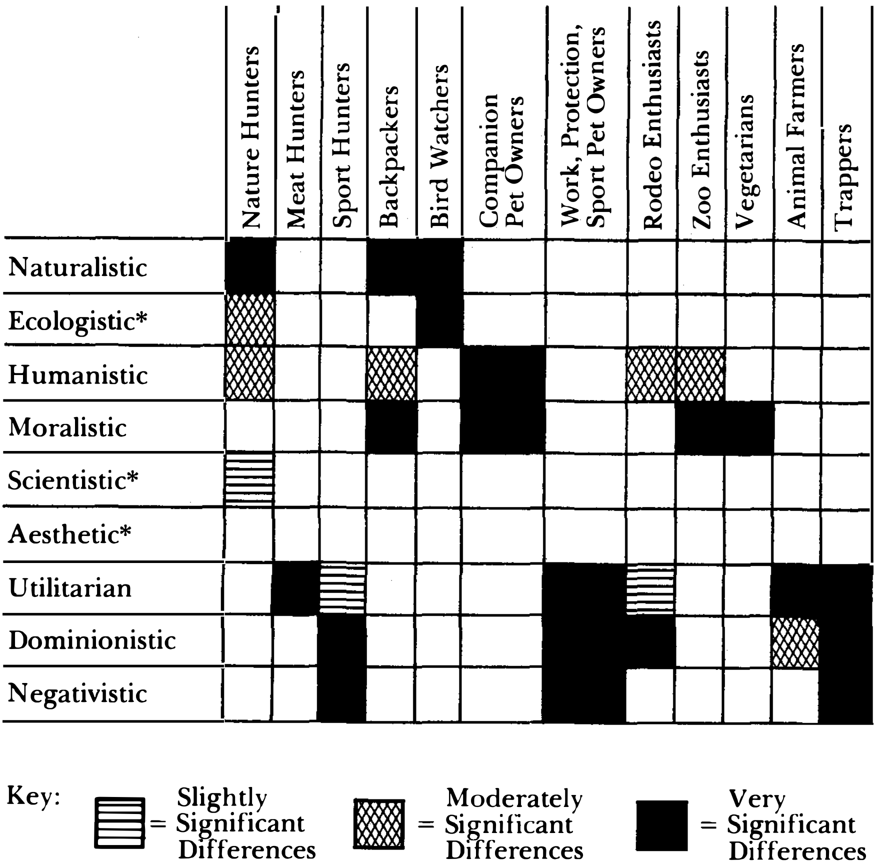
Figure 2 summarizes, in a manner similar to the previous figure, the various relationships described between animal activity groups and attitudes toward animals.

Summary

A wide range of results from a study of American attitudes toward animals has been presented. A typology of nine attitudes toward animals was described and related to 11 social-demographic and 12 animal-activity groups. A number of policy implications derive from this data; but, as this matter has not yet been sufficiently considered, speculation will be deferred.

Discussion

MR. CHARLES NEWLING [U.S. Army Corps of Engineers]: Dr. Kellert, I found the differentiation between the type of hunters rather incredible. Did your data suggest any way to reconcile differences between hunters and nonhunters, consumptive and nonconsumptive use of wildlife?



* Scale and item indices fair to poor in national study.

Figure 2. Summary of Animal Activity Group Findings by Attitudes

DR. KELLERT: I don't know if any data necessarily suggests any way for reconciliation. One of the problems is that many of these attitudes start from fundamentally different premises, and often these groups talk about one another rather than with one another.

If there is an opportunity for reconciliation, or compromise, it is probably in the ecologistic attitude. The two that oppose one another are the moralistic and the utilitarian groups, and I think there are elements which can be related to the ecologistic type and in that attitude type there may be a possibility for dialogue.

MR. LARRY HARRIS [University of Florida]: Based on similar research in Florida, we established a higher proportion of the anti-hunting segment is constituted of alienated former hunters. I wonder if you can address this issue that we commonly see, that the anti-hunters are Bambi lovers. Perhaps that is not true.

DR. KELLERT: It has not been my finding, although I think that is quite interesting. I have not found that reformed hunters were the most anti-hunting group in the study. The two primary sources for anti-hunting represent more or less a composite of the feeling that killing of animals is inherently wrong and involves a great deal of suffering; and I think the other is guilt by association phenomenon, where sentiment does enter, where opposition to guns and violence is such that the hunter is often found in that position.

CHAIRMAN CLUSEN: Let me ask one question. You said you had not raised strong questions of policy statements, and you may not want to answer this. Nevertheless, the obvious question as far as the public is concerned would be what does this all mean and what kinds of land or territory would or could be set aside for wildlife preservation or hunting? Is there anything in your analysis or your statistics which indicated attitudes toward this.

DR. KELLERT: That is a difficult question to answer.

There are a number of specific findings which may have relevance toward education and conservation of multiple resources, but they have not been developed in that category.

Input of Wildlifers Expected by Urban and Regional Planners

Moderator's Remarks

Aelred D. Geis[1]

In his interesting paper on Monday, Pat Noonan emphasized the increasing awareness of planners to our environmental matters. This is true, but only to a limited degree.

For many planners, recognition of environmental matters is almost synonomous with air and water pollution and waste disposal. Little recognition is given to wildlife in the planning process or, even more importantly, to maintaining the national productivity of urban areas that benefit wildlife with man.

As a modest step to improving this situation, Bill Crawford, the President of the Wildlife Society, instructed the Regional Planning and Urban Development Committee of the Wildlife Society to arrange for two presentations at national meetings. At the American Institute of Planners' meeting in San Antonio, Texas, in October 1975, four wildlifers, Carol Carlossi, Dean Longrie, Jack Thomas and myself, tried to convince the planners who had come to recognize wildlife in the planning process.

Today we will tend to reverse the situation. We have a panel consisting of representatives of two national planning organizations; a representative of the American Institute of Landscape Architects; and a wildlifer with an atypical involvement as a planner. We will receive some expert advice from this panel on how we can have a greater impact on the course of future development.

Our first speaker, representing the American Society of Planning Officials, is Chief of the Environmental and Technical Services, Office of Comprehensive Planning, in Fairfax County, Virginia. As most of you know, Fairfax County is not Washington, D.C. It is subject to great developmental pressures and has an environmentally aware citizenry. It has a planning staff that is privy to the full spectrum of environmental issues, including wildlife.

Despite this, there are still problems in recognizing wildlife in the planning process. We are very fortunate in having John H. Thillman who is to speak on this question. His paper is co-authored by Walter J. Monasch.

[1]The moderator is an Urban Wildlife Specialist with the U.S. Fish and Wildlife Service in Laurel, Maryland.

Wildlife As Inputs to Comprehensive Planning

John H. Thillmann
Chief, Environment and Technical Services Branch, Office of Comprehensive Planning, County of Fairfax, Fairfax, Virginia

Walter J. Monasch, AIP
Staff Director, Community and Economic Development Task Force, Urban Consortium, P.T.I., Washington, D.C.

Introduction

With all of the national emphasis that is placed upon environmental protection, wildlife concerns have yet to be fully appreciated as an integral element of environment preservation. All too often, comprehensive plans for the future of a community do not account for wildlife concerns.

This paper will, in a very brief way, look at the types of information that planners need to ensure that wildlife preservation is a consideration in the formulation of comprehensive plans. It will also attempt to deal with how those concerned with wildlife can get into the process of plan preparation both as professionals and as interest groups supporting the process.

Planning Focus

In discussing participation which planners of both local and regional perspectives would like from the various professions dealing with wildlife, some role definition as to the two types of planning is needed. This is necessary because the scope of problems experienced by the two different planning perspectives in many cases require different kinds of strategies and solutions.

Planning at the regional scale generally deals with a number of counties, towns and other major and minor jurisdictions; it is generally also more concerned with institutional issues and programs and refrains from delving into site specific problems. Planning at a subregional level, perhaps for a county, city or township, will be conducted at a much more refined scale and will primarily focus on and attempt to deal with site specific kinds of issues.

The wildlife concerns which this paper will deal with are those faced by planners at the more refined local level.

Planning at the local or subregional level is where the "action is." Land use planners at the local level are at the front lines of determining or at least recommending the determination of the eventual use of land. They help formulate policies for growth, change and preservation as identified in the minds of interested citizens and elected officials. They prepare plans which are a culmination of enunciated goals which that particular community may have set for itself.

Also, contrary to planners at the more abstract levels of government, planners at the local level are often charged with the responsibility of ensuring that the goals and policies embodied in their plans are achieved. This is usually accomplished with a variety of legal mechanisms empowered by state planning enabling legislation, the most common of which are zoning and subdivision regulations.

What Wildlifers Need to Know

Where, then, and how do professionals and interested lay persons dealing with wildlife conservation and/or preservation fit into the picture? Just as any other interest group, persons concerned with wildlife preservation belong in the total process of community planning from goal identification and policy formulation to plan preparation and implementation. Thus, the question should be rephrased to: What kinds of inputs do planners need to ensure that wildlife preservation is included as one of the many and often conflicting considerations in the comprehensive planning process?

In the past, the education of most land use planners has been somewhat cursory in the area of natural systems. In spite of this, there has been a strong identification among professional planners with the environmental movement. This identification coupled with planners' preoccupation with comprehensiveness and systematical methodology as an institutional response to problem identification and solving can overcome the educational shortcoming. It is the systems thinking which wildlifers need to identify with to fit into the comprehensive planning process. They need to educate themselves in the traditional planning concepts and be able to relate their particular wildlife concerns to planning for a total community. In addition, since comprehensive planning is in many instances a series of trade-offs between interest groups, the wildlifer also needs to know, among other things, how the game is played.

Urban planners have traditionally looked at wildlife professionals and interest groups as being preoccupied with studying game animals in remote wilderness places or defining protected wildlife habitats far from urbanizing areas. This has not exactly fostered an identification among professional urban planners with wildlifers or a concern for wildlife preservation. The planner essentially has not been exposed to wildlife as a concern in urban areas just as the wildlifer has had only peripheral involvement in urban settings. It is this kind of seeming preoccupation with wilderness areas and unconcern with urban habitats that wildlifers should reevaluate; they should recognize that prime wildlife habitats are being converted into quarter acre subdivision sprawl at a steady rate in all of our urbanizing areas. Wildlifers need to study and develop recommendations for the preservation of urban wildlife habitats. They need to define the habitats of wildlife in terms of range and area: which wildlife can and which cannot live in close proximity to man at urban and suburban densities?

The land use planner who is in the "trenches" needs the urban habitat information in the form of wildlife to development tolerance parameters such as: What level of density drives off certain species of land animals? What types of shrubs and how much cover is needed to preserve or enhance a bird population? What levels of dissolved oxygen and temperature are necessary to sustain high quality fish in stream valley areas? These are the kinds of information planners need when dealing with development pressures in urbanizing areas.

Adding Wildlife Concerns to Comprehensive Planning

Traditional comprehensive plans have formulated land use relationships to ensure among other things, adequate transportation, public facility, recreation and open space areas. Within the last few years a growing number of communities throughout the nation have taken the open space and recreation element and have revitalized it by an expansion of scope to devise an environmental element. In some cases the environmental element has been the principal driver of the plan such as in the Lake Tahoe plan. In other cases, the environmental element shares equal footing with other comprehensive plan elements. However, regardless of what has happened, the fact remains that an environmental element of a comprehensive plan would not be complete without important weight given to an analysis, identification and strategy for protection of wildlife habitats.

Earlier it was briefly mentioned that wildlifers needed to become familiar with the comprehensive nature of the planning process. The wildlife information which can be found in some current plans speak about general identification of wildlife areas including maps graphically illustrating the variety of species. This information is good as a beginning.

These nice graphics and maps often look good but wouldn't have really entered into the process. Why? Well, along with an inventory of types of wildlife, types of vegetation, geomorphology, hydrology, etc.—an analysis of the interdependence of these factors with each other and all other factors affecting the planning process must be available to the land use planners.

If the analysis stage is to achieve its purpose, it must contain information about the vulnerability or tolerance of a habitat or a species to development pressures. Can a unique form of wildlife exist within an urban area and if so what must be the minimum habitat size? How adaptable is a species to a totally different set of habitat circumstances? Another one of the elements of the analysis stage which is most often cited is "uniqueness" of the habitat or species. What is unique and what is prime? Planners must understand the interdependence of species and the wildlifer should be able to educate the planners to the meaning of unique and prime.

As a problem revolves, it is clear the inventory to analysis stages need a careful and constant monitoring of conditions to see if indeed the analysis is correct and the interrelationship and balance as injected into the plans are correct.

The analysis stage should logically progress toward providing a set of land use capacity or suitability indicators. This is the point at which the inventory and analysis come to fruition through an interaction with land use density and intensity levels. It is also where such issues as transportation corridors and the location of major public facilities are tested against and hopefully adjusted by information on wildlife issues.

However, it is at precisely this point that the planning process experiences its major test. After plans are drawn up including all of the various elements and trade-offs which go into the document through its adoption process, it remains only as good as the paper it is printed upon unless it can be carried through the final stage of implementation. No plan, irrespective of the time and effort of the citizens, professionals and elected officials will ever modify, change or preserve anything within that jurisdiction unless it is used, followed and supported.

The wildlifer just as any other professional or lay person involved in the planning process should be constantly aware of the need for implementation of the plan. There are two ways in which this can be accomplished. Local zoning, subdivision, site plan and other ordinances when applied should use the comprehensive plan and all its elements as the guide. When the plan calls for an area to be preserved as a unique open space area, the local ordinance should be flexible enough to ensure that this happens. If this is not possible at the local level, the federal and state governments can legislatively support the local government. This can take the form of amendments or new provisions to the state code. The other way to insure implementation in accordance with the plan is by using the natural impetus of the developer when he requests a change in zoning or a resubdivision to ostensibly implement the general land use intensity and density. Quid Pro Quo negotiations, giving bonus densities or other tradeoffs for community benefits in terms of better open space and habitat preservation can bring very favorable results. This approach, however, must also have the backing of ordinance and legislative policies.

The first approach would entail specific legislation at the local, state or federal level to ensure the preservation of unique and valuable species of wildlife whereas the second approach is the more flexible approach used in the "trenches." This is where site specific development proposals are amended or redesigned by local officials together with the development community into different development schemes which take maximum advantage of among other things, wildlife habitat. It is precisely at this point, the development plan amendment by planners, that the wildlife inventory data and analysis becomes of prime consequence. Without a complete inventory, the planning staff must either conduct one at that point or indulge in horse back opinions about species numbers and types. The first possibility is highly unlikely because of normal time and staff constraints and the second is vulnerable to criticism by the developer, elected officials, and professionals. However, for lack of better data, too often the staffs of planning agencies must choose the horse back opinion or refrain from using wildlife preservation as a site specific development plan concern at all.

To reiterate then, the wildlife conservationist must provide the urban planner with: (1) An inventory of wildlife citing specifically, location and diversity (2) An analysis of the wildlife citing vulnerability, tolerance and uniqueness (3) A translation of the analysis to both area-wide planning criteria for general density and intensity of use and site specific animal tolerance to different kinds of development schemes.

This kind of information and input into the planning process will, of course, take a great deal of time, money and professional support if it is to be achieved. Urban planners would support and welcome this kind of information as valid and necessary to comprehensive planning. The question of time and money is significant and cannot be easily answered but to look to the wildlife professional and activist as the nucleus to achieve these ends by lobbying for their input.

A Local Experience with a Wildlife Element

It will be helpful to this discussion, at this point, if we can take a brief look at one local experience in trying to add a wildlife element to the environmental section of a comprehensive plan. The Fairfax County PLUS (Planning and Land Use System) Plan is the example chosen because not only is the plan adopted but it is currently undergoing implementation through some 320 rezoning petitions representing thousands of acres.

Fairfax County's environmental element in the plan was not only a chapter written into the plan including the usual graphics, but it was a process which in many respects tried to modify and adjust land use density and intensity. However, all of the land use modifications did not take place at the general planning stage, but many are occurring at the implementation stage of the plan.

The PLUS planning process occurred over a period of approximately two years from restaffing the Office of Comprehensive Planning to adoption of a Countywide Plan, which is the final consolidation of a series of four Area Plans.

The nucleus of the natural open space preservation effort was contained in an effort called "Environmental Quality Corridors." They are modelled after a concept put forth by Professor Phillip Lewis, a landscape architect at the University of Wisconsin. The Environmental Quality Corridors or EQC's represent an open space system which we believed were necessary for the needs of Fairfax County. Many of our prime open space areas had been developed. We needed a new approach to open space identification and preservation and turned to the EQC concept. Our EQC's use the water resource network of the county as the core element for the system. The floodplains, wetlands, stream influence zones and other shoreline areas provide the skeleton while other essential elements such as prime wildlife habitats including upland areas, citizen identified environmental resources, historic features, public parks and other similar natural resources are added to the system forming a continuous network throughout the county.

The major strength of the system lies in its physiographic linkage. The EQC concept as adopted in Fairfax County provides a broad countywide contest for the eventual implementation of the open space element of the plan by providing a vehicle for open space analysis of individual development projects. Dedications of land can be evaluated within the context of a pattern that responds to the natural determinism of the landscape. Included in the evaluation of developer proposals are those elements such as wildlife habitats or wildlife parks, wetlands, steep slopes and floodplains which make EQC's distinctive.

The EQC element is of course not the only environmental element of the comprehensive plan. It is, however, the prime element which seeks to contextually identify wildlife habitats while providing a vehicle for their preservation.

Our experience in Fairfax County is that as an areas urbanizes, the pressure for development on all but the most unsuitable land from a developer's viewpoint is tremendous in its magnitude and has been constant over the post World War II period. This leaves little opportunity for specific interest groups to preserve significant but often isolated land areas without a unified planning approach. The EQC's gave Fairfax County the necessary vehicle for a unified effort at preserving many different natural, biological and scientific assets. Furthermore, when a developer of a 10 acre or 1000 acre parcel is ready to enter the rezoning and development process, the plan makes him fully aware of the land areas with special environmental concerns within his development package which the public sector is interested in. The public receives the land through fee simple dedications, perpetual easements or other prohibitions to using or changing the land by leaving it in any other but its natural state.

Furthermore, the development industry can see that a unique and valuable open space resource combining many elements can be of prime importance not only to the community but also to his development and the application of regulations to govern the preservation of these areas are not arbitrary, capricious, or unreasonable. We have been extremely successful in eliciting developer contributions of the EQC's wherever they affect land which is up for rezoning. One successful and notable contribution by a developer was a 700 acre development proposal at an overall density of three dwellings per acre. Of the 700+ acres, we were able to elicit 400+acres for EQC and other open space as dedications for public use.

While preserving EQC's and those elements embodied in them has been very successful, the wildlife element used in the initial EQC identification process was accomplished by using the traditional horse back opinion. So the preservation of EQC's does not necessarily convert into an automatic wildlife preservation method. During the EQC formulation period, the Environmental Branch of the Planning Office contacted local wildlife experts intending to elicit expert opinions of what we considered to be wildlife habitat areas. Our assumption was that this information was at their fingertips. What was received for the most part was an alogrithim which stated that good tree cover, under brush along stream valleys, or adjacent upland meadows were capable of supporting wildlife and for the most part equals good habitat. Only in rare instances was there any conclusive analysis available indicating that a species was known to inhabit a certain area or stream valley. In those instances we were able to specifically identify prime wildlife habitat areas for lack of better terminology.

The problem was not with the wildlife experts contacted, it was with the usual lack of time and money by the public sector to carry out the necessary inventory and analysis. After plan adoption, an additional opportunity to participate in a sampling project at minimal cost was available, but budget constraints once again disallowed our involvement. So in a very sophisticated and nationally recognized planning process, the wildlife element was only a token of what it might have been. Had proper pressure been applied by interested citizens and wildlife professionals, the outcome might have been different.

In the absence of comprehensive wildlife information as a part of the EQC plan component, preservation of wildlife has been a sometimes hit and miss process. There have been moderate successes in preserving wildlife or more correctly "suspected wildlife habitats" through a case by case review of all pending rezoning requests by eliciting EQC dedications. However, the lack of proper input at the planning stage has been an impediment at this case analysis stage. Staff would love to be armed with species inventory and vulnerability analysis when the County Board of Supervisors make decisions on rezonings. The information would be even more beneficial for litigation over particular development proposals. Instead of going to court armed with "Well your honor, the tree cover and vegetation indicates a possible wildlife habitat," we could respond with consequential damage to a particular species because we would have empirical numbers and vulnerability analysis.

The implementation of the comprehensive plan is going forth at a rate sometimes exceeding hundreds of acres per week and we are eliciting developer proferred open space contributions for an EQC system which we hope is also preserving wildlife. We are mindful of our shortcomings related to wildlife concerns and hope that the input to the comprehensive plan was not too little and that we may still be able to rectify the shortcomings through yearly plan reviews.

Conclusion

In conclusion, it should be reiterated that wildlifers must begin to shift major emphasis to the preservation of wildlife in the urban and urban fringe areas before opportunity to do so vanishes. Wildlife professionals and concerned lay persons must put pressure on the local jurisdictions to ensure that wildlife preservation is an element of the planning process and that plan implementation methods recognize and can deal with this issue.

Input of Wildlifers Expected by Urban and Regional Planners: Views of the American Institute of Planners

Royce LaNier
Urban Research Center,
University of Wisconsin–Milwaukee

The task of expressing the views of any national organization is an illusive and often illusory undertaking. When the organization is a professional association consisting of more than 11,000 individual members, efforts to achieve consensus or even a representative opinion on any given topic require implementing processes which facilitate broad participation. Within the structure of the American Institute of Planners (AIP), several mechanisms exist which seem appropriate to identifying the expectations of the profession with respect to the contributions of wildlife biologists to the planning process.

