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Opening Remarks

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

Good morning, ladies and gentlemen. Welcome to the 42nd North American Wildlife and Natural Resources Conference. Before I begin my remarks, I wish to read you a telegram we have just received:

> I send my warmest greetings to the participants in the Forty-second North American Wildlife and Natural Resources Conference. I regret that I cannot be there personally to welcome you to Atlanta but I am delighted that you have chosen such a nice location for your discussions of a subject that it so close to my heart.
>
> Renewable natural resources are the foundation of every nation's progress and development. We are fortunate in America to have a broad diversity and substantial quantity of soil, water, forests, wildlife, fish and other resources. Properly managed, these resources will sustain us and enrich the lives of our citizens for generations to come. Squandered, they will sap our national vitality and degrade our priceless heritage.
>
> I look to you to help provide the experience and guidance we need to pursue the proper course. Working together I know we will succeed. [signed] Jimmy Carter.

In this first year of America's third century, our interest stands at a new place along our country's evolutionary track. How far it has progressed from last year or from any year before that is difficult to say.

As individuals, our scope is brief and essentially personal. But our professional perspective is long. As we watch human population rise here and abroad, as we review the example-laden record of human impact on soil, water and air, and on the living systems they sustain, our professional mind cannot avoid questioning the well-being of fish and wildlife at the end of America's third century. Man's increasing commitment of air, water and soil to his needs and desires diminishes their availability to other life systems.

The beneficial result of our professional attention to date mostly is introspective. We continue to refine understanding of the workings of living systems. Much less effectively is our attention directed to those external forces, abundantly human associated, that degrade or destroy the air, the water and the soil that have everything to do with the well-being of the creatures with which we share the land. We have identified many of the disruptive forces and know their impacts. But little progress has been made in easing them on other than a local scale.

There presently is some reason for optimism. There is a new, but untested, Administration in Washington. An Administration that may believe that conservation and the environment are in the mainstream of society's concerns.

At this early time in the new Administration, we have no reason to assume, as we came to understand clearly in the last few years, that our recommendations will be discredited simply because of their subject matter. But we cannot expect them to be accepted simply because they are right for the environment and conservation. The toughest problem lies in freeing up the money to broaden and reorient existing programs and to initiate new ones. And freeing up the money means that the Administration and Congress must reorder old priorities.

Securing adequate funding, in fact, is a key observation of a new report, "The Unfinished Agenda," which is the terminal publication of a Rockefeller Brothers Fund project aimed at getting the new Administration on some kind of an environmental course. "The Unfinished Agenda" states that "The environment must be recognized as a top national priority on a level with defense, employment, health, education and commerce."

As has been pointed out all too many times before, the development, maintenance and protection of the natural resources that sustain all life and our society traditionally have low priority in terms of the national budget. We overdraw our natural resources account in many ways, but little is done about it in other than a piecemeal manner.

Other major recommendations of "The Unfinished Agenda" pertain to human population expansion, here and abroad, and to energy. The statistical implications of humans in terms of social and resources supply and demand factors are unsettling, as always.

Notably absent on the task force that framed "The Unfinished Agenda" was official representation of such resources professions as the Society of American Foresters, the American Fisheries Society, and The Wildlife Society. Such participation, I am sure, would have redirected many of its recommendations. For example, the reader is told that the strain on the life-support system of "little spaceship earth" could be eased by protecting endangered species, particularly on islands, by protecting marine mammals, by better enforcement of the Endangered Species Act, by favorable congressional treatment of wilderness legislation, and by increased funding for better management of public lands, especially for national parks. Great faith is placed on converting national forests and national resource lands to national parks as one method of answering society's environmental needs. Organic problems require more much than the cosmetic solutions of the kinds proposed.

Our ways of doing business on a day-to-day basis must be changed. We must stop operating on an 'oasis syndrome.' If we don't most of our landscape will be degraded, and our escape will be to already crowded forests, parks, wildlife refuges and other similar areas. Good management must take place on all lands regardless of their designation and ownership.

For our overall interest, one of the most important actions of the last Congress was its clarification of permissible lobbying activities. Heretofore, there was no fixed operating rule for national conservation organizations classified by the Internal Revenue Service as having scientific and educational purposes. Public interest expenditures judged excessive in one case were ignored in another. A finding of noncompliance with the law could result in IRS stripping an organization of its important tax deductibility. Understandably, most organizations have been reluctant to provide much of a profile.

The 1976 tax revision sets forth specific expenditure guidelines based on percent of budget. A number of major conservation organizations are expected to choose the lobbying option during coming months. Hopefully, this will provide an outlet for broader, sharper and more persistent expression in Congress on issues of substantial concern.