Geographically, AIP is divided into six districts of approximately equal membership. Each district is made up of chapters on a state or regional level and most of the 39 chapters are further subdivided into local sections. Through this grass roots network policy position papers are discussed and delegations are selected to a national planning policy conference where AIP's formal policy statements are debated, modified and adopted. After approval by the board of governors, the policy statement becomes the principal guidelines for AIP legislative activity and has considerable influence on program efforts. Between the bi-annual national policy conferences, a policy task force is appointed by the board of governors and charged with soliciting opinions on changes needed in the policy statement and with commissioning appropriate position papers for discussion.

Often the position papers for the national policy conference are prepared by one of the technical departments of AIP. At present there are eight technical departments, including one on Environmental Planning, which I chair. The technical departments are organized on a basis of professional specialization or topical interest. Membership is national and activities range from providing technical information and professional development services for members to reviewing proposed legislation. On occasion, specific projects are undertaken by departments to address questions of concern to AIP at large, or to the members of the department. Environmental Impact Analysis has been the primary focus of the Environmental Planning Department during the past year, in addition to its preparation of a policy position paper for the national policy conference and participation in an AIP sponsored national workshop on Urban Ecosystems.

The only mechanism for determining official AIP views is through direct actions of the board of governors. The board consists of the three elected officers, one representative elected from each of the six districts and three chosen at large, plus the Chairman of the Chapter Presidents Council and a student representative. The board may at times give an indirect indication of its views when staff and financial resources are used to support activities in areas considered of primary interest to the profession. In 1975 the board authorized the convening of a national workshop to consider the applicability of the ecosystems approach to urban management. The workshop was the culmination of a year long contract between AIP and the Division of Advance Environmental Research and Technology of the National Science Foundation's program of Research Applied to National Needs (RANN). AIP and RANN combined efforts to produce a truly interdisciplinary workshop charged with identifying methods by which environmental research could be more easily incorporated into planning and decision making processes.

Each of the organizational mechanisms described above has contributed to the formulation of an AIP viewpoint on the relationship of natural resources inputs to planning. My task is therefore a simple one: to extract pertinent information from these various sources and present them in a manner which may provide useful insights to wildlife biologists.

The report of the Urban Ecosystems Workshop provides an excellent beginning point. According to the report (Linville 1976) the urban ecosystems approach looks at the city as a set of interrelated systems (e.g., transportation, housing, natural resource utilization, etc.) such that a change in one of these systems produces corresponding changes in each of the other systems. This entails a comprehensive approach to the planning and management of urban problems including an examination of each of the various environmental systems and their interrelationships. From workshop discussions emerged a better understanding of component interaction within an urban ecosystem and a clearer definition of related problems requiring attention. In order for man to modify urban systems to better serve his needs he must, according to Stearns (1974) be able to intervene wisely and effectively in the physical aspects, the material and energy flow systems of the urban environment. In this endeavor he is likely to be restricted by available technology, resource limitations, and the capacity of various natural systems to absorb human effluence. The proposition which underlies the ecological method of planning according to the workshop report is

> . . . one of profound simplicity: it is merely that the knowledge of biological and physical systems is indispensible for the intelligent conduct of human affairs. The ecological method means understanding the place as a natural system and, through this understanding, identifying areas hazardous to life and health and areas which are intrinsically fitting for prospective uses . . . If a place can be identified as composed of different environmental attributes more or less suitable for various types of human uses, it is then possible to assemble all of the factors beneficial for every prospective use . . . The summation of this exercise is the representation of place as having variable intrinsic suitabilities for a number of land uses. The reverse image reveals those areas or processes which are stressful to life or health, where environments are intolerant or where nature performs valuable work for man.

Having set forth a methodology for integrating environmental with socioeconomic and physical aspects of the urban system, the workshop participants proceeded to formulate policy recommendations and suggest institutional changes needed to facilitate use of the urban ecosystem approach to urban management. These included five recommendations under the general heading of natural resource conservation. In this context, natural resource conservation refers to the wise management of all those elements and systems within the urban environment which are not man-made (i.e., wildlife, vegetation, soil, water and air). Most of these have direct implications for wildlifers.

1. One of the major problems involved with natural resource conservation is the proper distribution and management of its various elements. Prior to development more intensive efforts must be made to:
   a. Identify unique vegetation and wildlife so that more adequate decisions can be made about its management;
   b. Increase research aimed at identifying factors in the urban environment that define the density and variety of wildlife;
   c. Develop methods for managing open space in an ecologically sound manner that minimizes costs and maximizes public benefits;
   d. Establish a comprehensive approach which develops both the technical criteria and the institutional supports necessary for a meaningful delineation and wise management of areas of "critical concern;"
   e. Develop more adequate relationships between the distribution of natural resources in urban and suburban areas and the political jurisdictions responsible for providing and controlling those areas;
   f. Determine the point where the public enjoyment of common land resources (e.g., seashore or lakefront) outweighs the private right to own it. When does dedication of land or overregulation become a taking of land?
   g. Determine the possibility of developing areas which are sensitive to natural resource conservation without pitting environmental and conservation interests against economic and political interests;
   h. Reduce the confusion involved in identifying the appropriate aims of public policy in natural resource management. This action should include considerations about the timing and consistency of concern;
   i. Measure and predict the effects of new developments and different types of land use (e.g., residential, commercial, industrial, agricultural) on water supplies and water quality.

2. Aside from scientists and researchers, not enough people are adequately aware of and sensitive to natural resource conservation.
   a. Continue efforts to map basic data uniformly, describing physical and natural resources. Such efforts should include soil type, topography, underlying geology, wildlife habitat, land use and hydrology.
   b. Establish a common and understandable terminology among the various professions involved with natural resources conservation. Related to this is the need to bridge the communications gap between those professions and the general public.
   c. Identify the major remaining barriers which prevent federal, state and local governments from enacting wildlife legislation that requires species inventories and vital habitat identified for preservation as part of the planning process,

d. Recommend methods to overcome the inadequate levels and rates of understanding between the use of natural resources and the quality of human life.

3. Research based on the conclusions of METROMEX (a major study of inadvertent weather modification in St. Louis) and similar studies will more fully define the thresholds and limits of fossil fuel heat that may result in detrimental local climatic alteration. However, research is also needed to develop better mixes of vegetation, water surfaces, reflective buildings, roads and other structures in order to minimize the "heat island" effect.
4. Further study should be directed to the use of natural resources to alleviate space and noise problems
5. Current open space management practices are often ecologically and economically unsound. Vast areas are regularly mowed, wasting energy and increasing air and noise pollution while maintaining unproductive ground cover that yields few indirect ecological benefits such as increased water absorption, ameliorating adverse effects of urbanization on climate, etc. "Permanent cover" frequently utilizes exotic species that are not adapted to the area and therefore require intensive (and costly) management, e.g., watering, fertilization, liming, etc. We need better understanding of ecologically sound management procedures to correct these problems.
   a. Since the current management procedures reflect the attitudes of government agencies and the public, implementing changes in urban open space management will require research on how to communicate effectively the need for and benefits derived from such change.
   b. Research is needed to develop methods of managing urban open space in an ecologically sound way that minimizes costs and maximizes public benefits. Studies may include economic benefits derived from added land values neighboring open space areas, quantitative accounting methods for evaluating ecological benefits on a cost-benefit basis and proper maintenance of open space areas.

In adopting these resolutions, the workshop participants indicated a need for a wide range of site specific base information as well as for ecologically sound management techniques.

Resolutions adopted at the AIP National Planning Policy Conference in March 1975 further reinforce the need for incorporating ecological analysis into the planning process. Under Section 11, on land use, subsection 11.2 entitled State Land Use Legislation, includes the following statement (AIP 1975): "The comprehensive plan and planning process should be based on a thorough inventory of natural resources, hazard areas and scenic, visual, archeological and other critical or natural environmental concerns, as well as a basic understanding of the functional relationship between the physical and biological components of the natural environment." In addition, subsection 21.3, Environmental Surveys, Analyses and Assessments, under the Section entitled Environmental Quality, states: "As an integral part of the urban/environmental comprehensive planning process, certain environmental elements are essential to be surveyed, analyzed and assessed including but not limited to: energy usage, the water cycle, land suitability and vulnerability, wildlife and plant habitats, and other critical or fragile ecological systems." For such information, the planning profession is dependent on the work of wildlifers and other natural resource scientists.

In order to provide useful insights for the planner, wildlife biologists must go beyond descriptive studies which contrast natural habitats of considerable species diversity with simplified urban habitats characterized by exotic species such as dogs, cats, rats, pigeons, house sparrows and starlings. The planning profession has recognized the desirability of including open space in urban areas. What is needed is a clearer understanding of the types of open spaces needed to provide specific types of wildlife habitats and the value of such wildlife to the well being of the human inhabitants of the cities.

Gill and Bonnett (1973) have used Los Angeles to illustrate how inaccessible natural areas within the city can provide protection for those small areas of undisturbed habitats essential for the maintenance of wildlife indigenous to the area, even such large mammals as the coyote. Los Angeles is described as "a city with islands of wild landscape" while London is characterized as "a city with integrated suburban wildlife habitat." The contrasting images are vivid. The chapter on Los Angeles ends with the assertion: "When wild nature is an integral part of the city ecosystem the esthetic awareness that is engendered in urban man can become a vital force in enhancing the quality of urban life." Yet the authors do not provide any evidence to support this assertion, nor do they pursue the comparisons to illustrate qualitative effects of these contrasting treatments of open space upon the urban fabric. Wildlifers must follow through with this next logical phase if their descriptive studies are to be fully utilized. Without such insights the creation or protection of wildlife habitats is not likely to become a major concern in the development of human settlements.

Despite some studies indicating correlations between levels of specific pollutants and observable effects on various species, wildlifers have stopped short of defining a vital function for wildlife and natural areas as indicators of health within an urban system. There have of course been studies of the functional interaction and adaptive processes of individual species, but there are only casual references in the literature to any benefits or damages to human populations associated with maintaining wildlife habitats in urban areas.

Neither emotional appeals to live with nature nor exaltations of the greater wildlife diversity found in suburbs over that in city centers is likely to cause a reordering of planning priorities. This should not be taken as an indication that planners do not recognize any values in human contact with wildlife but rather as an appeal to tell us where in the city we should strive to create what types of wildlife habitats. What types of habitats are desirable in the context of different types of urban areas? Should an industrial park also be a nature preserve? How could this be achieved and what benefits would it offer? The inclusion of open space in an urban area is per se development of wildlife habitat but the literature which would guide a planner in laying out open space systems to protect unique habitats or in designing open space plans to support specific types of wildlife is not extensive. It is in these areas that the contributions of wildlifers are critical to ecologically sound planning decisions.

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Wildlife Research Needed by Landscape Architects

Robert O. Brush

American Society of Landscape Architects; and USDA Forest Service, Northeastern Forest Experiment Station, Amherst

This is the first time, to my knowledge, that landscape architects have been asked to suggest directions for research in wildlife biology. My colleagues in the American Society of Landscape Architects appreciate this opportunity to share in developing information that will help us to better fulfill our professional responsibilities. In preparing this paper, I spoke with several landscape architects in different parts of the country who expressed keen interest in the relation of wildlife to their work. Several of my colleagues who are avid sportsmen urged continued research in support of hunting and fishing; many also stressed the need for more information about nongame species of wildlife as well.

Before launching into a discussion of research needs, I would like to describe briefly some of the relevant aspects of the practice of landscape architecture; then I will focus on some areas where research needs are perhaps most critical, and where results may be mutually beneficial.

Landscape architects shape and reorder the outdoor physical environment to accommodate human activities. We are primarily doers—we analyze a situation, imagine alternative arrangements, and prepare maps, drawings, and programs to direct the implementation of the chosen alternative. In the practice of landscape architecture, we borrow knowledge from many fields—engineering, art, and ecology, among others. I would emphasize that we are as much concerned with natural processes and the function of natural ecosystems as we are with engineering and art. More and more of our clients and governmental employers are coming to recognize that the success of a designed environment depends as much upon the smooth functioning of natural processes as it does upon human convenience and pleasing appearance.

Most of the projects that landscape architects are involved with affect in some way the habitat and population dynamics of wildlife. Let me give a few examples that suggest the range of our professional activities: fitting highways on the land with as little disruption as possible of natural processes; siting homes and offices, even new entire communities, in natural surroundings; shaping landforms and restoring vegetation on sites where surface mining or excavation has taken place; and inventorying natural resources for the purpose of allocating land to the best conceivable use, be it a wildlife refuge or a resort community.

It is in metropolitan environments that the landscape architect is most influential as a manipulator of wildlife habitat. It is in and around cities that landscape architects face the greatest challenge in integrating man-willed activities with natural processes. And it is here, in and around cities, where it is most difficult for researchers in wildlife biology to isolate sources of variation and to measure effects. Therefore, I would like to focus on the information that we landscape architects need from you wildlife biologists regarding the untamed creatures in metropolitan environments that share their living space with people.

Ironically, we landscape architects often do not realize the full effect that our work has on the songbirds, small mammals, amphibians, and insects that still inhabit urbanized areas. But through our professional actions, knowingly or not, we are practicing wildlife management. Whenever we have an option to recommend that certain land be left undeveloped as open space, or whenever we set out to restore disturbed sites to more natural conditions, or whenever we have a choice of recommending plant materials, we have an opportunity to increase the extent and improve the quality of wildlife habitat.

The concern for wildlife in urban areas is growing, and the interest is most persuasively reflected in the marketplace. Many residents of metropolitan areas go to considerable expense to attract and observe wildlife close to their homes. By a conservative estimate, about $500 million was expended for birdwatching in this country in 1974 (Payne and DeGraaf 1975). Some species are especially desired by and compatible with people, such as chickadees, bluebirds, squirrels, and chipmunks. Other species such as feral dogs, skunks, and pigeons are sometimes nuisances and may even be health hazards. The coyote, which we consider harmless in the wild, is settling comfortably into the suburbs of southern California where he could become a troublesome pest.

There are three areas in which more wildlife research would be especially useful for landscape architects. The first concerns the patterns of open space in metropolitan areas that are most beneficial to wildlife. Landscape architects have long worked toward reserving networks of open space in metropolitan areas, networks that consist of large tracts of undeveloped, predominantly natural land connected by narrow corridors of open space along ridges or streams. One of the arguments advanced for providing networks of open space is the opportunity for wildlife to pass freely from one undeveloped open tract to another. The research question is: Do networks of open space really facilitate the movement of urban wildlife? Does the pattern of open space in a metropolitan area matter at all to a given species such as a chipmunk, a bluebird, or a garter snake? Which would better, many small tracts of an acre or less, or a few larger tracts of 5 to 20 acres connected by natural corridors along ridge lines, stream beds, or strips of woodland? Or would a single large tract be best? Where there is a choice of several alternative patterns of open space, which pattern would best serve the needs of given species of urban wildlife?

Second, it would be useful for us landscape architects to have a clearer idea of what you wildlife biologists mean by "edge effect." I first leaned about edge in *A Sand County Almanac.* Aldo Leopold pointed out the greater quantity and diversity of wildlife that is found at the transition between two vegetative types. It is commonly known that if there is a choice, more edge is better for wildlife. But when it comes down to designing edge between forest and field or between woodlot and lawn, there is very little for us to go by. There is little available literature regarding the structure, volume, and composition of edge vegetation that benefit particular species. To maximize the benefit to wildlife, for example, should the edge be broadened to include shrubs and small trees in rows of increasing height, or is an abrupt transition preferable? This sort of information would be useful to us in preparing planting plans for parks or institutional grounds or wherever wildlife is to be provided for.

Third, what guidelines can you give us for managing the vegetation in urban open spaces so as to attract desired species of wildlife or to discourage less desirable species? Should the species to be managed for be based on popular opinion, or does a stable urban ecosystem require that certain wildlife species be maintained regardless of popularity?

What are the vegetation characteristics of the optimal habitat for urban wildlife? Since most of the trees and shrubs introduced in designed environments are obtained from commercial nurseries, which of the commercial cultivars are valuable for wildlife habitat? Most of the projects we design are completed in a year or so with little consideration of maintenance over a long term. In urban environments where every acre counts, what vegetative management, if any, is needed over the years to maintain the quality of wildlife habitat?

When I speak of guidelines for managing the vegetation in urban areas, I don't mean to exclude the urban wetlands, estuaries, and lakeshores that are the habitat of aquatic wildlife. Many landscape architects would welcome more information from you about the consequences of development near aquatic environments, and about how to restore vegetation on disturbed sites.

A related problem is the reduction in wildlife habitat as town centers inevitably grow and pave over soil and streambeds. How might the habitat quality of the remaining urban opening space be upgraded or enriched to compensate in part for the adverse impacts of urbanization? Would more intensive management of urban open space in any way make up for the habitat we are losing?

I appreciate this opportunity to participate in defining research needs in wildlife biology. With your guidance and research, landscape architects could contribute more effectively to protecting the wildlife resources of urban areas. I hope that this exchange of ideas continues.

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Wildlife Biologists' Involvement in the Planning Process[1]

Dean Paul Longrie
Federal Power Commission
Washington, D.C.

For much of our history wildlife professionals have been involved in some phase of research, education, or management of natural resources which were ususally located away from areas of intensive development: national forests, state game lands, or wildlife refuges. Today, lands not intensively developed are diminishing and in the future will continue to vanish. Like the quantity of open space in our country, the quality of the urban and suburban environment has declined substantially. However, the public has recognized this decline in environmental quality and wants it stopped. This was forcibly illustrated by the enactment of the National Environmental Policy Act of 1969 and similar State regulations.

We Give and Gain

A quality environment is usually reflected by the diversity of wildlife species. Increased quality results in more species of wildlife (Evenden 1974) which people of all ages readily appreciate (Dagg 1974). The wildlife professional, a natural resource manager, concerned with species diversity and composition has the education and experience to integrate ecological concepts and management methods into urban and regional planning processes to help achieve a quality human environment (Stearns 1974, Dorney 1970, Maestro 1974). He is traditionally suited for this role because the wildlife biologist "... must continually relate human goals and environmental management ... " (Dorney 1970). The need for application of this expertise within the planning process has been recognized for years (Bennitt 1946, Davey 1967, Stearns 1967, Twiss 1967). Many planners and landscape architects have recognized that planting trees and shrubs of various varieties often result in instant wildlife. However, making over habitat by planting is probably the most expensive method of attracting as well as producing wildlife. Perhaps the most desirable, in terms of maintaining the quality of the environment, and the least expensive, is first identifying and then considering an area's wildlife habitat value prior to development. This should be done during the intitial phase of development when the feasibility of a preliminary plan is determined. The wildlife biologist is particularly qualified to assist in this initial phase of development because he can readily identify major natural resource problems before substantial expenditures of capital are made.

Professionally and individually we can gain from a partnership with planners and others involved in urban development. Most political and economic power rests in the hands of the majority of the population residing in cities. This increasing urban population could be exposed to the many ecological principles

[1] The views expressed herein are those of the author and do not represent an offical statement of the Federal Power Commission.

related to environmental quality through implementation of wildlife management practices in the city (Noyes and Thomas 1973). This exposure should result in increased support, political and economical, for existing resource agencies. Such support is much needed at this time when the wildlife biologist's traditions and philosophies related to the values of hunting, wilderness, and preservation are widely attacked in the media and by the budget administrators.

Action Needed

Due in part to our past concentration on managing undeveloped land, we need additional research such as described earlier by Mr. Brush; we also need increased committment on the part of agencies—State, Federal and local in terms of personnel and programs (Doig 1974, Greenwalt 1974); but most of all we need communication between active professional wildlife biologists and the planners, architects and engineers responsible for development.

How do we get this communication? One way of establishing avenues of communication involves getting wildlife biologists in all parts of the country to meet with their friendly next-door planner. They must establish communication at the local level (county or municipal) where decisions regarding "new town", subdivision, industrial park, and other developments are made. The benefits directly resulting from a partnership of these professions should be easily realized.

To facilitate the meeting of wildlife biologists and planners, representatives of both the American Institute of Planners and The Wildlife Society throughout the country have been asked, or soon will be asked, to set up joint meetings. At these meetings the participants will introduce their respective profession and briefly suggest what they could give to and receive from such a partnership. The format for these meetings could be a panel discussion, such as we have here, a brief scenerio or a case history discussion.

A pilot program incorporating the above suggestions has been planned for the Pittsburgh area in the very near future.

The success of such meetings will be measured in terms of increased mutual understanding and respect for each profession, the increased quality of human environment due to integration of ecological concepts and wildlife management methods in subsequently planned development, and the establishment of similar partnerships between other professional groups—all to the benefit of man and other natural resources.

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Discussion

MODERATOR GEIS: I think Royce Lanier presented an interesting challenge when he pointed out that there is very little evidence to support the contention that society really benefits from wildlife in their natural areas in the environment. I am looking forward to the publication of the transactions of a symposium held in Canada, not long ago on, "Wildlife in an Urbanizing Environment," because one of the papers presented at that conference, was a very fine one by Dr. Val Geist of the University of Calgary, presenting very substantial evidence that experience with substantial open areas and wildlife has a beneficial effect on man, particularly children.

MR. DAN LEEDY [Urban Wildlife Research Center]: I think each of you has addressed the point that there is a need for communication between the wildlifer and the planner, but I am wondering if once this communication is established and you have some of the answers as to who manages wildlife in urban environment, do you have the resources to do it? I am referring, of course, to financial resources. Are these resources available? Are they available within the region you are in as a planner so that you could proceed with a positive program of planning?

MR. THILLMAN: Being the pragmatic one and down in the trenches, I think you do not really need the resources if you preserve the space, and if you know how to preserve the space.

I am going to react to the zoning pressure that we are having in Fairfax. When you talk about probably 20,000 or 30,000 acres being zoned between now and June 1, we may get 10, 12 or 14 percent from the developer, whatever percentage of that zoned land in open space that is usable. The whole issue is that we do not know how much land we need to preserve wildlife. I think after we get the land it is not an issue any more. We are not going out with lawnmowers and make sure the grass is cropped, or make sure there are roads paved to get into that area. It is the land being left, and that is my concept of the way we want to see those things preserved. If you want to look at some of the things Moderator Geis has done, specifically, what kinds of units the suburban bird population consists of, we know that certain kinds of birds are going to roost and nest and set in the trees over there, and we do not have to go out and keep kids away from the trees. We do not have to worry about cats and dogs.

I do not think it is the cost. I think the cost is at the implementation stage from the planning process. I do not think the cost that happens five or six or seven years down the pike is the real concern. I think the cost is additional in preserving that land now and knowing how to preserve it.

This is the only answer I can come up with and that is the way I feel.

MR. BRUSH: With regard to maintaining open space for wildlife, I think part of the challenge is to find ways to minimize the cost of maintaining it; to work with natural processes to perpetuate wildlife with the minimum amount of human interference in the open space environment.

MODERATOR GEIS: I just want to add a post-script to his comment. I cannot help but emphasize the cost will not be great. The costs will actually be lower if they can do as he suggests. There have been tremendous amounts of money wasted in overmanaging urban open space areas in a manner that is environmentally bad, as was recognized by the AIP in their statement concerning this.

MR. JOSEPH SHOMAN [American Conservation Planning Associates; former Director, Nature Center Planning Division, National Audubon Society]: I do not have any questions, but I do have a comment or two.

First, I congratulate all of you for your fine presentations here this afternoon. It is high time that we had this kind of a discussion at the North American Wildlife and Natural Resources Conference.

I just completed a 12,000 mile trip about the country, including Canada, visiting nature centers all over the United States, mostly in urban areas, and seeing the cities. I must say that I am absolutely appalled at the amount of money that is being wasted on projects commemorating the Bicentennial by many of our cities.

These are being done by landscape architects and architects and planners, with very little consideration for just the simple needs of biological systems.

I will just give you an example. Norfolk, Virginia, is trying to do something to rejuvenate the city. They have spent millions and millions of dollars, and they are spending this money to redo Grandy Street, the main street. Somehow the architects, landscape architects, and planners that have come up with this incredible master plan, which completely destroys the enclosed system that you must have in nature, in the cities, if your living green walls are to be viable. They have just closed off the street with concrete and asphalt, brought in all these concrete hot pots where the plants are going to die because they are not in contact with the soil that is down in the streets.

I see this all over. I see it in Miami. I see it in Houston. I see it all over California. Somewhere we are missing a tremendous bet by not training landscape architects, architects and planners in some of the simple fundamentals of everyday plain living. Some of them have never even had a course in biology.

Somewhere we are missing the boat way back in training, and I would like to leave you with a couple of suggestions, that all the professions try to get something introduced first at the academic training level. The University of Michigan is trying to do that. The landscape people are integrated in the School of Natural Resources. This is great.

But the planning people should be in there. There is no reason why wildlife people in forestry should not have some courses in planning, just as landscape people and architects should at least have some rudimentary knowledge of urban ecology. But this is not being done. This type of communication after we get out into the professions I think, is all right, but it is missing the best. We have to get way back there to train the right kind of people so that we know what we are doing when we are trying to change or trying to improve the urban environment.

MS. POLLY DYER [University of Washington]: After his comments, these will probably be supplementary. This summer, in connection with the cities, we are having an evening series of programs. One of them is to take a look at urban wildlife in highly developed neighborhoods, going from the park outward. One of the classes in wildlife is working on it.

I was seeking information for a bibliography which would give the students and the lay public something when they ask if there is any such literature that I could track down. Apparently there is not.

MODERATOR GEIS: I do not think that is a fair appraisal of the situation. There has been, if I understand the situation correctly, a substantial amount of information collected on wildlife in urban areas.

One really good reference is the transactions of a symposium that was held some years ago in Massachusetts titled "Wildlife in an Urbanizing Environment."

Perspectives on Training Needs for Future Resource Managers

R. Keith Arnold
Director, Center for Natural Resources and Environment, and Associate Dean, Lyndon B. Johnson School of Public Affairs The University of Texas at Austin

The invitation to present this paper gives me an opportunity to examine many thoughtful analyses of the rapidly changing role of renewable resources in society. To do this requires exploration beyond the traditional training to expand man's domination of nature and environment. I am forced to conclude that as social needs outpace the capability of land to produce and to dispose of waste, we must innovate a new concept and training regimen for resource managers.

The argument is presented in four parts: (1) changes the title; (2) describes some inadequacies of resource manager training; (3) proposes a diagnostic model for a "new professional": *Manager of Resource Affairs;* and (4) suggests one approach leading to a new concept.

Title Changes

The title, "Perspectives on Training Needs for Future Resource Managers," was satisfactory to me just seven months ago but is no longer adequate. In fact it parallels the inadequacies of resource manager training. If I were to select a title now, it would read, "Perspectives on Training Needs for Future Managers of Resource Affairs"—not just a play on words, but a description of a broadened professional. If you will accept this change we can move rapidly into the argument.

Inadequacies of Resource Manager Training

There are too many inadequately prepared professors in too many schools training too many students to perform tasks that no longer exist. In other words, today's academic approach to resource management lacks force and substance related to current and future problems. My many friends and colleagues in academia will know that this criticism applies to me as well as others. I make this self criticism because of my responsibility for academic direction of one leading school and for my failure to face the facts when advising and consulting with others.

Traditionally, resource managers have been totally absorbed in solving the biological, engineering and economic problems of resource utilization—and rightfully so. A great nation has been built from its rich abundance of natural resources. We had to expect from our lands greater productivity, increased waste disposal and a wider array of amenity services.

With increases in scientific knowledge and the advent of new technologies, the resource manager's tools became more powerful and complex. Education and educators kept pace with change and often generated the changes. I only need to mention such examples as genetics, photogrammetry, computer programming and systems analysis to prove this.

Further complications for the resource manager developed concurrently with transportation as it stimulated the vast array of outdoor recreation pursuits. Two phenomena particularly have stretched the traditional resource manager to the breaking point. The first is the scarcity of land. We all know the story of competition for land, not only among competing natural resources, but among uses for highways, pipelines, airports and new towns. The resource manager must be aware of the public interest and be sensitive to the will of the people. Second is the quality of the environment. The capability of our forests and wildlands to provide amenity services is a resource in itself that we are just beginning to appreciate and measure. We now know that wildlands and their associated air and waters cannot continue to be used to absorb and diffuse the pollutants and excreta of expanding populations. We cannot measure the psychic and/or health benefits of a forest environment. Yet they affect nearly every decision a resource manager makes.

Today, the American people—and to some degree world populations—have awakened to the fact that our natural resources lie along a continuum which starts at the door of the high rise apartment and extends to the heart of our wilderness areas. Furthermore the entire globe is a complex, interlinked ecological web which cannot be manipulated by single-purpose projects. Daily papers and the TV keep us in touch with the sights and sounds of legislative debate, the record of legal actions and the polemics of public hearings. We know that economic, social and policy interactions in resource management are real, complex and critically important to our daily lives and possibly to man's future existence on earth.

Natural resource schools have broadened their programs, added courses, diversified faculties and otherwise done all they could to adjust to the changing role of the resource manager. They have led in the development of biological sciences; they have adopted and adjusted to new technologies; and many have added strong programs in ecology and environmental quality. Curricula such as recreation, planning and landscape architecture have been added.

Natural resource schools have also taken advantage of general interest in environmental affairs to attract better students. Unfortunately this has also led to major increases in enrollment. Most if not all resource schools have at least doubled their enrollments and some have increased three to ten times. Faculty-student ratios are beyond reasonable standards. Professional education has been replaced by a generalist approach. Many new students in professional schools are actually seeking an environmental education. Of significance is the fact that a larger proportion of graduates are not finding employment in resource management jobs.

In support of deans of natural resource schools, we must recognize their plight. They must play the numbers game to effect development or improvement and often even to survive in today's zero-growth university. Inflation, reduced public support and limited private contributions have forced university presidents and governing boards into no-growth policies which generally preclude new programs and growth in any area without a compensating reduction elsewhere. With the impetus of environmental concerns and student demands, able deans of existing natural resource schools have ridden the growth wave;

and universities with little to no background in resource education have entered the field. Competition for great and even able professorial talent is severe—there are just not enough experienced professors to go around.

A Diagnostic Model for a New Professional: Manager of Resource Affairs

It is not difficult to find support for a new professional. Gilbert White (White 1966) emphasizes that "one striking fact is that a large number of environmental quality decisions are made by people who feel a strong professional identification. Their views of themselves as conservationists, economists, sanitary engineers, foresters, etc., may be expected to shape their perception of the environments and their competence to handle it. Their perceptions and preferences become the implicit and usually unchallenged determinants of plans presented for public choice."

Joseph Fisher (Fisher 1969) in a symposium on Undergraduate Education in Forestry describes how "future foresters must be sensitive to people: their aspirations, needs, capabilities, foibles, inconsistencies—especially to the desire people have to take part in the decisions that will affect them . . . We enter here the field of social engineering and institutional design . . . The remaking of decision processes is one of the most exciting frontiers for foresters . . . "

Henry Vaux (Vaux 1972) stated that "social and political change in the years ahead are likely to be more drastic than most of us have ever experienced, and less predictable. Much of our educational effort in the past has been directed toward pre-programming the student behavior—giving him information and knowledge that would permit him to do things effectively in kinds of situations that could be foreseen and in the interest of goals that were both certain and widely understood and accepted. Education exclusively defined by this view of our social and political environment may not only be suboptimal in the future—it might be a total disaster."

Many have expressed needs and concerns similar to White, Fisher and Vaux. Inadequacies of resource manager education find their way as subject matter into most meetings of resource professionals. In fact, today it would be difficult if not foolhardy to claim originality in this area. Experience, though, of a number of universities in establishing new schools of public affairs and in attempting to create a new "professional" in public administration does provide some insights and concepts which appear germain to a diagnostic model of a new professional in resource management.

Let's call the new professional, "Manager of Resource Affairs," with two broad, coequal areas of responsibility: management of natural resources and management of related social resources.

Under management of natural resources are the traditional tasks of implementing resource policy and solving resource problems through knowledge and skills in biology, engineering, and economics. Based on land capability, there are three identifiable yet interrelated goals:

Preservation. Resources such as wilderness areas, research natural areas, natural germ plasm reservoirs, outstanding natural phenomena, and aesthetic areas must be preserved for future generations. I agree with Brubaker (1975) that "our obligation to future generations is to avoid irreversible damage to the large global ecosystems, to the human gene pool and other genetic stocks and to ecosystems."

Multiple use. Most natural resource lands must of necessity be managed for multiple uses either simultaneously or sequentially. There is no question that available land is scarce when it is projected against an ever enlarging demand to meet the needs of humans for physical products, environmental quality and amenity values. Multiple use as a strategy aims to provide the largest sum of social, economic and spiritual benefits. In practice it allows for exclusive uses in some areas, primary use or predominant management with secondary uses in other areas and in still other cases, general use where neither predominance or exclusion is necessary. There is no question in my mind that most of our lands, even in cities, will have to be managed for multiple purposes.

Intensive production. Our needs for food and fiber have been predicted by some to fall so far short of capability to produce them that survival on earth is questioned. Others question ability to continue to increase production as we have in the past. This element of land management recognizes the opportunity for intensive management of natural resource lands far beyond current practices. Biological engineering with advances in genetics, cultivation and protection from insects, disease, fire and atmospheric extremes can multiply presently projected yields several times. We have only to look at agriculture for guides for developing and harnessing science to achieve this goal.

Equally important with management of natural resources, the new professional must be able to manage related social resources. Similarly, we can identify three elements in these professional activities: work force, resource users and policymakers.

Work Force. The resource affairs professional must employ a sizable work force to perform the management tasks just described and to achieve appropriate interaction with resource space users and policymakers. Complexity and diversity of problems and responsibilities lead to a broad spectrum work force of many disciplines and professions. The manager of resource affairs must be disciplinarily multilingual to communicate with his work force; he must be skilled in motivation and administration and reasonably competent in a least one discipline or scientific area. His work force is a social resource which results from and leads to private or public investment in resource management. It is used to relate to resource users, to interact with local government and business entities, as well as to implement policy and solve problems.

Resource space users. Resource space users occupy the natural resource environment in one way or another. They include traditional campers, hunters and fishermen, motocyclists, snowmobilers and skiers who use the land considered as the base for natural resources to do their thing. TV viewers, photographers and movie producers also are resource space users. Stockmen and miners are among those who modify parts of the same lands for their productive enterprises. These and other groups of people each have specific needs and preferences and usually develop different perceptions of the resource environment. The manager of resource affairs obviously must deal with all such users—balancing needs, resolving conflicts, establishing priorities. Together these users form a strong social force that can support or oppose, contribute or restrict, conserve or destroy.

Policymakers. This activity of the manager of resource affairs is the newest, most important, complex and least understood. It is here that management aims are related to the driving forces of society. In the final analysis, policymakers in our country are the people. They exert their influence on the decision processes through the Congress and the courts, through resource and environmentally related organizations and citizen groups as well as by their individual actions. As John McGuire, Chief of the Forest Service, recently stated: "Administrators of Federal land management agencies have no mechanism for determining the public good or the will of the people." It is the people and their executive leadership who will finally determine our national priorities as related to standards of living, quality of life, defense, etc. In terms of resource management we need to establish national priorities for food, energy, materials, waste disposal and amentities.

People, furthermore, demand the right to be in on the planning process that precedes policy determinations and the decision process. A new form of participatory democracy must be innovated in the natural resource area which provides a new role for the manager of resource affairs.

A New Concept

Resource schools cannot continue to adjust, adopt, improvise, establish new curricula and introduce new courses. Generally the better schools have achieved some balance as they reduced science and other basic requirements for resource management in order to accommodate new subjects for some understanding of new uses and for some exposure to management of related social resources. Five and six-year curricula have been debated and explored and special graduate programs employed.

Two propositions are suggested. The first deals with the four-year undergraduate curriculum in resource management. The second presents a new professional degree designed to produce a new professional, Manager of Resource Affairs; emphasizes related social resources management; and integrates the two propositions.

First. Schools of natural or forest resources should emphasize their traditional, sound, proven resource management curricula in a four-year undergraduate format. Their goal, within the framework of a good general education, would provide the biological, physical, and economic bases for the management of natural resources. Heavy emphasis would be placed on land capability as it relates to preservation, multiple use and intensive production of needed materials.

Second. Some three to six universities should establish *new* schools or programs to provide a two-year Masters Degree in Resource Affairs. Specifications for the program might include:

Admittance requirements:

- Graduation from an accredited curriculum in natural resource management with grades appropriate for demanding graduate work.

- Accepted achievement on the Graduate Record Examination.
- At least three years, preferably five, or professional-level resource management experience.

Curriculum:

- First year—special background seminars in:
  - . . . resources economics
  - . . . policy processes
  - . . . social and behavioral sciences
  - . . . policy analysis
  - . . . professional ethics
  - . . . administrative behavior.
- Summer—internship in a government agency or large resource industry working on policy or planning projects to extend prior experience.
- Second year—
  - . . . Resource policy research seminar to develop team approach skills to solve real policy problems for public agencies.
  - . . . Independent policy research project for an industrial concern or public agency.
  - . . . Topical seminar on a contemporary policy issue.

Teaching staff—multidisciplinary, with extensive government or private experience at policy levels, or experience in applied social and behavioral research.

A faculty/student ratio no larger than 7 to 1.

Close ties with public and private resource management agencies and associations of citizens and professional groups concerned with resources policy.[1]

This is an expensive proposal, but universities willing to innovate should be able to obtain direct and indirect assistance from foundations, public agencies and resource industries. The stakes are high, and much hinges on a new breed of professional to manage resource affairs. The new schools of public affairs started six years ago with support from the Ford Foundation to provide direction for such an effort. Some few universities must have the fortitude to create, to modify and to redirect resources to a new approach. Private interests and government agencies would have to contribute to the success of such a "new" degree program. If this hope is realized, I have no doubt that foundations will also support the development of a truly innovative program.

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[1]The Forest Service has had cooperative graduate programs with universities in fields of watershed management, outdoor recreation and forest fire. Weyerhauser Timber Company has had "high yield forestry seminars with several universities." These kinds of activities would be critical to the relevance and success of this proposal.

Discussion

CO-CHAIRMAN TEER: We have heard several times today references made to the fact that we are prisoners and oftentime victims of our own training and narrow views, and Dr. Arnold has given us a formula for escaping that.

While some of you are making up your minds to come to the front with questions, perhaps I can address a question to Dr. Arnold. Did I understand that you would have this training at the undergraduate level to be traditionally in the discipline that ordinarily one would train in at the present time and the specialization, or maybe the generalization, take place at the graduate level?

DR. ARNOLD: Yes, following practical work experience.

MR. JAY McANINCH [Ohio State University]: If you expect to train the undergraduate as he is being trained today, and expect three to five years experience before he takes his Masters, you might explain to a lot of bachelors how they can get their three to five years experience.

DR. ARNOLD: I know the present job situation is difficult, and that is one of the reasons for the statement that there are too many schools and too many courses in the natural resource management area.

I think this is understandable because the established schools are riding the crest of the wave of environmental interest. Many people have come in that normally would not. We have, as I understand it, much better scholars and students in our schools. But there will be two things that I predict will happen. One, that there will be an opening up of the job market; and two, there will be a shaking out of some schools and some individuals in the programs.

MR. McANINCH: I think almost everybody will agree that at the bachelors level in environmental studies the crest has been there for some time. I sometimes wonder if the Master's level is working on the basis that graduate students get a lot of work done for individual state, federal and private concerns.

DR. ARNOLD: This will not be a research program and have any of the traditional academic approaches. I would agree with your comments.

CO-CHAIRMAN TEER: Are there any further questions?

MS. A. KEITH [Ohio State University]: Many times as wildlife students we are taught to believe we should place more emphasis on what people demand, and this tends to bother me. We should change our emphasis to demand more of people. Would you comment on that idea?

DR. ARNOLD: That was a little bit the thrust of my comments. People management is not a very good description. That was why I labeled the second major division of natural resource affairs as the management of social affairs, which involve three kinds of people contact—one, the milti-disciplinary work force, two, the resource users, and three, the policy makers, including all the people as well as the Congress and other legislative bodies.

CO-CHAIRMAN TEER: Thank you very much, Dr. Arnold, for a very provocative and innovative idea about training new resource managers. I sometimes think that we will have to train a superman to accomplish some of these things we want to do and perhaps your formula will work.

Selling Sound Resource Management—Investment in the Future

Eleanor Horwitz
Society of American Foresters
Bethesda, Maryland

In 1948 an ecologist named William Vogt wrote a book entitled *Road to Survival* in which he tried to alert Americans to the idea that natural resources are not infinite and that they should be managed with care. In those days few people, aside from some professionals, worried about natural resources. Vogt was dismissed as a Cassandra and his message was widely ignored. Twenty-eight years, 40 space flights, and about a dozen resource crises later, a lot of people care about natural resources, their management and their future. Once natural resource managers hoped that the public would learn to care. Now the public cares and, as Ruth Clusen put it in her address to the American Forestry Association last fall, we "have become the victims of our own success."

By rights, natural resource managers should be delighted with the transformation—but somehow they are not, perhaps because public interest has come dragging with it a string of complications. In the old days all a resource manager had to do was to determine what needed to be done and then to figure out how to do it. That was job enough but today he must determine what must be done, who will be affected, and how they will react. He must explain and justify precisely what he intends to do. But in spite of the manager's increased concern with public reactions, in spite of environmental impact statements and public hearings, programs still stall because of lack of public understanding.

The public is no longer content with the old "spectator" role. It is demanding the role of an active partner, not, as some managers fear, in telling professionals how to do their job, but by taking an active part in setting goals and in program oversight. This trend is increasingly apparent in land-use planning, at PTA meetings, and in the offices of legislators to name just a few. It is a function of an increasingly interested public and it may, in part, be a legacy of the Watergate problem.

There is nothing new about the need to sell natural resource programs. Sixteen years ago, R.D. Calkins spoke at this same forum on "Public Relations and Education in the Wildlife Management Field." If his suggestions had been translated into funds and action then, the problem would be far less pressing today.

Nor is there much new about the practice of selling resource programs. Members of federal, state, local and private resource agencies produce articles, pamphlets, movies, teach in schools and conduct tours, all to promote various resource programs. Thirty-nine states responded to an informal survey with a great pile of material. Most of it is aimed at sportsmen although a number of states report programs aimed toward a broader public through use of the mass media. Only six reported material suitable for use in schools.

Where programs are weak it is invariably blamed on budget restrictions, a chronic problem even for such big organizations as the National Wildlife Federation. But regardless of size or budget, every natural resource organization should try to sell its programs to the public, if only to force itself to examine those programs from an outsider's point of view.

There are basically two ways to sell management; *directly* by advertising and explaining the need for a specific program or *indirectly* by improving the attitudes and predispositions that await a program outside its fostering agency. Successful programs can be of either sort. They can be large, middle-sized, or small in both scope and budget. For the agency with a specific problem the most effective approach is a direct one.

Probably the largest, most effective direct effort has been the fire prevention campaign symbolized by Smokey the Bear. This program began in 1942 as a wartime conservation measure. Federal and state foresters approached the War Advertising Council with a request for a campaign to help reduce fire losses. The council responded with a patriotic solution which portrayed fire prevention as an attack on the enemy. This approach could not continue after the end of the war but foresters were eager to continue the successful campaign so the council cast about for a symbol to replace Hitler and Tojo on the posters. At first they used Bambi but after a year of extensive negotiations with the Walt Disney Corporation, they opted for a symbol of their own and created the bear named Smokey.

What is behind Smokey's exceptional appeal? The bear was selected because it is essentially human-sized and because it looks natural walking on two feet. Smokey is brown, a soft, neutral color with which it is easy to identify. He is strong and protective—following a stereotype familiar from fairy tales—and so he speaks to children and through them, effectively to their parents. One evaluative survey performed in 1968 (Haug Associates 1968) indicates that Smokey has the second highest symbol recognition in the nation: second only to the Coke bottle. Contrast this success with that of Johnny Horizon—white, western, distinctly male, and not very well known east of the Mississippi river.

The basic principles which make "Smokey" work can be applied to any other program.

— Concentrate on one idea
— Develop a simple slogan which calls for an action (because nothing can "set" an idea as effectively as active personal involvement)
— Choose an appealing symbol or spokesman
— Repeat the message often (It is easy to believe that because you have heard a message five times, everyone else must have heard it at least once. That is not so. The Smokey program uses $10 million of donated radio and TV time each year.)

A middle-sized, middle budget approach to selling resource management is this spot announcement designed for television by Al McClure of the Society of American Foresters to "sell" scientific forest management. It is still too soon to know how effective this spot will be or even what would constitute success, but my guess is that it will appeal to many viewers. It presents one idea, plant a tree and does so through an appealing little girl. The contrast of the child and the loggers is a "grabber." So is the fine photography. A TV spot may be beyond the means of many low budget agencies. This one minute spot cost $10,000 and required 50 hours to produce. A similar message, designed as a radio tape, cost only $300 and took virtually no time. Like the Smokey program, this campaign is aimed at a broad audience. But a campaign need not be broad or expensive to be effective.

During the summer of 1975, Linda Gintoli, manager of Great Meadows National Wildlife Refuge in Concord, Mass., faced a resource manager's nightmare. The refuge she managed contained two pools. At one time they had been well filled with cattails, rushes, sedges, and grasses—hence the name "Great Meadows"—but gradually conditions changed and in 1967 a flood washed most of the remaining vegetation down the Concord River leaving two large expanses of open water. Biologically the solution was simple, the pools could be drawn down to expose the mud flats and stimulate the growth of new vegetation. The banks would be seeded with millet for good measure. Drainage would take place as soon as the wood ducklings had fledged and the pools would be refilled in time for the southward fall migration.

Unfortunately, Concord's sewage treatment facility pumps nearly 30,000 gallons of chlorinated waste into the upper pool each day. Furthermore, the homes of many wealthy and influential citizens, including the editor of the local newspaper, abut the pools. These citizens were going to face a long, stinking summer. There was no way to lessen the problem short of forgoing the drainage and there was zero public affairs money.

The only possible approach was to enlist public support of the drainage. Citizens were told about the project through the local newspaper. Those whose homes were near the refuge received additional hand-delivered, explanatory letters soliciting their help and patience. The letters addressed specific problems; the health department had determined that there would be no health hazard, the refuge staff would dispatch or redirect wandering snapping turtles which might weigh up to 65 lbs. The bad news was presented "straight"; it would smell awful from July until September and for this the manager apologized. In the meantime residents were urged to enjoy the shorebirds which were expected to visit the area during the drainage and were asked to assist stranded amphibians. The pools finally were drained and the refuge staff anxiously stood by . . . but the expected storm of complaints never materialized.

Some residents asked for additional information. A lady stopped at the office to say that she didn't like the situation but hoped the program would succeed. In the end there were a few biological difficulties but no "people problems" and manager Gintoli's stock was never higher.

Resource programs can and are being sold successfully but this must not be allowed to create a false sense of security. Occasionally, when things are going well, an agency may neglect to sell its program. This was the case in West Virginia in 1964 when the U.S. Forest Service changed its management programs on the Monongahela National Forest by fiat. Although existing contact programs were excellent, the Service scheduled virtually no lead time. Citizens were unprepared and angry. As a result they brought suit and effectively blocked even-aged forest management on the national forests of a four state area in the now famous "Monongahela Case." The end of that controversy is not yet in sight. By contrast, the same switch of practice took place in Pennsylvania after a period of careful explanation. It was completely trouble free. Today Forest Service officials wonder why no one allowed lead time to introduce the program to the public. Their neglect of the public's need for involvement has damaged the Service's "good guy" image and has made forest management extremely difficult in many areas.

There are many ways to sell resource management directly; through TV and newspapers, on matchbooks and milk cartons. The World Wildlife Fund, for example, recently purchased the back of the "Spoon-size Shredded Wheat" box. It seems unlikely that their $4.95 needlepoint offer will earn back the cost of the advertisement but with a simple message, "Save an Animal," a course of action, buying a needlework kit, and frequent exposure, the World Wildlife Fund will have gained priceless visibility.

It is beyond the scope of this paper to detail who to reach and how to reach them, or to enumerate the many avenues for direct selling of resource programs. Gilbert has already provided an excellent introduction to this, specifically for resource managers, in *Natural Resources and Public Relations* (1975). I recommend it to any of you who are not already familiar with it. Nor is there time to inspect the many factors related to changing public opinion. That is a field unto itself, with its own journal, the *Public Opinion Quarterly*.

For those who are interested in the actual mechanics of the ways in which people form and hold opinions and the basic techniques for affecting those opinions, I would suggest Cutlip and Center's *Effective Public Relations* (1964) coupled with a good basic text on social or attitudinal psychology (e.g. Asch's *Social Psychology*). And for those looking for specifics, the recently issued proceedings of the 1975 meeting of the American Association for Conservation Information is filled with good ideas for communicators.

The real issue is not, "can we sell specific resource management programs?" That is already being done. Nor is it, "how can we sell programs?" for that must be handled on a case by case basis. It is how can we sell the idea of managing something which is supposed to be wild and, by definition, unmanaged? How can we improve our rapport with people outside the natural resource professions? For this, direct selling is helpful but not sufficient. This requires indirect "selling" through public relations and education.

In the Wildlife field, public relations and education are usually lumped together in a generalized program called "I & E." Although it is frequently considered a single program, I & E is actually a conglomerate of three programs: providing information, developing good public relations, and educating the public about resource management. Each has an important role in selling resource management and each is a distinct and separate profession requiring different practitioners.

The information program serves people who are already interested in the resource. It is a responsive program which meets the needs of the agency's "constituents": sportsmen, hikers, wildlife enthusiasts. Such a program is best handled by a knowledgeable and articulate resource manager like the many current I & E specialists.

Public Relations and Education programs deal in large part with people who are indifferent, so these programs must initiate contact.

Public Relations is goal-oriented. It aims to create and maintain a positive image of an agency and its work; to let people know what is being done and why. It is a field which requires ease with people and an understanding of what makes them tick. It takes artistry with words and sometimes graphics. Any natural resource agency can keep at least one public relations specialist busy and would be well advised to have one on its payroll. The agency which "cannot afford a specialist" will find that job added to its director's load, for it cannot afford to neglect public relations either. Budget, of course, is a consideration and it will determine the nature and extent of the program. It is not cost-effective to reach out too far or to worry over residual resistance to a proposed program. There are some people who, because of honest differences, will never like an agency or a given program. They should not be written off but should be contacted with the understanding that their grudging consent equals success.

Education is *not* goal-oriented. It provides techniques for handling ideas and materials, enabling a student to build a conceptual framework of his own. This framework will help him to deal with new information later on and will predispose him to respond to resource conflicts, for example, in a particular way. It is a long-term and expensive program which should perhaps best be undertaken by one or two groups on behalf of a whole profession. Education requires expertise in the subject plus an understanding of teachers, students, and social and behavioral processes.

Because good public relations and education programs are essentially "invisible" and because they don't often lead to papers or grants, they are usually among the first programs cut in an economic squeeze. This is especially unfortunate since good public relations and education efforts may well be an agency's best hedge against future cuts.

Traditionally, neither public relations nor education has been held in high esteem. There are many who regard public relations with distrust. They overestimate what a public relations specialist can do. He cannot transform a bad program into a good one. In fact a large part of his job is to advise his agency about public reaction to proposed programs and prevent the agency from becoming committed to an unjustifiable program. These same people confuse public relations with advertising in their conviction that public relations specialists will sell anything for a price. Most won't. They need public trust and can't afford to abuse it. Support of a bad program can destroy years of carefully established credibility.

Teachers in this country have never enjoyed the prestige of their European counterparts. Book-learning has not been considered "manly" and there is still the feeling that "those who can't, teach." Well-educated resource managers are still "those university guys." The attitude exists within the profession too and there are times when first class I & E specialists are written off as second class researchers, although communications and research are separate professional specialties requiring a thoroughly different set of skills. Recently, an I & E specialist on the staff of a large agency informed me that members of his staff were not always taken seriously by other professionals within the organization; that he sometimes got the feeling that his people had been "shipped off" to I & E. Yet these are the people who are out in front, molding attitudes which may affect the entire future of natural resource management.

The job calls for people with special skills and abilities. Universities can help attract these people by offering new, creative courses and making existing programs more flexible to allow students to become professional in a resource field together with public relations, education or journalism. They should encourage entrants who have unusual backgrounds, for those students will be able to communicate with others who share their background. Finally they should resist the temptation to use the new programs as channels for student overflow. There will be many demands on people in these programs. Training will take longer than that of other wildlife students and, at first, jobs will be scarce.

Of 60 colleges and universities responding to a recent questionnaire, 11 offer natural resource public realtions, but at most schools this is a single, introductory course. Two schools offer a degree option in resources and public relations. Twenty one schools offer a course in natural resources education, but only nine offer that as an option. Five schools offer a course in resource journalism but only one offers an option. Four schools report plans to initiate some sort of communications course in the near future. A single school—Purdue University—requires that *all* prospective teachers be exposed to a fourth "r," resources. This is a good beginning and the Purdue approach holds a great deal of promise but it is not enough. There are still too few communicators in the resource professions and too few resource people in the communications fields. Until there are more, agencies must work through their existing programs and should consider working closely with existing professionals in public relations and education. Communicating is their business.

Whether an agency should hire an "outside" public relations specialist or one who has the specific resource training which will enable him to speak the language of those he represents, is a matter for individual decision. Either way, any agency needs a public relations staffer to guide it in dealing with its "public partner." Key agencies and the profession itself should undertake some form of education so that the task of wildlife managers in the field becomes easier in time rather than more difficult. Initially, a professionally staffed public relations or education program may look like a luxury, but if managers wish to have public pressure work for them rather than against them, it is not a luxury at all. Far from being frills, the programs in education and public relations are actually our investment in the future.

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Discussion

MR. ROBERT HOOVER [Colorado Division of Wildlife]: I come from a state which sells 100,000 deer licenses a year and so we kind of resent people putting on mule deer as an endangered species. I would like to raise one question in regard to some information you presented.

You said you conducted a survey of the various states to find out what they were doing in the way of public participation and you said, I believe, that 39 states responded and you also said that most of these were working with sportsmen and only six were addressing themselves to other segments of the public.

MS. HORWITZ: Let me correct that. Thirty-nine states responded and almost all the material they sent was suitable for sportsmen. Only six states indicated they were reaching the general public through mass media.

Blueprint for the Tricentennial

Chairman:
ERNEST W. HARTUNG
President
University of Idaho, Moscow

Cochairman:
J. MICHAEL McCLOSKEY
Executive Director
Sierra Club
San Francisco, California

The Environmental Movement in America's Third Century

Henry L. Diamond
Chairman, Citizens' Advisory Committee on Environmental Quality
Washington, D.C.

In these times of dramatic change, it is perhaps presumptuous for anyone to talk about the future of anything. Each day's headlines bring events which only a short time ago no one would have predicted or even dreamed possible. Each Tuesday's primary brings a new front-runner.

But it is important, I suggest, despite the difficulties to try and look ahead to the future of the environmental movement. After all, this is not academic speculation about an interesting social phenomenon. Lest we forget, our basic survival is at stake in how we treat our land and water and air.

My basic theme today is that we are at a critical point in the history of the environmental effort in this country. Concern for the environment emerged from obscurity and even derision to become a major item on the agenda of the public and the politicians. That day in the sun may have been short-lived. Other public needs and other pressing problems brought environmental advances into question. How well we answer that question is one of the critical choices facing this nation in its third century.

Let me review some history briefly as a basis for trying to forecast the future. The environmental movement did not burst full blown onto the American public scene on April 22, 1970. In a sense this is the centennial of the environmental movement, for the antecedents of the Earth Day phenomenon run deep in the mainstreams of American social thought. They spring from a number of disparate strains in American life which came together rather dramatically in the late 1960's. These strains included:

> The classic and romantic relationship of man and nature expressed by Emerson and Thoreau;

The resource conservation movement thought through by Marsh and Pinchot and brought to action by Theodore Roosevelt;

After the turn of the century, the public health movement, first concerned about water borne epidemics and municipal sewage and later about air pollution as its impact on public health became known;

The parks movement, starting in the cities very early led by Frederick Law Omstead, and then expanding to the national and state parks;

The sportsmen's movement, interested in fish and game, but aware that to enhance wildlife every living thing's environment had to be protected;

And finally the new activists who turned their interests to environment as well as to the Vietnam War and consumerism.

In the late 1960's some chemistry brought these diverse elements together as a major new force on the American scene. Perhaps it was a nation's realization of the essential and interrelated nature of air and water and land on which it depended. Perhaps that chemistry was as simple as the fact of an idea whose time has come.

But whatever it was, the environmental movement emerged as a force able to get things done in a major way. After years of crying in respective wildernesses with only modest success, the environmental movement was able to put together a series of astonishing victories.

There were demonstrations in the city squares, songs sung, books written, but more than that there were solid and surprising legislative achievements:

The extraordinary National Environmental Policy Act of 1969 committed the country to treating its environment sensibly. It directed Federal agencies and those spending Federal money to put down in writing what they were going to do to the environment before they started doing it in something called an environmental impact statement.

The Clean Air Act of 1970 committed the country to controlling air pollution and mandated specific and strong standards including control of the heretofore sacred automobile.

The Water Pollution Amendments of 1972 set lofty long term goals and specific interim standards for cleaning up the nation's water and appropriated $18 billion to pay for the job.

In the state houses and city halls across the land these environmental victories were matched and even surpassed. Some states banned harmful pesticides and phosphates in detergents and took major strides toward good land use planning. In addition to these legislative landmarks, there were equally important legal victories won in the courts. There was also action on the international front. In June of 1972, 113 nations met in Stockholm in the first U.N. World Conference on the Environment. A start was made toward cooperative international action and a special U.N. agency for the environment came into being.

While the dates of waxing and waning of major social and political movements are never precise, this golden era of the environmental movement can be dated from Earth Day 1970 until Yom Kippur of 1973. On that day of atonement the

Egyptians crossed the canal, the sheiks turned the valve and the environmental effort faced a new and radically changed circumstance in this country.

I will argue that the oil boycott and even the overall energy crisis are not the major cause of concern for the environmental future, but their arrival affords a convenient and perhaps even accurate dating. Since October 1973, things have changed for the environmental movement—and not for the better. Let's take a brief look at the situation before trying to project the future.

Environmentalists have been frustrated in achieving the third major building block of a national environmental policy—national land use legislation. The national commitments to clean air and clean water are set forth in statutes and despite problems in programs, the basic goals are there. But no land use legislation got through in halcyon days and the political clout of the environmentalists has not been up to bringing about the passage of a land use bill since.

And this is a telling and ironic failure—ironic on several grounds. First, the Federal government is already into the land use planning business through coastal zone management, flood plain management, comprehensive planning grants and a number of other programs which are in fact land use planning by other names. Second, a number of states, Hawaii, Vermont, Wisconsin, are already exercising far more stringent land use controls than any proposed for the Federal government. And the final irony, the Federal land use legislation proposed is very mild stuff indeed. It simply says to the states you ought to do some land use planning and if you do, we'll reward you with some money. If you don't, we won't. When the backers of this modest proposal tried to get it to the floor of the House of Representatives back in June of 1973, they failed and it was sent back to committee where it has not been heard from since.

There is no motion forward on the land front and there may be some motion backward on the air and water fronts. A major revision of the Clean Air Act is underway. The committees involved are just finishing their work but it is clear that their basic thrust will be a reduction in stringency of standards. The automobile industry is going to get either two or three or five more years to meet standards according to which pollutant or which bill one is talking about. The non-degradation edict is going to be ameliorated in some fashion. While the Congress will still be some time in working its will, it is clear that the vision of the 1970 Act will be viewed through somewhat less rosy hued glasses by the time this Congress goes home.

The same may be true of water. The basic water pollution statute, the Amendments of 1972, is also up for review. The National Commission on Water Quality has just issued its report after three years and $17 million worth of study. In a number of areas, the Commission found that the legislative requirements could not or should not be met. The Commission proposed a number of changes either allowing exceptions or changing the dates for compliance with the deadlines mandated in 1972. The Congress itself must work its will on these recommendations, but it is clear that about half of the municipalities of this country and some of the industries are not going to make the Congressionally mandated deadlines and that something will be done.

There have been also sporadic and for the most part unsuccessful attacks on the provisions of the National Environmental Policy Act of 1969. Proponents of various specific projects, or categories and projects have argued that their particular undertaking is so important to the national interest that it must be exempted from the environmental impact statement requirements. Most of these efforts have been turned back but one unfortunate exception was granted in the case of the Alaska Pipeline.

On the state level, some very astute politicians are beginning to tilt away from the environment when employment is at stake. In recent months, the governors of New York, New Jersey and Rhode Island have each explicitly come down on the side of jobs and done so with both feet.

In New York, Governor Hugh Carey asked the legislature to delay the major part of the State Environmental Quality Review Act—a little NEPA of sorts. Seven months ago he signed it with high praise. Last month, Governor Carey noted the state's economic problem and urged indefinite delay of impact statements for private developers and local governments. Further, Carey unleashed his Commerce Commissioner to take on the environmental movement generally and the State Environmental Conservation Department specifically. So far, the Commerce Commissioner has been doing very well on the labor luncheon circuit.

Governor Byrne has announced that New Jersey was relaxing air pollution standards to allow the burning of high sulphur oil in New Jersey. Standing shoulder to shoulder with his Environmental Commissioner, Byrne said he wanted to lower the cost of doing business in New Jersey.

In Rhode Island, Governor Noel has taken sharp issue with what he believes to be the delays caused by environmental impact statements. He, too, would ease environmental restrictions in the name of economy.

The present situation is then, I suggest, one where after a surge of victories, there have been some limited setbacks for the environmental effort. To predict the future, one has to examine the forces which have brought about this leveling off. How strongly those forces impact the basic thrust of the environmental movement will determine in large measure its future.

I suggest there are three major forces working as brakes on the environmental effort. They are general economic problems, the energy and other incipient resource crises and, perhaps most important of all, the natural difficulties of implementing programs with lofty goals.

General Economic Problems

The most pressing problem in the minds of the American public today is their economic well-being. The polls and the street corner conversations make it clear that Americans are more concerned about their economic future than they have been since the Depression. Inflation, although slowed, is eating away at earnings, savings and confidence. It is an extremely insidious and divisive force in our society.

There are those who argue that expenditures for pollution control are inflationary, that these expenditures are "unproductive" and add to the cost of goods and services without adding to real productivity. In fact, this was the inflationary argument which was used in impounding water pollution control funds over the past several years before the inflationary pressures and the public concern were so great.

Now industry is making this argument. Some are arguing that from 20 to 33 percent of their total capital outlays are for pollution control equipment.

Certainly for the short term, the projections are that the inflationary trend is going to continue. If it does, it will place continued pressure on limiting the environmental expenditures.

The problem is, as indeed it always has been, that the costs of pollution control show up clearly and dramatically on government and corporate books in hard terms. The benefits are spread across society generally and are not so easily accounted when they exceed the costs. The argument can be made that if inflation pushes up the costs of carrying out pollution control, it also pushes up the cost of not doing it. Setting aside the human and social values, the benefit of a day lost from work from respiratory disease becomes more valuable as wages go up. If you paid a house painting, window cleaning or dry cleaning bill lately, you know that the cost of these services have gone up as well as those of electrostatic precipitators.

Energy and Other Resource Crises

The 1970–1973 honeymoon of the environmental effort was helped in no small measure because of the lack of competition or public attention and loyalties. The Vietnam war was winding down, we had been to the moon, the country was tired of agricultural programs and reclamation schemes. In a relative sense then, there was a vacant boulevard awaiting the environmental parade.

The energy crisis changed that. It, of course, not only competes for public attention and dollars, it interacts very directly on the environment in a number of ways. The move to ease restrictions on fuel quickly and emissions from cars were first steps to save energy at the expense of the environment. Acceleration of strip mining, offshore oil drilling and the Alaska pipeline make more energy available sooner, but they impact land adversely.

The energy crisis is perhaps but the first of a series of major problems which we and the rest of the world must face. Perhaps the next and even more serious will be food. Already it is clear that parts of the world are doomed to starvation, even under the most optimistic of scenarios.

As with energy some of the measures which will be advocated to ameliorate this next crisis will have an adverse impact on the environment. Food production can be increased, at least in the short run, by intense application of fertilizers. Heavy doses of pesticides will also increase yields. Already there is an incipient "bring back DDT" movement. Cultivating marginal lands subject to erosion can also bring temporary production increases.

And the "crisis" which lies beyond the next one will also have environmental problems. If it is metals, then increased and unrestricted strip mining may be advocated as the answer. If it is balance of payments, the reduction of environmental standards may be advocated to cut domestic production costs.

The point is that competition for environmental quality does not end with the energy crisis. We can expect crisis after crisis and environmental quality must become an accepted norm and not sacrificed to the problem of the day.

The Difficult Stage

A third force acting to limit the pace of environmental progress is the fact that the key programs have now moved from the stage of ideas to implementation. For a long time high national air and water quality standards and programs to achieve them were only lofty ideals in the minds of a few dreamers. Then the action came and the Congress enacted the Clean Air Act and the Water Pollution Amendments of 1972. Victory was achieved—or so it seemed. The forces of darkness were at long last overcome; the Congress had legislated pure water and clean air!

We are now in the process of implementing these acts and the going is much tougher than crying in the wilderness or even passing legislation. Controlling water and air pollution to rigid standards is complicated, expensive business. Oratory little affects the daily lives of people, but limiting parking spaces in central business districts or closing down the local pulp mill and its payroll does.

Further, the implementation stage of a program brings out difficulties and complications. Translating complicated legislation into actual programs sometimes shows up complexities and even occasional ridiculous results which the legislative drafters never foresee. Deadlines hammered out in legislative conferences on Capitol Hill sometimes just do not make sense in the countryside. Slogans translated into legislative finding and then translated by courts into mandate of law can create problems. These problems offer those who opposed the program in the first place a chance to seize upon an occasional ridiculous result and bring unwarranted ridicule to the whole effort.

An added complicating factor in long term execution of programs is the fact that we naturally tend in any massive effort to do the easy things first and save the more difficult for later. It just makes sense to do the cheaper projects which pay the biggest dividends and leave the tougher ones with smaller dividends till later. In the water and air pollution field this means that we have in many cases cleaned up the obvious, gross polluters and now must focus on the less obvious, more indirect and more complicated pollution sources.

One example of this phenomenon is agricultural run off. Perhaps one third of the total water pollution in this country comes from land run off, yet we have done virtually nothing to control or abate it.

The reason we have not is that it is very difficult and expensive and we are really not sure how to go about it. The Water Pollution Act of 1972 commits us to remedying this problem and we will be hearing much more about it.

How severely the future of environmental quality will be limited by these and other factors will be determined by a complex interaction of social, economic and political forces over the coming years. If the economy shakes off its sluggishness and booms, if the energy crisis wanes and no new one arises like a hydra to take its place, if there is good administration of present programs, then the environmental effort will thrive and grow. To the extent that these "ifs" do not happen and the reverse transpires, environmental quality will suffer.

To summarize in conclusion:

The environmental movement has come a long way since the days when its adherents were all thought to be out of the mainstream people in funny footwear.

In the first years of this decade, outstanding political victories were won as the strains of the environmental movement merged to create potent forces.

Now the bloom may be off the ecological rose because of economic pressures, the competition from energy and other crises and the difficulty of implementing the lofty goals of complex programs.

The days of easy victories and unbridled public enthusiasm may be over in the face of the changed new realities. Environment may lose its status as a favored child of public opinion. It may no longer be a fad or a political sacred cow which cannot be denied. There may be some adjustments and even some setbacks.

But even in the face of these limitations, I am optimistic about the future of the environmental movement. I am hopeful that the environmental movement will prevail over its obstacles. Two basic strengths of the movement give me this hope.

First, that very basic element of the environmental movement—old fashioned conservation and wise use—is cogent and relevant for the problems of the 1970's. We have tended to underemphasize this aspect of the environmental movement while some of the more glamorous aspects took the headlines. What could be more germane to the new problems of our third century than old fashioned conservation supplemented by modern recycling technology? The time tested thrift of turning out the lights is being applied to the megawatts of aluminum production as well as to the household electric bill. It can be applied to other crises as well. By not wasting we can produce more food; by recycling, we can produce more materials.

The conservation ethic applies to the problems of inflation as well. The new throw-away society mentality has increased the cost of everything. Toasters that cannot be repaired cost more. The three of four unnecessary layers of packaging from the department store adds to the price tag. The convenient foods sheathed in plastic require more dollars that the fresh item wrapped in newspaper or a net shopping bag.

Thrift and conservation even practiced on a wide basis won't solve all of the problems of our country. But it can be a start. It may help swing the delicate balance toward continuing the trust toward quality of environment and quality of life.

Second, the basic soundness of the issue and its relevance to today will help insure its success. The basic strains which make up the environmental movement, the balance of nature, public health, the quest for recreation and respite, the wise use of resources are essential to our well-being as a nation. What is at stake here are not frills or liabilities which must be borne and paid for to appease some special interest. The basic elements of a good environment are essential to our survival as a nation.

Thus, while there are strong forces which will tend to slow down the environmental movement—economic problems, other competing public needs and implementative problems—I am convinced that an environmental ethic has now become part of the American consciousness and that rational decisions and actions will reflect this new awareness.

In the final analysis, the decisive factor of whether the basic strengths of the environmental movement shall prevail over the natural obstacles will be performance. In its second century the environmental movement must do less oratory and more operating, less posing and more performing. How well we can pass from the easy stages of lofty goals to the mundane but crucial phase of execution will determine the success of the second century of the environmental movement. More importantly, it will do much to determine the quality of the land and the water and the air of America in its third century.

Discussion

CHAIRMAN HARTUNG: Thnk you, Mr. Diamond, for that fine overview. Many of us share your feeling of optimism of the final outcomes, though I think most of us do recognize the seriousness of some of the problems you have pointed out.

This paper is now open for discussion. Are there questions or comments?

MR. ROBERT DENNIS [Zero Population Growth]: Mr. Diamond, following up your final comments on the reasons we still have to sell the environmental concept, what is your view of the economic situation and the energy crisis as events that reflect what environmentalists have been saying all along? To what extent do you think it is going to be politically possible to convince decision-makers that we are really going to have to be tough in applying those standards to alleviate economic impacts of limited resources?

For example, do you think we are going to be able to sell that point or do you think we are going to be continually having to defend environmentalists against charges that we caused the shortages and we caused the economic upheaval?

MR. DIAMOND: That is a very astute question and I must say that I have been thus far rather disappointed that we have not been able to sell to the Congress or decision-makers elsewhere the energy conservation measures which seem so logical and make so much sense and that most of the proposals have centered on elaborate developmental schemes to raise the supply rather than reducing the demand.

The logic of reducing demand curves and the fact it seems to be so compelling, indicates we should have made more progress than we have. Therefore, that is discouraging.

There seems to be, however, a growing awareness in this country about this factor and at least the issue can now be raised where, only a few years ago, to even raise the issue of growth was considered sort of anti-American. We have at least started debate in this country and that, in turn, is a healthy sign, although I cannot point to any evidence that the energy crisis has shown we are making decisions that way as yet.

MR. NEAL SAMPSON [Soil Conservation Service]: In view of the current emphasis on section 208 of the Water Pollution Control Act Amendments, would you care to comment specifically about that emphasis in light of your comments about needs?

MR. DIAMOND: Well, I probably should not because, as an old state administrator, I don't like Section 208 very much. However, it is a way of getting an overall approach which in my view, is a land-use planning bill which we need and so probably it is a good thing. However, probably in deference to my prejudice against this section, I would like to not comment. I found it was an interposition of a layer of government which was not wise but, if it works, then God bless it.

Are National Environmental and Economic Objectives Compatible?

Beatrice E. Willard

Council on Environmental Quality, Washington, D.C.

As we celebrate our Bicentennial, remember our rich, precious national heritage, and project a "blueprint for the tricentennial" in managing the Nation's wildlife, natural resources, its whole environment, including its economic propsperity, it is fitting to recall that Thomas Jefferson firmly believed and practiced that, " . . . civilization itself rests upon the soil." I feel sure that he used soil in the broad sense—including land and sea, air and water, all creatures and systems therein.

What would we like to have America be in 2076 A.D.? Is there any question that we want it to be a free, prosperous, efficient, effective society composed of happy, independent people? Is there any question that we want that society to have adequate natural, cultural, and intellectual resources for continuing on into the fourth century? Is there any question that we want the activities and structures of that society to be accomplished with a maximum of consideration for the needs of healthy, productive ecosystems and a quality environment, here and throughout the world?

The Critical Question

In designing this tricentennial blueprint, it is exceedingly critical and key how we ask the question posed to me this morning: Are national environmental and economic objectives compatible?

In thinking this through, I submit that the way we choose to ask this question will go far toward determining the answer. Not only that, the way we ask the question will determine whether or not future generations will be able to fulfill the blueprint of a prosperous, healthy society in productive harmony with nature as we all desire, and as our National Environmental Policy Act mandates.

If we define our environmental objectives only as preserving everything intact, in place, and in a status quo condition, and if we define our economic objectives only as exploiting the Earth to make a big profit, the answer is "No, these objectives are not compatible." If we do not transfer costs for pollution-caused health problems, dirty lakes and rivers, and toxic substances in air, water, and soil to consumers of products, the answer is "No." If the multitide of dislocations and disturbances from necessary economic activities to Earth's ecosystems are done so that ecosystem productivity and vitality are lost, the answer is "No."

On the other hand, if we define our environmental objectives as including a sustainable, prosperous economy and our economic objectives as including a livable, productive environment for the future, the answer is "Yes, these objectives are compatible." If we transfer the costs of environmental pollution that all of society has been bearing for decades to the consumers of products, the manufacture of which produces the environmental damages, the answer is "Yes." If we bring human activities into adjustment with the vital functions of Earth's ecosystems, the answer is "yes."

But what makes us ask this question? Is it not concern about the potential costs to Americans for environmental clean-up? The 1975 CEQ Annual Report estimates potential expenditures for the decade of 1974-83 *alone* at over $200 billion cumulative for all segments of the economy. It says that in 1974, clean-up cost $47 per person. The report estimates the highest cost per family to come in 1983 at 2.5 percent of the median gross family income.

As with all large investments, this one seems big at the time of payment. Attention to the benefits and positive side effects of this investment can help offset the feeling of burden. For example, the total expenditure on pollution control equipment in 1975 was $15.7 billion, which put hundreds of thousands of people to work.

Analyses cited in the 1975 CEQ Annual Report show that although the amount of gaseous wastes increased substantially between 1940 and 1970, with values ranging from 15 percent increase for particulates to 400 percent for nitrogen oxides between 1970 and 1974, actual emissions were down 29 percent for particulates and up only 10 percent for nitrogen oxides, with other gases falling in between. EPA finds that 15,600 of the 20,000 largest stationary sources, which produce 85 percent of the total air pollution, are now in compliance with emission regulations.

Many of the worst point sources of water pollution are being controlled and some of the most polluted waterways are being cleaned up. In 1961, only 69 percent of the national water quality stations were "good" or "fair" categories and 10 percent were in the worst category. In 1974, 92 percent were "good" or "fair" and only one percent were in the worst category.

It would be desirable to predict a percent decrease in damage costs, crop damage, and damage to materials from these improvements in air and water quality. There is no question that these damage costs decrease as the amount of pollutants removed from our environment increases. But they are not straight-line functions of each other. Actual relationships between pollution and damages will become more clear as we learn more about the diverse and complex systems involved.

There is no question that this has been a strenuous, difficult, and critical period. But to conclude, on the basis of experience during these few years when environmental investments have been made at the same time as steeply rising inflation, an energy crisis, and economic recession, that our environmental and economic objectives are incompatible would be overlooking the basic principles that govern our own health systems, our life support systems, and what these ecosystems need for continued healthy activity to produce goods and services for the Nation and the world, now and in perpetuity. In addition, it would be overlooking that capital investments made in improving the Nation's "environmental plant," its natural resources and wildlife, do pay off, as numerous instances of the past demonstrate to us. If we allow ourselves to believe these objectives are incompatible, we risk short-changing benefits to future generations.

Critical Choices for the Tricentennial Blueprint

Let us examine what critical choices must be made in the next century in light of these two ways of asking the question. In so doing, it is important to recognize two facts:

1. We all plan—either by design, or by default, having no design.

2. We all make tradeoffs—either consciously, dynamically, in a controlled, negotiating manner; or by standing pat on an issue, giving nothing. So we are always making choices and tradeoffs of one sort or another. Today we have an opportunity to see that economic choices we have neglected in the past (long-range effects, intangibles, externalities, etc.) are the ones we need to make for the tricentennial.

We can choose either to believe that our environmental and our economic objectives are incompatible. *Or we can* recognize that our environmental and economic objectives are compatible, when viewed in the longer range. In fact, we can recognize that the broad range of environmental objectives is essential to continued realization of our economic objectives in the longer range.

Examples from the past, where profits have been reduced or foregone and sizeable capital investments have been made in regenerating renewable resources to produce greater subsequent profit, provide evidence that our environmental and economic objectives can be compatible.

Specific examples are well-known to this audience. One is the rebuilding of the Pribilof fur seal herds from around 200,000 animals in 1912 to around 1.4 million animals today. This effort netted the U. S. Treasury $25 million in the first 50 years of operation.

Another is that the Pacific halibut fishermen chose to answer "Yes, our environmental and economic objectives are compatible." They recognized that the halibut stock was very low and they were catching little. They agreed to taking no fish for a period. Investments were made in research into halibut life history, populations and habitat. The Pacific Halibut Fishery Commission has calculated the cumulative gain paid to the fisherman from these investments, coupled with management practices and regulation built on research findings, has amounted to 50 times the dollars invested.

Another choice for compatibility of our environmental and economic objectives is investments made in restoring the sockeye salmon runs on the Fraser River in Washington and British Columbia. As you know, this stock had once had 30 million fish in peak years. By the mid-1920's the population declined to one million fish in peak years because of overfishing, pollution, and modification of habitat that blocked the salmon from going into their ancestral spawning areas. In 1940, a long-range management program was undertaken. It included restoring the habitat by removing obstructions to salmon movement to spawning grounds, like the Hell's Gate rockslide, cleaning up the waters, and regulating the take of fish at a level well below the annual production. An investment averaging $2 million per year for a 15-year period (total $30 million) restored the sockeye stock of the Fraser River to a point where stocks were increased four-fold and the economic value of $30 to $50 million boatside is now annually harvested. So an annual boatside gross income resulted that was equal or greater than this initial $30 million investment.

It is clear that had we chosen to believe that our environmental and economic objectives were incompatible in 1940 by not making a financial commitment to this long-range sockeye salmon management improvement program, we could not have realized a significant economic and environmental gain.

We can choose either to think that human actions are quite separate from those of other living things, from the ecosystems in which we live, and from the rest of the world; *or we can* recognize the primary principle of ecology: that everything affects everything else, directly or indirectly.

The National Environmental Policy Act requires preparation of environmental impact statements in advance of making decisions "about major actions significantly affecting the environment" so as to determine the number, kind, direction, and size of effects radiating from people's actions. Doing this enables us to evaluate in advance of action how closely our proposed projects will harmonize with the ecosystems of the region, the Nation, the world.

Such a choice was before the executives of the Climax Molybdenum Division of American Metal Climax, Inc., in 1966 when they were planning a new mine in Colorado. They chose to design with a maximum of environmental concern, to minimize the disruptions of a large mine, in spite of the fact that extant environmental laws required little. Early on, they proposed that a committee be established to explore what environmental problems might be encountered and to recommend how they could be alleviated. This committee was composed of five Climax executives directly in charge of planning the mine, and five citizen conservationists.

The committee intently explored the many environmental ramifications of developing the mine and how to minimize them. The first meetings of the committee were tense, each person uneasy about the proverbial black and white hats associating. From the outset, it was the policy that each person be candid, ask any question and make any comment that occurred to them, with no thought of forbidden subjects. This policy soon revealed dedication and sincerity in all involved. As a result, the black and white hats soon dissolved.

Then the committee settled into being of a body of ten people, dedicated to balancing development and environment by designing, planning and overviewing construction so that it would have the fewest environmental impacts. New engineering concepts soon emerged, such as placing the tailing pond 14 miles from the mine in an out-of-the-way valley on the other side of the Continental Divide, where the incoming and outgoing waters could be controlled and recycled through the mill where the tailing would be seen by fewer tourists. This required tunneling 10 miles uphill through the hard rocks of the Continental Divide. Yet this was accepted by the company executives as the cost of doing business today.

Sound too ideal? You are not the first to say so. This reaction from another mining company set the committee to evaluating their experience, which only reaffirmed what they thought was happening. The mining people really were developing a concern for environment and learning what was required to design a mine in harmony with ecosystems. They told of how their concern for environment was influencing their employees. An example of this was a foreman saying to his boss, "Bill, if we move that road over 10 feet, we can save those six trees." Another was making a survey road for four-wheel-drive vehicles through the forest by removing rocks, logs, and a few live trees, instead of bulldozing a road out of the forest. This route was barely discernable after four months use.

The environmentalists really were hearing the problems, needs, and constraints under which mining engineers must operate. They were recognizing that once engineers learn what ecosystems need to remain productive and healthy, engineers can provide for those conditions. Result: a large mining complex has been developed with wise environmental choices.

We can choose either a linear path for use of materials and be highly consumptive of energy; *or we can* recycle and reuse materials and goods, and use energy in a highly effective, efficient, and economic manner. Multiple economies of recycling materials and of conserving energy are being reported throughout the Nation. IBM found it could repay its investment in paper recycling equipment in a few years; the electroplating industry is discovering that recovery of metals it once dumped in streams makes a substantial return on investment in pollution control equipment.

We can choose either to ignore application of an engineering practice to environmental matters; *or we can apply* the time-honored concept of a safety factor to environmental facets of decisions, to allow for the many variables and unknowns of the systems managed. Engineers use a safety factor of two in routine design. The engineer uses an even larger safety factor when he has less information. He does it to insure safety of the engineering systems for people. Are we allowing a 200 percent margin in management of natural resources, to allow for the many variables and for insufficient knowledge and understanding? We have as much justification as the engineer. Resource managers need to insure safety of Earth's ecoystems so they can continue to provide for "life, liberty, and the pursuit of happiness" for people in perpetuity.

We can choose either to do something *now*, then *find out later* what short-term and long-term disruptions we have brought to our environment and economy; *or we can* calculate in advance what effects our actions will have on social, psychological, energy resource, economic, aesthetic features, as well as physical, chemical, and biological features of our environment—our ecosystems.

John Krutilla's statement is valuable. If we really believe in progress, we should be willing to defer a controversial decision, because delay will produce better technology and more information with which we can make a more intelligent decision and develop better. Delay of the Alaska Pipleline bears out this statement. Yes, the waiting has increased interest and inflation cost. But what would the engineering and environmental costs have been, had construction proceeded from the information/technology base of 1968-69? Alyeska admit they learned a great deal between 1968 and 1973 that saved them money, time and effort.

We can choose either to exploit resources for present gain, *or we can* use resources in a way that will provide for future generations. The former choice liquidates resource capital; the latter choice is living off the interest from resource capital.

We can choose either to think that investments in improving grazing and forests on public lands is unnecessary; *or we can* realize that moderate investments now in range and forest improvement can produce sizeable increases in forage and timber. Choosing the former will allow present deterioration to increase. Choosing the latter will begin to pay sizeable return on investments within a decade.

We can choose either to pay billions of dollars for flood control programs that encourage development on floodplains; *or we can* grant rivers rights-of-way wherever possible. The latter choice will reduce the need to pay billions in flood disaster relief, in spite of the existence of flood control structures.

In 1972, Rapid City chose the latter. The people were lulled into false security by two upstream dams, only to be wiped out by a cloudburst that dumped 14 inches of rain between the dams. They learned from the experience, chose to acquire the floodplain, and relocate structures out of it. This choice was less expensive than rebuilding in the floodplain.

We can choose either to believe that as long as there is space, there is no limit to the number of houses, highways, industrial complexes, that can be developed; *or we can* analyze land capabilities, site facilities where they will make the least social, ecological, and economic disruption, and still provide their vital products. The latter choice will retain productive agricultural land and will recognize the cumulative values of open land demonstrated by Eugene Odum. He has shown open land to be doing work for man worth more than sale of the land for development.

We can choose either to mine with little regard for land use afterwards; *or we can* design strip-mining scientifically, determining in advance how to establish ecosystems on newly created landscapes. The latter choice is not easy; it takes commitment of various resources. It must be done in a site-specific manner, taking into account the peculiarities of the resource to be mined and the ecosytems of the site.

Conclusions

In all these choices are there some criteria for maintaining compatibility between our economic and environmental goals in the third century? A few obvious ones are:

1. Does the project maintain or enhance the productivity of the existing systems? What are the proofs? If not, can that productivity be restored within five to 10 years?

2. Is the Nation consistently investing a small fraction of its GNP in comprehensive improvement programs for natural resources and environment?

3. Is the Nation consistently investing a small fraction of its GNP in basic scientific research that can contribute significantly to better compatibility between environmental and economic goals?

4. Is the rate of gathering environmental information proceeding ahead of the rate of demand for it?

The ancient Greeks used the terms "economics" and "ecology" interchangeably. We can use them synonymously, too, if we practice sound, long-range, ecological management of environment and natural resources. But if we allow short-range views to prevail, the two sciences will diverge and our objectives will be incompatible. If our environment is healthy and wealthy, we will be healthy and wealthy. If it is not, we cannot be.

Discussion

CHAIRMAN HARTUNG: Thank you very much, Dr. Willard. I think we too often take the view that the environment and the economy must necessarily diverge. That was a beautiful paper in terms of bringing back into focus this very important point.

DR. WILLARD: There was a question asked of Mr. Diamond about energy conservation programs and I would like to solicit the help of all of you in following through Congress each year, following the hearings each year in relation to the responsibilities given the Council on Environmental Quality.

In 1974, in relation to the Act, they asked the Council to study all energy research and development programs from the standpoint of energy conservation and the environment and adequacy of programs. Now, we have held our first set of hearings and we would like your focus on this and assistance in making sure it is well understood.

Wildlife 1976: A New Perspective is Needed

D. Kent Frizzell
Under Secretary
U.S. Department of the Interior
Washington, D.C.

Ecologists tell us that not a raindrop or a leaf falls but they affect our world for all time. They are telling us of the timeless importance of each raindrop and each leaf. The same can be said of wildlife. Each species, each animal is important in the order of life. Each generation begets the next. So it is with us. Each of us is important. Each one of us can make a difference in this life. That is the philosophy of America—the integrity and inherent dignity of each individual.

You and I—each one of us—can make a difference in American wildlife. That is my message today—that we can change the world. We can do it as surely as rain falls and leaves are recycled into the earth.

The public genuinely seeks a better wildlife future. It continues to be manifestly aware and concerned about the wildlife resources of the Nation. In the media, in the courts, in other public forums, we are witnessing a public message on wildlife; people care. Our job is to respond to those wishes. I am proud of the superb job done in recent years by the 50 State conservation departments, several Federal agencies, some 50 of this Nation's universities, and a host of private organizations in the field of wildlife conservation.

We have most of the tools to do the job. Much of the machinery is in place. We are fully capable of dealing with wildlife crises. We can deal effectively with a host of wildlife issues today.

I think Secretary Kleppe summed it up pretty well the other day when he compared the effort that has gone into the wildlife field to a battle. We are on the verge of winning the wildlife battle with an assembled force of laws, and agencies and working teams of scientists. Victory lies ahead. But it can be ours only after considerable, consistent hard work. Each of us must continue the dedicated professionalism that has delivered the positive results of the past decade.

The theme for the speakers today is "Blueprint for the Tricentennial." The topic assigned to me is to relate that theme to future resource management plans—balancing demands, needs, and priorities.

You have heard this before but it will be as true tomorrow as yesterday. If this country follows the technical and social progress of the last quarter century, no one can predict what will happen to wildlife, or for that matter, any resources in the next century. There may be cutbacks in our standard of living if energy problems are not resolved, for example. Therefore, it would be more realistic to consider what has been accomplished in recent years and what this means for the future.

Legislatively, we have seen real progress: Three versions of the Endangered Species Act, a National Environmental Policy Act, a Marine Mammal Protection Act, a Federal Pesticides Control Act, a Wilderness Act, an Historic Preservation Act, and a Wild and Scenic Rivers Act. That represents solid progress.

From the organization standpoint a separate agency of government—the Environmental Protection Agency—was created. Also, a Presidential Council on Environmental Quality was formed. These two events—plus the reshaping of the lower levels of the federal bureaucracy in the past 10 to 12 years—all directly benefit wildlife.

With these legislative and organizational steps in mind, we can take a direct look at wildlife. I have reviewed some of the more tangible accomplishments of recent years and I am impressed. Let's take a look at some of them:

An international treaty for the protection of endangered animals has been ratified by 15 countries and is now being implemented worldwide.

Since 1966, virtually the entire world's animal population has been reviewed at least once. This has resulted in the official listing of 426 animals as endangered.

The alligator has made an amazing comeback because of sound federal and state management. It is no longer considered endangered in most of its range, and can be harvested commercially.

Although not widely known, three species of trout have been removed from the endangered species list in the Southwest—showing what federal and state cooperation can accomplish. This is what the Endangered Species Act is all about—to pare down the list of flora and fauna that are in trouble.

Though not an endangered species, bald eagles have been transplanted successfully from the Great Lakes region to New England. Populations there had been almost obliterated by pesticides and other detractors.

Whooping cranes are more numerous this year in the wild on their traditional route. Also our scientists have taken first steps to reestablish a second flock in the wild in a former part of their natural range.

Peregrine falcons have been successfully reintroduced east of the Mississippi River. This is again necessary because of man's pollution of the birds' environment.

Six federal projects in conflict with the Endangered Species Act—ranging from dams to interstate highway projects to aircraft flight patterns—are under legal negotiation right now.

Nearly 20 States are close to signing cooperative agreements with the Federal Government for the management of endangered species.

We are proud of the other joint federal-state-private effort in wildlife management. The first solid evidence of the return of the Atlantic salmon to the Connecticut River of New England was collected when a live male specimen showed up at the Holyoke, Massachusetts, fish ladder last year.

By all of us working together imagine what the future would be if salmon once again return to the Hudson and other major rivers. This is an example of the one raindrop and one leaf philosophy.

Since the early 1960's almost 2 million acres of habitat have been acquired with duck stamp funds and set aside for waterfowl. It's unfortunate that figure isn't two or three times as great.

Four lonely but vital islands in the South Pacific have been set aside as sanctuaries for sea birds in the National Wildlife Refuge System.

Waterfowl management has entered the space age. We now rely on earth satellite photography for breeding ground survey work in the high Arctic.

Snow goose and Atlantic brant numbers have increased so much on the East coast that they were reopened to hunting this year. So good game management works.

In the field of wildlife disasters, we've developed the know-how and field force to react rapidly to natural wildlife emergencies like disease outbreaks of botulism, avian cholera, crop impaction, and thallium poisoning.

Those are the visible efforts that most of us can readily identify with a particular animal or its habitat. The basic reason for such success is the day-to-day slogging through marshes and other ecosystems by all wildlife scientists. They keep us abreast of energy and coastal development projects. There is still much to be done—you know it and I know it.

It doesn't matter much whether you're talking tricentennial or bicentennial and a half when you are addressing the problems of pollution and loss of wildlife habitat. This is the real bottom line for the future of wildlife in this country. Yet, there is a good sign for the future. Only recently, the Wetlands Loan Act was extended for another seven years. This gives a new lease on life to that important program. This legislation alone will not solve the problems of diminishing habitat. It will require the combined efforts of all groups represented here. As in the raindrop theory, if we have enough rain, we can create new rivers of public initiative.

Poor land use planning still characterizes far too many decisions. Wildlife is still not getting the support that it needs. This may be our fault, but the word on wildlife somehow has not yet penetrated the minds of some officials. It has been elevated in the minds of Americans in general, but in a detached way. Most of the wildlife shows on television, for example, focus on Africa, Asia or Latin America. Only a few shows have been done on domestic wildlife in the United States. This is where the challenge lies for American wildlife professionals.

The habitat problem is the story that must be told as a first priority. Some of the past massive engineering projects that have been undertaken in this country have not been adequate as far as preserving wildlife values. And we all know, there are far too many valuable wetland acres being drained each year. The public must be informed of these threats.

As all of you know better than anyone else, that habitat loss is the major and fundamental threat facing wildlife. If we can unite on this issue, I think greater progress can be achieved.

We did it for DDT and other pesticides detrimental to wildlife. The professional and citizen ranks closed around this issue and reversed a major threat to wildlife. We see still another threat today in the pesticides field. We are now learning the PCB problem in great detail. This, too, must be conquered before we can state that wildlife is in good shape.

Much ground has been gained, we have some significant battles ahead during the next 100 years. It's obvious they can be made easier if we work toward a common goal. Let me invite all conservation groups to continue to promote your views vigorously. But, let's try to drop some of the emotion from the issue. If this can be done then our job to convince the general public of wildlife resource needs will be easier.

In the final analysis, our wildlife resources and our own lives will be enriched. Let us join together on these problems as a bicentennial gesture of cooperation between the public and private sectors of the conservation movement. Let us do so secure in the knowledge that each one of us can make a difference.

Discussion

MR. RICHARD REINAUER [Associate Producer of "The Wild Kingdom"]: I have been here as an observer for the last four days and have had very little to say. However, I must take issue with you, sir, for the comment you made relative to television productions and specifically to productions in the United States.

I want you to know that in the last 15 years, of the 205 shows we have put on, 60 have been done in the United States and of those 60, at least 40 have concentrated themselves on work being done by the state and federal officials and game and conservation management.

I would like to think that we are partly responsible for the good public reation to the very difficult work being done by conservationists all over the world and particularly in the United States.

MR. FRIZZELL: My only answer would be—more power to you and I hope that more do the same as you have done.

FROM THE FLOOR: I am a writer of animal and wildlife and conservation subjects. You spoke in rather obscure terms about emotionalism and suggested that there be a more rational approach. It would be most enlightening if you would explain to us by example the emotionalism to which you were referring?

MR. FRIZZELL: Your question catches me a little offguard. I wish I had done my proper and necessary pure research before I made a statement.

Let me say this, however, that during approximately a year and a half in the litigation end of the type of lawsuits that you and I are both indicating, both in the Department of Justice and two and a half years in Interior, I have too frequently found individuals and groups, both within government and without, that come to an issue not with an open mind but with a predetermined judgment, not always substantiated by facts, figures and scientific evidence. In fact, they are not interested in the other side—they do not want to meet with the other side—they want to meet with the Secretary and espouse their one-sided view.

I will give you a current example. I will probably get into trouble. A decision has not yet been made on this because we have only just recently heard it. We have talked to both sides.

Some of the officials from the State of California came in last week, armed with the Rand Study, and they set out that the power companies in California had no doubt overprojected the needs of California during the next decade or two, to the year 2000 and beyond and pointed out that the consumer is going to end up paying for that overage. However, in turn, they had their own figures and projections that were considerably under that and it was based, for example, on the premise that if we had nuclear power, we would not need coal and if we have coal, we don't need nuclear power and, thereby, we don't need comparables—it is not the proper place to site such a plan.

Very frankly, I have to ask, "where do you think a proper siting would be? If you don't believe in nuclear siting (which they oppose), if you don't believe in strip mining of coal, even though you rehabilitate the surface, if you don't believe in off-shore drilling, if you don't believe in oil spills or imports or a pipeline on the edge of a refinery, what are you going to do when the lights go out and people start getting cold in this country?

Now, I know both you and I see some heads shaking here in the audience but the truth is that in this country we have to balance those respective needs.

It takes energy to clean up the environment and the American people, just as they are interested in wildlife, are interested in their day to day living and in keeping warm and driving their automobiles and also in sufficient electricity and power. Therefore, if the two respective sides become so polarized that nothing is reasonable—we want zero pollution or there is the attitude of some in industry that pollution isn't bad—then we are not going to make much progress in this country.

I want to see the enlightened leaders of both sides come forward and try to reach the proper balance that this country needs.

CHAIRMAN HARTUNG: Do we have other questions or comments?

MR. FRED EVENDEN [The Wildlife Society]: I appreciate your response in relation to emotionalism. Your points are well taken. We are all guilty of utilizing jet airplanes to get around and to do our battles in relation to these very issues.

Now, I would like to touch briefly on one of the earlier comments you made when you said that your duty with the Department of the Interior was to respond to these needs and interests within the wildlife area itself, meaning, according to my observations, that quite a few and too many of these responses have been, even by your agency, to the emotional reactions of these people.

A recent example could well be the wolf problem in Alaska. That is just a comment.

Now, the question I would ask is this—whether or not this great increase in man's interest in wildlife, increase in the problems that have taken place, the realignment of organizations within the Fish and Wildlife Service, such as adding on the biological services program—that in spite of all of these things being done, they do not necessarily fit when you put them altogether and they do not fit, for example, because the Department of the Interior has not been working with the Fish and Wildlife Service to support its needs.

For example, the endangered species program, which was set up even before the Worldwide Convention on Threatened and Endangered Species, has never really gotten off the ground and they are being criticized for this. As a matter of fact, however, it was a long time before they had any manpower that could do any of it and they still do not have enough.

Therefore, my question is this—can the Secretary's Office assure this group that we can have better financial support of fish and wildlife programs?

MR. FRIZZELL: I would like to be able to say "yes," but I would be dishonest if I were to say "yes." I cannot assure you of that.

First of all, the Secretary and the Secretariat of the Interior Department do not have the purse strings as such. We can support increased budgets for fish and wildlife but the process, as you well know, does not end there. It goes to the OMB, it goes to the Hill and everybody has their favorites in relation to their particular affections. These are hard times, despite what some of you think.

You know, the Federal Government just does not print money.

Further, there are the considerations of other groups, such as yours and mine, that they have to think about in terms of wildlife but for the whole field of wildlife, as recently as sixteen years ago, the total federal expenditure was $100 million. Today it is $358 million.

We have been successful in doing this by mortgaging future generations but, as you know, there comes a day of reckoning and that is what we are concerned with.

New York City found this out. Certain states are finding it out, and there will be no one big enough or willing enough to bail out Uncle Sam when it happens to us.

Now, all I am saying is that we have to make our choices. I used to have to make them, for example, as a Board of Education member at Wichita and as a State Senator.

I would like to say "yes" to your question but I cannot honestly do so. I can say we will be able to articulate advocates for conservation in the Interior but I cannot assure you that adequate monies will be forthcoming. I have to go further and say that I recognize that when a hard choice is made, sometimes we are not always going to win.

You know, I am grateful, because some people look at Interior and say, "I don't know what your mission is, you are a "Jeckyll and Hyde," and indeed we are and are glad of it.

I would hate to be a single-minded, single-purpose agency that only had one point of view especially when decisions are to be made. I am glad we have opposing groups and points of view. I am glad we get both sides of the facts before we come down to the issue. We get better decisions as a result of it. I think we do have a vital and vibrant Department because of our Jeckyll and Hyde existence.

DAVID NELLIS [Virgin Islands]: I would like to return for just a moment to emotionalism in our public media.

Just this morning on the *Today Show,* they devoted an entire hour's program to the seal harvest off Newfoundland and in the course of their program, they showed, on the one side, the strict preservationist groups, who advocated zero seal harvest and, on the other side, the sealers.

Now, there was not one minute of this program devoted to anybody from, for example, the Canadian Wildlife Service, who have been studying this problem for many years and have much data to actually present on both sides of the subject.

The entire one-hour program was strictly devoted to emotionalism, with no reference whatsoever to facts.

It seems to me that if our national public media were to concern themselves more with facts than emotionalism, that the public would indeed be more informed on exactly what is happening, both as to natural resources and wildlife.

MR. FRIZZELL: I could not agree more.

MR. JOHN Van DERWALKER [Fish and Wildlife Service]: I am going to suggest something that may be a little easier.

Earlier a gentleman suggested an increase in budget. I am going to suggest a decrease in budget.

In other words, I would like to know if the Department would be willing to withdraw support for development programs that have been demonstrated to not be economically viable in the national interest; that do have unneeded energy requirements and have a tremendous environmental cost.

For example, I have reference to the present project on the Colorado-Wyoming border and, further, irrigating land at 6,500 feet of elevation to raise hay.

MR. FRIZZELL: You are talking about a cost-benefit ratio in relation to these particular projects and I think you should bring those facts and figures to the attention of myself in more detail so that we can take an honest look at them and see if we can preserve some wildlife habitats or make trade-offs in relation to the money side of them.

MRS. COTTRELL FREE: I have one final question. I would like to ask it because it is not often we get an opportunity to go right to such an authoritative source.

What is happening, for example, on implementation or revision of the Lacey Act, because that has gone through so many convulsions it is very hard to untangle the strings and lead us back to what it is all about. I am sure you know what it is about. To me, it seems to be a terribly unfair thing and you all suggested it first and then it seemed to disappear.

MR. FRIZZELL: I had an inquiry from the press in the last week and I have asked Lynn Greenwalt and his people to come into my office to give me some answers to the concerns that you have just presented.

I franky don't know the answer. However, I will be glad, if you will give me your name and address, to respond to you in writing after I have learned more of the facts, which I do not possess today.

MS. POLLY DYER [Seattle, Washington]: You left me with the impression with respect to energy development, that it had to be either one or another type of development. Yet, the other day, a speaker from the federal conservation agency gave some telling figures of how much per barrel we save by doing certain things. Now, my question is this—how much, on this basis, are we actually saving by practicing proper conservation methods?

MR. FRIZZELL: Well, it was my error, in my remarks, not to mention conservation and stress it more strongly because, believe me, I don't know if we have gotten well enough into this, at least in these few short moments here this morning.

However, as the devil's advocate and when I appear before energy-related groups, my main theme is conservation and, in truth and fact, the case for conservation isn't in question any more. The jury has been out. It cannot be appealed. Conservation has to be here and now.

As to what the Interior Department has done about it—well, not enough.

Last year, for example, we did have one of the highest percentages of savings of energy of any federal agency. We had about an eighteen to twenty percent savings over our prior year and yet, during that same year, I well realized the winter before leaving my office one evening, walking up and down the halls, and noticing about some 125 lights on. I turned off a great deal of them. However, had this not been done, they would have been burning from Friday night until Monday morning.

For example, we could employ one man full time just to go around and turn off lights on Friday evenings and still save money—in other words, more than make it up in energy costs. No, we are not doing enough.

The case for energy conservation has been made and I want to pursue it and preach it and teach it as you do.

Strengthening State-Federal Cooperation for Western Energy Developments

The Honorable Thomas L. Judge
Governor of Montana
Helena

Charles Marion Russell was a cowboy artist, a sculptor, a poet and a cow puncher. He lived in Montana both before and after our region became a state. More than any man or woman, he taught us to appreciate what the Creator had given us, to see what was around us, to remember how it had been when Russell first arrived there, and to accept responsibility for being guardians of the part of the American heritage given over to our trust.

Russell, like many Montanans who came after him, loved people as he loved the land—respectfully, not sentimentally. He didn't like to associate with people in huge numbers. He didn't love people as a statistical abstraction. Writing from Chicago in 1916, he said, "If I had a winter home in Hell and a summer home in Chicago I think I'd spend my summers at my winter home. There might be more people in Hell but there couldn't be more smoke." Russell, however, was understanding. He went on to say in the same letter: "But there is lots of good people here. Maybe it ain't their fault. I suppose Great Falls will be like Chicago some day but I don't want to be there."

Montanans today feel about their state the way Russell did 60 years ago. They cherish the wide green spaces, the clean air and water, the scenic beauty and the unlimited recreational opportunities. Last week we had a birthday party for Charlie Russell in Great Falls and if he were there, he would be pleased that Great Falls isn't like Chicago.

There are more people in a suburb of Chicago than there are in Montana. We have 4.7 people per square mile, compared with the national average of 58.5. We are somewhat removed from the mainstream of American life in other ways. The post-war economic boom of the 1950's and 1960's passed us by. Although Montana's per capita income in 1950 was 8 percent above the national average, it had by 1970 plummetted to 12 percent below the American standard. During these two decades, over 83,000 more people left our state than came to live in it. Many of the decisions which profoundly affected, even determined the quality of life our people enjoyed were made in corporate and bank board rooms far distant from our cities. Over $9 billion in minerals had been extracted in our state prior to 1973 and our people had received little, if anything, in return. Ghost towns dotting our landscape serve as decaying yet still standing reminders of the boom and bust economy that prevented countless families from leading decent lives in the communities they had built.

The old state constitution, adopted in 1889, prohibited Montana's units of government from enacting a tax on the mining industry. In 1972 the people of Montana drafted and approved a new constitution—designed to place in the hands of the people—for the first time in Montana history—the greatest possible control over the state's destiny. And that constitution came none too soon.

The people of Montana find themselves cast into the very vortex of the nation's and the world's two most pressing problems—the shortages of energy and food. Overnight our remoteness from the rest of the country has been bridged.

Today, one out of every three people in the world—a total of 1.3 billion people—lives in a country that does not grow enough food or cannot afford to buy enough from other nations to provide adequate diets for its citizens. Five hundred million people are starving or are seriously malnourished. Only seven nations in the world, containing a mere 8 percent of the world's population grow more than enough food to feed their people. Of these, the United States is by far the largest exporter of food, shipping abroad as much as the other six combined. The poor nations must look to the United States to meet their very critical needs for food.

The State of Montana is an enormously significant contributor to national food output. We are second in the nation in production of barley; fourth in wheat output; sixth in sheep and eighth in beef production. And we have enough water near agricultural areas to increase greatly the amount of land under irrigation.

And at precisely the time when the muscle of America's agricultural industry must be stronger than ever, when the federal government is asking our farmers and ranchers to unleash completely their productive capacities, federal policy is playing havoc with our farmers. We are faced with embargoes on grain exports; presidential vetoing of the emergency farm bill; an apparent effort to phase out overseas market development programs; and a looming proposal to phase out farm disaster programs.

Federal farm policy, however, is not the only threat to Montana's agricultural productive capacity. For the nation and the world are also looking to Montana and to some of the other western states to provide a large part of the solution to the energy crisis.

Since World War II, America has developed what can only be described as a gluttonous appetitie for energy. With only 6 percent of the world's population, we in America, have been consuming over one third of the world's total energy output. The average American uses as much energy in 2.7 days as half of the world's people consume on an individual basis in one year.

The Congressional Joint Committee on Atomic Energy warned in 1973 that if the growth of energy consumption continued at its then present rate—even if Alaskan oil is developed, if our nation's shale oil reserves are tapped, if our coal reserves are stripped from the earth, if domestic natural gas exploration is promoted, if geothermal plants are developed, if hydroelectric power sources are expanded and if nuclear power plants are built as fast as technology allows—if all these plans become reality—by 1985 we still will have only two thirds the energy supply that this nation will require.

Should international consumption continue to grow at a 3.9 percent rate, known and proved worldwide petroleum reserves would be exhausted in 20 years. Even if—miracle of miracles—new discoveries equal to five times the existing reserves were made, our wasteful ways could be indulged for only another 25 years. In the face of this demand the vast storehouse of energy located within Montana's border becomes almost overwhelmingly attractive.

Technically, Montana has enough coal and oil to supply the world's energy needs for the next 36 years. We lead the nation with the most known coal reserves. The U.S. Geological Survey recently announced that Montana has 105 billion tons of coal, significantly more than the second coal rich state, Illinois, with 65 billion tons and Wyoming, ranking third, with 51 billion tons.

Montana coal is close to the surface, lies in relatively thick seams, has a low sulphur content, and is cheap. Accordingly, we have witnessed coal production increase from 1 million tons in 1969 to 11 million in 1973. By 1974 the figure was 14 million, and in 1975 over 22 million tons were mined. By 1980 Montana's coal production will exceed 43 million tons per year if no new contracts are let.

Coal fired power plant capacity in Montana has gone from zero several years ago to 1100 megawatts; applications now pending, if approved, would double that figure. Montana currently is being eyed by the dozen or so energy companies. The national administration, for its part, has offered as its only concrete proposal for resolving the energy crisis the Nixon-Ford Project Independence scheme.

A report prepared last summer for the U.S. Bureau of Mines and EPA entitled "A list of proposed planned, or under construction energy projects in Federal Region 8," lists 175 energy and utility projects. Twenty-eight coal fired power plants including 10 plants with a capacity of 1000 megawatts are proposed, planned or under construction in a six state area that includes Montana, North Dakota, South Dakota, Wyoming, Colorado and Utah. A total of 47 coal fired, hydroelectric, gas fired, oil fired and nuclear power plants are listed with a combined generation capacity of 31,010 megawatts.

The Federal Government has failed to assess the precise nature of the crisis confronting us and the consequences of the various solutions to it. They have not determined the costs and constraints of accelerated development of our finite energy supplies. They have not acknowledged the present and pending constraints in material availability. They have not accounted for the severe impact of development on small rural communities. Nor have they considered the degradation of previously clean air. A serious energy conservation program is obviously taken no more seriously than some child's pipe-dream.

Worse, the Federal Government seems bent on repeating the mistakes made before in treatment of the northern great plains where Congress turned stone ears to factual presentations concerning the arid and semi-arid nature of the land and caused thousands of homesteaders to lose their savings and even their lives in trying to make 160 acre farm tracts produce enough to feed themselves and their families.

Water, as Walter Prescott Webb pointed out 40 years ago, is the critical element on the plains. The cattle baron who controlled the water supply controlled the land. The industry—agriculture or energy development—which controls the water supply today will determine use of the land for scores of years.

The 1972 North Central Power Study predicted that 2.6 million acre-feet of Yellowstone Basin waters might be needed annually for coal development in Montana and Wyoming by the year 2002. By early 1974, less than two years later, filings, options, applications and requests in only the Montana portion of the basin already totaled half that figure or 1.3 million acre-feet.

Wyoming has estimated its share of the river's interstate tributaries under the Yellowstone compact of be 2.4 million acre-feet. The Montana Department of Fish and Game has requested a 7 million acre-foot reservation for instream flow requirements. Including water for energy, these three categories total 10.7 million acre-feet each year. But the annual flow of the Yellowstone is only 8.8 million acre-feet and its low flow only 3.7 million acre-feet. Not even considered in these figures is the projected increase in the demands of irrigated agriculture—an additional 1.6 million acre-feet by the year 2000. Obviously, all demands for Yellowstone water cannot be satisfied, competition for the limited resource will be intense and critical.

The National Academy of Sciences warned in 1974: "Not enough water exists for large-scale conversion of coal to other energy . . . and the potential environmental and social impacts of the use of this water for large-scale energy conversion projects would exceed by far the anticiapted impact of mining alone." Nonetheless in the same year the U.S. Department of the Interior prepared a draft Coal Programmatic Statement, detailing the Department's justifications for an expanded coal leasing program. This statement did not answer the question of whether expanded leasing is necessary, if alternative energy consumption patterns are encouraged and if existing non-developed federal leases totalling 16 billion tons are put into production. It did not mention what levels and types of coal based industrialization are likely to follow coal leasing. It did not touch upon the crucial question underlying all others: are the nation's needs best served by massive exploitation of the nation's dwindling, irreplaceable natural resources?

The Programmatic Statement of Interior further assumed that energy use would continue to grow at an annual rate of 3.6 percent. Two years ago, the National Energy Research Associates projected the life span of some hypothetical energy reserves when subject to compound rates of growth. An energy reserve that would support us for 1,000 years at present levels of energy consumption, when subjected to a 3.5 percent growth rate per year would be exhausted in 104 years. Doubling the energy reserve—giving us a 2000 year supply at present levels of consumption—would only give us 124 years of consumption at 3.5 percent growth rate. A 10,000 year energy reserve at present consumption levels would last for only 170 years with the 3.5 percent annual growth rate. The federal government must examine these larger questions, thoroughly and immediately. Montana's fate and that of our western sister states hang in the balance.

Since January of this year, winds carried away a full inch of topsoil in some of our richest wheat producing areas. When you consider that it takes 500 to 1000 years to accumulate one inch of topsoil on the Plains and that these areas have only 5 to 6 inches of topsoil all total, you realize just how precarious nature's balancing act in our region is. Will the place we hold in the national heritage—with our forests and mountains and open spaces-be sacrificed for eternity because of the vanality of the energy companies or the bumbling of the federal bureaucrats? We cannot permit it to happen. And we will not.

The people of Montana have demanded firm state action to protect our renewable resource based economy and the unique natural surroundings entrusted to our keeping for our children, the nation and the world. During the past several years we in Montana have enacted the finest, roughest environmental protection laws in the country and we are enforcing them. It is our responsibility, as Montanans and as Americans, to make certain that industrial development occurs in accordance with the principles of our guardianship of our resources.

In 1973 the Legislature passed the Coal Conservation Act, to guard against coal wastage and to minimize the possibility of reclaimed land being again disturbed; and the Strip Mining and Reclamation Act, the toughest bill of its kind in the country, which provides for protection of critical areas, a ban on contour strip mining, and control over methods of operation and land revegetation.

The year 1973 also marked passage of the Utility Siting Act, requiring the Department of Natural Resources and Conservation, assisted by other state agencies, to conduct comprehensive analyses of proposed energy generation and conversion plants, transmission lines, and associated facilities. That act further requires that the Board of Natural Resources and Conservation must grant a certificate of environmental compatibility and public need before construction can begin.

In 1975, the Utility Siting Act was amended to include any plant using 500,000 tons of coal annually, regardless of the form of its final product. In 1974, the Strip Mine Siting Act, which necessitates site analysis before capital investments are made or permits considered, was added to the state's responsibilities.

Montana has also taken steps to allocate tax revenue realized from energy development to the best and most lasting use. Leading the way in 1973 was the Resource Indemnity Trust Act, which established a special tax on the gross value of the production of industries extracting non-renewable resources, and provided that the proceeds be invested and eventually used for long-range environmental improvement.

The 1975 Legislature developed this theme more fully. The base of coal taxation was changed from a flat tax per ton on BTU content, to a tax of 30 percent of the market value of the coal produced, the highest tax of its kind in the nation. The revenues will bring in $67 million in this biennium, which will be directed towards improving many aspects of the lives of Montanans—including local government, parks, schools, highways and funds to offset social and economic impacts of coal development. The days of public subsidizing of the mining industry are gone forever in Montana. Although Detroit Edison's Board chairman complained of this tax, the company still buys its coal in Montana because it's still the cheapest to obtain.

A third group of laws may be the most far-sighted and the most beneficial, for they go beyond reacting to proposals and wisely disbursing revenues, to anticipating energy development, and planning for the future of our State. Some steps had already been taken in this direction. Preparation of a state water plan, for instance, had been mandated by the legislature in 1967.

The Montana Constitution lays state claim to all water that originates in the state. In implementing this article, the 1973 Legislature passed the Montana Water Use Act, which requires anyone beginning a new use of surface water to file an application with the Department of Natural Resources. This Act has been a vast improvement in enabling the state to identify how much water is being used, for what purpose and who has rights to it.

With increasing requests for water from the Yellowstone, the 1974 Montana Legislature enacted a three year moratorium on processing large water applications in that Basin. And Montana is opposing attempts to challenge that article of the Yellowstone Compact which prohibits inter-basin diversions without the consent of all signatory states.

The Renewable Resources Development Act provides low cost loans of up to $100,000 to farmers and ranchers for worthwhile projects to develop or preserve land, water, timber, or other renewable resources. With approval of the Legislature, larger loans can be made to political subdivisions for the same purpose.

Funded by the sale of bonds, backed by 2.5 percent of the coal tax, this program is a significant and positive approach to the utilization of non-renewable resources, based on the theory that the one-time harvest of coal should help to ensure a strong, broad and enduring economy based on resource uses which are, with proper management, virtually inexhaustible.

Through tax incentives, the Energy Conservation Act will encourage investment in non-fossil fuel forms of generation and will promote energy conservation in buildings.

The Alternative Energy Act, still another innovative measure, allows grants to be made for research, development and demonstration of alternative energy sources from a fund consisting of 2.5 percent of coal tax revenues. The importance of this law cannot be over-emphasized. The sun and wind, for example, promise energy which may be available in limitless supply. Each hour the sun could provide 800 trillion kilovolts, which is about 100 times more energy than man has used throughout all of recorded history.

Another act provides a vehicle by which Montana's energy future can be guided.

While the Legislature has reacted decisively to the specific problems created by energy development, a comprehensive energy policy, which balances all considerations and establishes common goals to guide our actions in the future, still was needed. Legislation mandated the development of just such a policy. I have directed the Lieutenant Governor and the Montana Energy Advisory Council to prepare such a state energy policy and plan which will include attention to alternative long-term growth goals. That policy will be ready to present to the people within the next year.

I don't mind telling you that I am proud of this package of laws and legislative mandates. With vigorous and fair enforcement, these bills will protect our state's unique store of natural resources while encouraging the kind of development that our people need.

All our work can be undermined by the Federal Government which owns 41 percent of the mineral reserves in our state. In the 900,000 acre Decker-Birney area, where development is being pressed forward, the Federal Government controls 88 percent of the mineral estate.

Since President Ford twice vetoed a federal strip mine act, the lessees of federal land would not be bound to reclaim stripped areas. At the same time, the Department of the Interior seems determined to embark on an even greater coal leasing program.

Secretary Kleppe promises the states "maximum input." Maximum input is not enough. We know our own states, and in the last century the Federal Government has far from demonstrated adequate knowledge or sensitivity to the needs and aspirations of our people.

Realizing that each state cannot alone deal effectively with the Federal Government, the governors of ten western states formed last year the Western Governors' Regional Energy Policy Office to monitor federal action or inaction in the energy field and to represent the interests of our region with one, strong united voice.

As the Chairman of the Western Governors' Regional Energy Policy Office, I can tell you that the 10 western governors have taken strong stands on issues such as:

Passage of federal strip mine legislation;

Amendment to the Mineral Leasing Act of 1920;

Opposition to federal pre-emption of state's rights—land use, air and water pollution control and utility siting;

Research and impact funds for the western states; and

Proposed coal surface mining regulations.

We've heard speech after speech from the two most recent occupants of the White House calling for a partnership, a relationship of equality and cooperation, between the Federal Government and the states. If such a partnership exists, it is all too clear that the states are the junior partners.

Any Federal Government attempts to preempt state laws dealing with reclamation, land use, water rights, utility siting and air and water pollution will be resisted. Such confrontation of politics, however, serve neither this country nor its people. The states would prefer to cooperate with the Federal Government. I suggest that the Federal Government celebrate the 200th anniversary of our nation by getting rid of the new federalism we've been hearing so much about and returning some of the old federalism guaranteed by the Constitution.

When Plenty-Coups, the Chief of the Crow Indians, was a young brave he had a dream. Many years later he described the dream to Frank Linderman who was a contemporary and close friend of Charley Russell's. Plenty-Coups saw a hole in the ground out of which came buffalo without number. They spread wide and blackened the plains. Soon they disappeared and were replaced by strange looking animals, buffalo he thought at first, but they were smaller, had longer tails, and some were spotted.

Later Plenty-Coups was told by one of the elders of the tribe what his dream had meant. The strange animals from another world were the cattle of the white man. His dream was telling him that the white man with his cattle would drive away the buffalo and would overtake the plains. His dream told him that the only hope for his tribe to hold their lands was to side with the whites. Because of Plenty-Coups and his vision the Crows never raised their weapons against the whites and they were not slaughtered.

We in 1976 have received a similar vision although it has not come to us in the form of a dream. We know that if we do not stop our wastrel ways, if we do not act with reverence toward the fragile natural environment surrounding us and giving us life, we too will be destroyed.

For the sake of our people in the west, for the sake of our children, for the sake of all the people of America in this generation and in generations to come, we will not permit our sacred land and water to be destroyed, our homes transformed into a national sacrifice area. Such destruction would not be sacrifice at all. It would simply mark the death of the heart of our nation's heritage and ideals to which we must return if we are ever as a nation to experience life, liberty and the pursuit of true happiness.

Discussion

FROM THE FLOOR: Mr. chairman, I would like to comment on this session, and also make a suggestion.

We believe, for example, that the environmental movement is helping us in all directions. In this connection, a survey taken in 1972 of college students showed that, at least the younger people in this country, their priorities are more geared toward protection of the environment and well-being of the habitat than to economic growth.

In the light of these two points, the Chamber of Commerce, which conducted this survey, presented a report which indicated, among other things, that protection of the environment and economic growth are not necessarily incompatible and that many acknowledged interests are not recognizing this as a fact.

In some cases, as has already been pointed out, some private companies are moving in a direction to help protect while others are resisting.

My suggestion to this Society is that we should not be limiting ourselves in relation to our own group; we should not be adversaries on the other end of the fence but, rather, our societies should, on a regular basis, send representatives to meetings of the Chamber of Commerce, to the meetings of various national organizations such as real estate associations, county and regional organizations, to present the views of larger interests in the environmental field—in other words, tell them what the attitudes of the people are, the costs involved.

As I indicated at another session, we have found that people in this country are willing to pay almost anything, at least from 1 to 5 percent of their income, for protection of the environment. This, in turn, will help them reduce conflicts, save time and resolve issues more carefully.

The thing I want to emphasize is that our societies should not go to these meetings, for example, as adversaries but as advocates—trying to get these people on our side. Thank you very much.

Communications and Resource Management

James R. Shepley
President
Time Incorporated
New York

Thank you, Mr. Chairman—and thanks to each of you for being here and for being concerned.

I'm told that James Bryant Conant, when he was President of Harvard, after writing a speech would ask an assistant to check and make certain there were no headlines in it. Without checking, I'm reasonably certain there are none in mine, though I do hope there are some guidelines which may make the relationship between environmentalists and communicators more fruitful.

To be effective, that relationship, like others, must be founded upon reasonable expectations. In a sense, the '70's in America have been a learning period about expectations. Most liberals have learned that government cannot provide everything for everyone. A great many conservatives have come to realize that business cannot meet all the demands made of it. For environmentalists the lesson of the '70's must be that the communications media cannot accomplish everything many expect of it.

I believe the media can and will be the ally of environmentalists in their fight to manage wisely our bountiful but not limitless resources. Environmentalists and communicators found one another and romanced one another with extraordinary intensity in 1969 and 1970. Those were years when journalism helped make "ecology" a buzz word. *Time* magazine in the summer of '69, when I served as its publisher, introduced a new section called "Environment," noting that "more and more people are increasingly alarmed by man's abuse of his own earth."

Early in 1970 all of Time Incorporated's magazines published cover stories, special reports or even special issues on the ecological crisis. So, too, did *Newsweek, Business Week* and a great many other publications. Newspapers, radio and TV displayed equal interest and the environment became what one writer called "the most fashionable solicitude of our time."

That fervent two years or so might be considered the second phase of the environment-communications relationship. Phase one had begun during the Industrial Revolution in England when Sir Edwin Chadwick first perceived the dangers of pollution. Chadwick, I am happy to say, was among many other pursuits a contributor to magazines, where his writing helped pass what we would now call environmental legislation.

Phase three of the environmentalist-communicator relationship occurred in the early 1970's when the peak of anxiety had passed, but its momentum converted that anxiety into laws seeking to control air and water pollution, establishing the EPA and other government agencies. Then came the energy crisis which ushered in the fourth phase of the environment problem and the response of media to it. A fifth phase may be already emerging, marked by industry going on a counteroffensive against what it believes are excessive demands in the name of ecology.

My point in sketching this history is to suggest that the relationship between environmentalist and communicator is and will continue to be a changing one. You should not look back and expect a revival of the ardor of the peak years. That phase is finished. At least I hope it is, because only a terrifying and imminent threat of extermination could recreate the intense media seizure of 1969 and 1970.

I think that the earlier Doomsday phase served a useful function. Without it, we might have had, if not Doomsday itself, certainly even more serious health and resource problems than now confront us. However, too many shrouds continually on display seem after a while like nothing more than dirty linen flapping in the wind. So my first suggestion is not to look back to the fervent years of 1969–70 and not to fall back on the hyperbole which characterized them. My second suggestion is to look at the present with a clear realization of how difficult environmental journalism has become, how inexact is much of environmental knowledge, how fumbling is more than a little of much ecological expertise.

Journalists are used to depending on authority. And the good ones know how to separate instant experts and lifelong fools from the real authorities to whom they turn with eagerness. But what happens when the authorities on one side are Harvard-MIT scientists and on the other side, industry researchers of equal repute arriving at conclusions that contradict their Cambridge peers? Worse yet, what happens when the Cambridge peers differ among themselves, Harvard coming up one way and MIT another? To compound confusion, the scientists at either of those great universities may quite likely differ among themselves.

One journalistic reflex is to look for an arbiter, perhaps within a government agency such as the National Science Foundation or the EPA. Well, I suspect that many of you realize the dangers of looking to government for judicious neutrality. So do good reporters.

There are admittedly too few good environmental journalists. And little wonder. To do their job they have always needed a scientific education. Today they should also have a masters in economics and, increasingly, doctorates in law and in medicine would be helpful. Anyone with that range of interdisciplinary education knows too much to remain a journalist.

One of the first specialists in environmental reporting, Russell Lynch of the *Milwaukee Journal*, has written that he was depressed by his lack of knowledge even though he was clearly among the more knowledgeable. Gladwin Hill of the *New York Times* has called the environmental beat "probably the toughest story newspapers have ever had to come to grips with." Phil Herrera, who edited *Time* magazine's environmental section from its beginning in 1969 until last November, described his job as "a hot spot in which you're caught in the crossfire of economists, industrialists, politicians, scientists, lawyers and doctors, and perhaps most of all in the concerns of ordinary confused citizens."

I suspect that many of you at one time or another may have been frustrated by the kind of coverage or the lack of coverage of a particular story. I can only urge you to remember the western adage, "Please don't shoot the piano player. He's doing the best he can." My own feeling is that, under very difficult circumstances, he's often doing a fine job.

If able journalists sometimes get lost in the maze of arguments and counter-arguments, if they feel tugged one way, pulled another, then brutally yanked in yet a third way, what about their readers?

In recent weeks I have read that when the world population reaches 5 billion, widespread famine dwarfing anything we now know will inevitably result. Conversely, I have read that technical advances properly applied to food production would allow the world to feed 40 billion people. Not only is that confusing, but remembering some rather spectacular predictions of famine which, fortunately, have not come true, one more dire prediction gives me a strong feeling of *deja vu*.

The conflict between scientists on nuclear energy is equally difficult for readers and becoming almost as repetitious. Early last month when three engineers resigned to protest that the nuclear power plant on which they had been working was unsafe, the news media gave the story considerable coverage. There were experts galore to both applaud and condemn the San Jose three. *Time's* story ended with some skepticism about their position, and we received some letters approving what we had written, though more brickbats than bouquets, including at least one cancellation.

Some highly reputable scientists consider nuclear power plants, despite their serious drawbacks, the best way to supply our energy needs. Others, equally reputable, regard nuclear power plants as an invitation to disaster. I am not suggesting, of course, that scientific or for that matter ethical disagreements among scientists and ecologists should be patched over or concealed. I am pointing out that when those disagreements are oft repeated, readers yawn and editors spike. When the disagreements, despite interest and effort, defy understanding, readers turn the page and editors turn to politics or crime, travel or sex, to any of a thousand stories vying for their space. Such an editorial reaction may be unfortunate. It must nonetheless be recognized.

But I do not want to stress only the difficulties of the environmentalist-communicator relationship. It has, as they say, a number of things going for it. For one, tremendous interest.

A moment ago I mentioned reader reaction to a story in *Time.* What is really most heartening about response to environmental stories in all our magazines is not particular attitudes of readers but the breadth and intensity of their response. Without doubt ecology is one of the great continuing stories of our day. Interest in it is no more likely to disappear than the instinct for self-preservation is likely to vanish.

However, ways of responding to that fundamental interest may change and one such change is the response of business to accusations of environmental wrongdoing. The old corporate assurance that "we care" has been replaced by more precise, sophisticated explanations of what the company is doing to reduce mercury or eliminate sulphurous fumes. Today almost all large manufacturers have environmental directors whose substitution of the pragmatic "we do" for the pious "we care" is helping to improve the dialogue to which environmental journalists listen and in which they sometimes join.

I suggest that articulate industrial spokesmen, the relatively new environmental directors, represent one such change. Their constituency may not always be yours. They may be defending what used to be called "the interests," now transferred into "the establishment," but they frequently represent companies which do have motives other than profit, companies which create jobs, pay heavy taxes, fulfill very real product needs and—increasingly—spend billions of dollars to avoid befouling the air, the water, the land.

On the positive side, too, is the greater availability of spokesmen within the environmental movement. Only about 4 years ago here in Washington, a number of journalists who wrote on ecology formed an association of environmental writers. One reason they did so was to help them get to the top people in government, industry and academia. In 1974 the association disbanded, in part because the top people had become more accessible, more readily responsive.

Some of you here this morning are very likely among those "top people." Let me urge you to be available, to be lucid, to be patient. To a good journalist a press release is at most a beginning. One good interview can be worth 10,000 releases. Try not to confine your interviews or your interest to scientific or intellectual publications. The lay press may be equally or even more important.

Let me also urge you to be alert to another change, the great number of women and young people who are particularly active in environmental battles. Today new magazines edited especially for women and for young people are enlivening the commucations world. Talk to them and through them to their active readers. In television women are moving into roles of real importance, comparable to roles they already play in the print media. My instinct tells me these women in TV are likely to be highly receptive to environmental stories. Technological advances in televsion help them translate that interest into actual programming. Small, highly portable cameras using new types of film that eliminate the need for special and expensive lighting equipment are making it possible to cover environmental stories with new mobility and highly visual insights.

I have suggested that you do not overlook the popular press because of your attachment to more erudite publications. Let me point out that the trade press can also be an important ally, especially as environmental stories become more technical. For the industrial trade press is taking an increasingly professional and discriminating interest in your activities. The industrial edition of *Business Week,* for example, covers environmental stories which may not run in its national edition.

Fundamental to both the strengths and the problems of the environmentalist-communicator relationship must be the realization that we have hard underlying choices, difficult to make and equally hard to carry out. Until the mid-60's ours was an optimistic society. We belived we could do almost anything. Since then we have heard a great deal about reducing our sights and lowering our expectations. Those words "lowered expectations" have, in fact, become a catch phrase. One result has been a plethora of apostles who philosophize that less is more.

It may be, but for millions who already have too little, less is certainly not more and they need more. For others who possess what many regard as plenty, less is equally unattractive. We have learned some realism in the last decade, as I noted in beginning these remarks. I did not say, however, and I do not believe that we have embraced negativism. Instead of lowered expectations, what we need are often different ones, based on our understanding that acquisition is not the central fact of life. Undoubtedly we need to make sacrifices but *for* goals as much as *of* things. Changed expectations need not diminish, they can revitalize. Trimming can lead to growth, rechanneling can increase fertility, pruning can produce more.

Conservationists have always understood these truths. They are part of the environmental ethic, and today, more than ever, environmentalists and communicators need to convey them to the American people. They are the truths that underlie almost every ecological story. For the environment is not just a beat, like city hall or night court, but a mantle over all beats—political, economic and sociological; local, national and international; physical and metaphysical. Who among us—environmentalist or journalist—could ask for a more challenging assignment?

Educating Citizens to Improve Resource Management

Walter J. Bogan
Director, Office of Environmental Education
Department of Health, Education and Welfare
Washington, D.C.

Ladies and gentlemen, during these past few days you have heard described, through the various presentations, the current prospects that we face regarding the depletion of our resources and the attitudes that we have traditionally maintained toward resources. We are now forced to come full front with the reality that the resource picture has changed and, as a result, there are new needs and new challenges. As these challenges impact the educational community, we have experienced and continue to experience all of the difficulties of the media as described by Mr. Shepley. The education community's difficulties are further complicated by the fact that our mission includes both the adult public and students at all levels of the formal education system. The task and challenge is that of developing conceptually meaningful educational programs that will contribute to a changed perspective with regard to how we utilize resources in the most thoughtful and meaningful manner and, equally important, inculcate an understanding of the limitations of resources and the complexity of resolving the problems of limited resources in the light of the various competing and conflicting interests.

The dilemma faced by journalists in attempting to understand, for example, a discussion of power plant siting in the light of conflicting expert advice or testimony is one that is experienced continuously by those attempting to develop meaningful and viable educational programs. Those in the formal education sector and those of us responsible for problems at public school, pre-college and university levels have to be able to provide or find ways to provide conceptually sound, meaningfully communicable insights with regard to how to understand resource problems, and design learning opportunities that will help the learner learn how to learn—develop the capacity to deal with new and changed situations in the future. There is a dual challenge—that of understanding our present resource picture and that of being capable of understanding our future, and therefore unknown, resource requirements. These challenges must be met and they must be met in a way that provides for a positive educational experience, an educational experience that engenders a positive feeling on the part of the learner that there are measures that can be taken, that there are areas where one can get technical expertise or support. The educational experiences must, in addition, be provided with the full understanding and appreciation of the fact that the problems we face today and the problems that we cite in our educational programs are not the problems that the students we are addressing will face because the situation changes so rapidly.

This, in turn, imposes a burden on the education system which we have not felt before—that is, the problem of a redefinition of the concept of education. The principal purpose of education can no longer be considered that of producing an educated citizen. It has become more subtle and complex because we are now faced with the challenge of producing an educable citizen, one who as the system changes will be able to respond in very different ways. Many of the things that we know today or think we know are not going to be particularly helpful as answers or solutions to the problems that the generation of the 1970's and 1980's will be confronted with.

With that perspective I would like to look at the resource picture *against* the larger task of education, and specifically the new and different challenges that the education system is faced with as a function of the environmental crisis. I will not take time to list the things that have been stated so eloquently in a number of papers over the course of the past several days. However, we must come back to the question of the tricentennial. Young people must be encouraged to consider what the previous 200 years experience has meant—the successes and all of the accomplishments which give us such pride—and what it means for the future.

Our accomplishments make it necessary to begin now to look for new opportunities and to consider the ways in which the experiences of the previous 200 years can provide guidance in planning for the next 100 years. Therein lies the principal challenge and responsibility of the public education system.

The major function and purpose of government, as conceived by the founding fathers and reflected in the Constitution and the governmental structure devised, is that of providing to citizens and maintaining for posterity the resources required for life, liberty and the pursuit of happiness. When those words were written, resources were perceived to be unlimited. That is a posture from which we can no longer operate. We now know that this is not the case.

One consequence of this new realization is the requirement and responsibility to rethink and reconceptualize the meaning of "resources"—a term, the definition of which, we are beginning to expand. Traditionally, we have thought of "resource" only in terms of those physical and biological phenomenon we use at will. However, we are now forced to take the broader definition of resources, namely "available means." With this broader definition, "resource" becomes a term that subsumes a number of things that we have not heretofore associated with it including human resources. The energy issue is a case in point. Contrary to our assumptions during the past 200 years, we now know that we can no longer plan for growth that is predicated on an unlimited energy supply or on increasing energy use. The whole notion of resources and how we proceed has to change significantly. We are, per force, required to concern ourselves with development—extending the resource or "available means" to meet the needs, rethinking how we can be responsive to the ideas embodied in the Constitution, enhancing the ability to develop new ideas that will permit both progress toward social and human development goals and greater harmony between these and the controls, requirements and limitations of the natural environment.

Resources defined as "available means" is a multiple, changing and evolving idea-oriented phenomenon. As such, it must be presented in the context of societal goals, values and needs as perceived by citizens. Management of these resources must be undertaken with full appreciation of the realities of the task, including the obvious inter-relatedness of resources. We have, for the past several decades, thought about resources in compartmentalized terms such as water resources as one category, and mineral resources as another category, without the comprehensive perceptual view that allows us to see the relationship between water, other mineral resources and increasingly the holistic perception of what we are being challenged to come up with. We need, then, integrated approaches for resource use and we need to think of the implications of short-term decisions and their long-term impact—that is, the extent to which some kinds of decisions that we make with a one or two-year time horizon will affect the future if we project them out for a longer period of time, say 20 years, as an example.

In addition to the resource/environmental management problem is one which I'll describe as the communications dilemma.

Much of what we're dealing with in the environmental dilemma is a failure of communication, a failure of common image, a common base from which we perceive problems and project idealized alternative futures. In the past three or four years we have seen a number of instances in which this has been brought to the attention of the public through events like the UN's conference in Stockholm in 1972, and more recently the population conference in Bucharest. That is, there are different perceptions held by different communities. There is one community that argues that we have to have limits to growth both in population and in terms of economic growth. There is another, much larger, somewhat less vocal community that does not believe that any of these things are real, and they have faith in some other answers.

The reasons for suggesting that dilemma are very simple—that is to ask what mechanism do we have for attempting to establish a dialogue between those very divergent groups and what processes do we have in this country for dealing with the "fact", that is the scientific fact, that rational perception of reality versus the values that people espouse. How do we put them together? I think we have some rational reason to have hope.

There are two specific pieces of legislation that provide vehicles for addressing the fact—value dichotomy. One is the National Environmental Policy Act. The most important feature of that act, at least for our purposes as I view them, is that it requires public participation in the planning process, which is to say that a small group of planners or people with one set of values or one particular point of view, should in fact not make decisions affecting large numbers of people without an opportunity for some appreciation, a dialogue about what they view as the future they want to strive for. Additionally, we have in the passage of the Technology Assessment Act another possible vehicle, a device for planning. We have another means of projecting the future, and again the explicitly stated requirement that there shall be public participation.

These laws and other similar mechanisms are "available means" for resolving or alleviating the "communications dilemma" and for educating the public to rethink how we go about managing our affairs. The notion of an impact statement is a significant change in the perception of what is needed in order to manage one's affairs.

We have, in the course of the last two or three years, begun to expand the notion of the impact statement so that we think not only of first order consequences or direct physical impact, but are now beginning to look for ways of looking at second and third order consequences such as the social implications, for example.

It is through these kinds of mechanisms that we think there is a powerful opportunity for the education of citizens because in the range and pieces of legislation we have seen with regard to resource management and environmental control, in almost every instance, the fundamental position placed in the law is a direct requirement for citizen participation.

How does the citizen develop the wherewithal to participate meaningfully? This, in my judgment, is the role of the educator and we use that as a variable term, including all of us in all of the institutions and organizations through which we work. However, the thing that is of particular and significant consequence is that we are talking about very different perceptions being held in different regions of the country, in a given locale, on different sides of the issue.

How does one create a vehicle for providing the citizen a sense of a willingness to go ahead into a dialogue without necessarily assuming that he has to persuade the other person or persons to his point of view but, rather, to put forward his point of view and listen to the point of view of the other party, in an attempt to identify the areas of common interests? Ultimately, of course, all decisions have to be made on this basis.

Technical expertise and testimony notwithstanding, our social ideas and decisions have to be applied through political processes. Therefore, the problem and challenge becomes one of not just educating the expert but educating the citizen to understand how to utilize and recognize the limitations of the expertise and how to communicate effectively with the expert at the point at which the technical expertise ends and a value or a social judgment is engendered—in essence, the point in the process where all are "laymen" and we operate from a position of value and choice and perception.

The challenge, then, becomes one of creating a context or providing the forum in which the various interests can be articulated, argued, discussed, and explored and judgments made that are to the maximum degree supportive of the total societal interest, so that each incremental decision becomes a contributing factor in upgrading the total system and not just the various individual segments of it.

The most benign example is the trade-off between air and water pollution as it relates to electric power generation. We go back and forth and we talk about nuclear plants, we talk about decreasing discharge of effluents in the air. But if you are not careful, solutions to this problem can impact negatively on the quality of water. Again, we have to have an integrated perception, an integrated regulatory perception so that we will not only have clean air and water but also viable land use. We must assist in the generation of an integrated perception on the part of both the adult voting public and students. This requires a determination to learn and to consider with a degree of detachment, which is not to suggest disinterest or passivity.

There are certain "facts" and specific guidelines that have to be adhered to but, fundamentally, all the issues we are talking about are issues of value and of judgment and, if the education community is to contribute to the resource debate, the debate about the continued habitation of our planet, then there has to be the opportunity for students, if we are talking about public schools, to understand issues. This means that we have to engage in more and more meaningful dialogue.

We need more opportunities for public exposure to the decision-making process and for the development of skills for meaningful participation. Those who are in positions of articulating a policy or describing a program have to learn how to communicate much more effectively both generally and in meetings such as this. I think there is a tremendous wealth of knowledge and expertise resident in each individual and it should be shared.

One of my continual frustrations is that there is so little opportunity for dialogue. I am more comfortable with some kind of feedback because, without it, I am not so certain a specific message that I have is of particular importance. Hopefully, it will serve as a point of departure for discussion which, in turn, would sharpen my own perception and enable me to be more responsive to those responsibilities that I have.

Thank you very much.

Discussion

CHAIRMAN HARTUNG: Thank you, Dr. Bogan.

I think you have highlighted for us very clearly and quite appropriately as a termination of this conference, some of the kinds of things that we should be thinking about as we go out to our various portions of the country and to the various groups we represent. That was a fine and thoughtful conclusion to this session.

MR. ROBERT WANSOME [Seattle, Washington]: We are actively involved in educational projects in the State of Washington and I am wondering what your office does in trying to find out what specific student needs are and what specific programs you have throughout the states dealing with those specific needs?

DR. BOGAN: Through the institutions, we receive applications for support of projects that directly support student efforts. Quite often, these proposals are student generated but submitted through a department of a university or a public school system.

We have supported a number of projects of this type—namely, those developed by secondary school students, with the support of faculties in their respective schools, and conducted by the students, including management of the project budget.

In summary, we are very much interested in student-generated work.

We are emphasizing the importance of the learner assuming responsibility for his own learning and being accountable for it, as contrasted with presenting the learner with a situation which he or she is not interested in and does not see as a relevant and valuable experience for his own life.

Therefore, the kind of programs that we are interested in and interested in being supportive of financially are those that give clear evidence that there is a perception on the part of the learner that this is something he or she wants to go through or know how to do and which would obviously require some skill development but, for all practical purposes, we are looking for a real live learning experience.

However, I would also like to point out that we do not believe that advocating a particular point of view, whether it be the students' or teachers', is necessarily an instructive or educational activity.

The role of education in this context is to assist students in perceiving the range of points of view, to come up with some studied response to these points of view, and have them then suggest to him that there are a number of values implied in those points of view and that exploration of these through dialogue is necessary for meaningful understanding of an issue.

While we do not deny that there are very strong feelings about many of the issues, we feel we have a responsibility to help, as best we can, students and adults to be more creative in resolving some of the conflicts and to invigorate people to dedicate themselves to exploring ways of engaging in more meaningful dialogue.

As I indicated earlier we need to "de-escalate the conflict and elevate the dialogue" and begin to look for points of common interest. This is the only way we are going to get any movement. There is a larger public that does not perceive the need for any change, that does not perceive a resource scarcity, that does not perceive any energy problem, because there is no difficulty, for example, in getting gasoline at the moment—in other words, there is a community that we have not heretofore been in dialogue with. Such a dialogue will require much more creativity than we have exhibited heretofore.

MR. DON VISCARA [Texas A&M]: I would like to shift from motivation to content if I may.

Dr. Willard eloquently spoke about the Alaska pipeline and the improvements involved therein and, further, Governor Judge talked about the 30 percent surcharge on a ton of coal from Montana.

Without passing any values on these programs, we must realize that the Alaskan Pipeline's cost has increased from $1 billion to about $7 billion and a 30 percent increase in Montana's coal would certainly affect poor urban residents of Detroit—in relation to that, how do you feel about the poor kid's parents who are struggling to, on the one hand, feed him and heat the house while you are trying to convince them that sound resource management is good for the country?

DR. BOGAN: Well, because of time constraints, many of the points I made will be more fully articulated in my writings. Here the attempt, of course, was to recast the notion of resources because the context in which I used the term "resource" subsumes and puts people at the focal point. Just as we have not readily come to grips with the need for recycling and reusing materials, we have also not fully come to grips with people from this perspective. In other words, people have not yet been fully perceived as a natural and national resource.

We don't frequently speak about them in that light. However, I did want to make that point and then attempt to respond to the differences in ability to give attention to particular problems as a function of that situation.

There is no question but that any shift in the economic picture, any increase in cost, is going to impact differently on different sectors of the population.

It was very eloquently stated by the two previous speakers that if you increase the cost of coal, this is clearly going to have a greater impact in urban Detroit than in suburban Detroit. Therein lies, in my judgment, the challenge, and perhaps the principal challenge of the tricentennial. In other words, how do you maintain the principles of assuring the opportunities for life, liberty and the pursuit of happiness of all people and, at the same time, be realistically responsive to the resource constraints?

One of the areas that should probably be discussed in a conference of this kind is to begin to look at what sector of the population attends, participates, and feels strongly about the issue, and what sector of the population is absent.

The environmental movement, in my judgment, has been the confluence of a historical preservation/conservation movement, with the enthusiastic input of the late 1960's, which culminated in the Earth Day of the generation of the 1960's and 1970's. They broadened the notion of conservation to recognize that it is an untennable position to think that one can preserve or conserve a sub-sector of the environment while the rest of the environment just goes happily along with air pollution, water pollution, etc. This was a new realization and, unfortunately, many have not yet come to that realization.

We are still not communicating effectively with the poor, the minority communities, the labor community.

The environmental discussions of the early 1970's, concerning the confrontations between environmentalists and the workers, was not a confrontation that was particularly evident but one that was obvious to anyone who was monitoring the situation in which the environmentalist would say, "we want to close down that plant, it is polluting the air."

It is incumbent, in my judgment, upon the environmentalist who makes that statement to also understand the implications of closing that plant and to feel a very real responsibility for those people who would, as a result, be dislocated or otherwise unemployed and unable to function. This is an example of a sub-sectional improvement that does not upgrade the total system.

As the scarcity problem goes on we will be increasingly confronted with situations in which the environmentalists are on one side; certain sectors of the industrial community on another; and the minority community, a variety of the poor, rural as well as urban, on still another side.

It is the hope of the environmentalists (and I think there has been considerable movement in the environmental community), having had the insight and the wisdom to appreciate the dangers to the physical environment, that it will also have the capacity to use that same insight and wisdom to appreciate the importance of perceiving the social environment; and to understand, in the same way that we understand natural systems and interrelationships, the relationships between elements of the social environment and the natural physical environment; to understand both this and ecology in such a way that it would include or speak rather kindly of man as an integral part of the ecosystem.

Now, this is a somewhat lengthy but by no means exhaustive response to the philosophical debate on man-nature problems, which is not, of course, appropriate to explore at this time. However, that is at the base of some of our problems.

But again for any and all of these issues, there will be many different interests involved and different positions taken. Unless there is an opportunity for a forum and for the exploration of implications of a given action on all sectors of the community, we are not going to be able to manage. Also, I think the system will grind down.

On the other hand, I don't think we can stress the adversary system to the point where it becomes bogged down. For example, in connection with Section 102(c) of NEPA—here we look at the instance in which collection of cases over a course of a number of years raises some real questions about what are the trade-offs and how do you get all of the community involved.

Now, if you go to any public hearing, which sectors of the community do you find testifying?

Well, it is those that are organized and have access to expertise.

I trust that will give you somewhat of a general and broad answer to your question.

Closing Remarks

Laurence R. Jahn

Vice-President, Wildlife Management Institute
Washington, D.C.

Friends, we have come to the close of another North American Wildlife and Natural Resources Conference. If not the most successful of this long series of annual meetings that had its origin in 1915, this Bicentennial Conference has certainly been broad in scope and among the more stimulating.

The Institute and the cosponsors are grateful to the members of the Program Committee who labored long and hard to develop the agenda and to the participants who have given so generously of their wisdom, time and energy. Special acknowledgement is due Keith Schreiner, Vice Chairman of the Program Committee, and his assistant, Phillip Agee, both representing The Wildlife Society, for their fine contributing efforts.

We hope that the information you have accumulated at this Conference will send you home with new perspectives and new ideas for advancing sound resource management. Each of us, in our own way and through our own channels, has opportunities to make the America of 2076 a better place to live than that of 1976. Achieving that goal will depend largely on how intelligently we manage and husband our resources. If this Conference helps produce some means to that end, our progeny will remember us with gratitude.

In 1977 the North American Wildlife and Natural Resources Conference will be held in Atlanta, Georgia from March 7–9. It will be followed in the same hotel by a meeting of the XIIIth International Congress of Game Biologists from March 11–15. The Congress first met in Germany in 1954 and since has convened biennially in various European countries. Upon invitation of The Wildlife Society and the Wildlife Management Institute, the Congress will assemble in the United States for the first time in 1977. The program is being designed to yield information on wildlife and other resources that has transfer value among countries.

The opening and special sessions will be followed by a post-Congress field trip designed to review examples of wildlife and other resource management and research in the southeastern United States. This is a unique opportunity to become more familiar with this region of extensive forests. We cordially invite you to participate. Contact my office for further information.

The Program Committee will meet next month (April) to start building the agenda for the 1977 meetings. Your suggestions for topics and speakers to highlight research findings, management experiences, and international, national, and regional resource problems and solutions will be welcomed. They should reach me no later than early April.

On behalf of the Wildlife Management Institute and cosponsoring organizations, many thanks for your attendance and attention. Best wishes for a pleasant trip home. The 1976 North American Wildlife and Natural Resources Conference, designed to commemorate the U. S. Bicentennial, stands adjourned.

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WYOMING
George F. Wrakestraw

CANADA
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COLUMBIA
Clemencia R. de Barriga, Ernesto Barriga-Bonilla

IRELAND
Fergus O'Gorman

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