Some of 1977's most important opportunities do not require new legislation. They involve implementing authorities that already exist and in protecting others from weakening amendment. Foremost are appropriations to enable resources agencies to carry out authorized activities for which they long have been poorly equipped.

Congressional appropriations committees are working on the Bicentennial Land Heritage proposal, floated mainly for political reasons late in the last Administration. While intended to appeal to public opinion, the proposal actually confesses to long years of neglect in our national parks and wildlife refuges.

Many conservationists are urging that the needs of the Forest Service and the Bureau of Land Management be included. Those agencies' lands make immense contributions to general outdoor recreation and to fish and wildlife. More so in many cases than those of parks and wildlife refuges. Other authorities warranting full funding are the Land and Water Conservation Fund and cooperative activities under the Endangered Species, Marine Mammal, and Sikes Act military lands programs.

The new Administration should re-examine recommendations of the previous Administration with respect to land-use designations under the Alaska Native Claims Settlement Act. As the Senate committee chairman said when introducing implementing proposals, "The committee will be forced to undertake a unique role . . . addressing legislation which requires us to conduct a full-fledged planning exercise for some 40 proposed areas many of which are much larger than most states and much richer in scenic, mineral and other natural resource values than most other areas of similar size anywhere else in the United States."

Conservationists should spare no effort in soliciting and exploring the broadest range of alternatives for land designations in Alaska. Conservationists should support the maximum designation of wilderness, too, because the large carnivores, sheep, moose, caribou and a host of animals those lands support truly are the yardsticks of wilderness quality.

Another positive step that could be taken by the new Administration would be to reorient the goals and direction of the Council on Environmental Quality. Highest priority must be given to resolving contradictory government policies and programs that stimulate environmental destruction. There is acute need to correct long-standing problems that rise from the very heart of resource allocation and commitments. The Council's reason in being should be judged by what it accomplishes in this regard. And the White House's political decisions should be tempered by the Council's environmental judgments.

Attention should be given to the Bureau of Land Management's publication of guidelines, issuance of regulations, and implementation of the many new authorities conveyed under the Federal Land Policy and Management Act of 1976. One of the most significant things the new Administration can do is to assure that BLM moves forward to become a major federal natural resources agency as contemplated in that new Act.

Until recently, I had thought that the Congress, at long last, would be agreeable to amending the Fish and Wildlife Coordination Act to assure that state and federal fish and wildlife experts are brought into decisions regarding the location, planning, and operation of federal or federally assisted water resources projects at the earliest moment. Now, I am not so sure. Influential members of Congress are irritated by recent court actions, under the Endangered Species Act, that have interrupted pet water developments. Plans now are afoot to circumvent that Act. Perhaps a convincing argument can be made that by bringing fish and wildlife agencies into consultation at the earliest stage, as they should be, areas critical to threatened or endangered species can be identified more quickly. Needless confrontations can and should be avoided. Ecological services of state and federal agencies must be strengthened to assure better evaluation and planning for proposed projects. Another problem is the recent Senate reorganization that has placed fish and wildlife responsibility in a heretofore mainly public works oriented committee. How well that will work out, we cannot say.

Conservation interests should prepare for a rugged fight to protect essential features of Section 404 of the Federal Water Pollution Control Act. This vital section requires permits for dredging and depositing fill materials in rivers, streams and associated wetlands. Interests seeking to compromise it are using rumors and half-truths to arouse support for their stand. A crucial vote could come in the next few weeks. Members of Congress should be advised that the permit process prevents unwarranted environmental damage to priceless aquatic resources, saves money, and, by forcing applicants to seek advice in the earliest planning stages, results in better project applications.

A major legislative initiative, which we hope both Congress and the new Administration will embrace, is a nongame fish and wildlife species program, patterned after the eminently successful Federal Aid in Wildlife and Fish Restoration Acts. As recommended by many leading conservationists, the program would be funded by new manufacturers' excise taxes on selected items of outdoor recreation equipment—tents, sleeping bags, air mattresses, backpacks, binoculars, bird houses, bird seed and the like. The money would be apportioned to the states on a cost-sharing formula basis much like that of the Wildlife and Fish Restoration Acts.

As reported in the Wildlife Management Institute's 1975 national study of nongame fish and wildlife programs, most states are prepared to initiate much broader and more vigorous nongame species programs. Lack of funding is the primary obstacle. By placing a modest tax on certain recreation equipment used by persons whose outdoor experiences are enriched by fish and wildlife, Congress will uphold taxation's finest principle, that being that those benefited should pay the bill.

Two other initiatives can benefit from the new Administration's support. One is the Land and Water Resources Conservation Act, patterned after the earlier Resources Planning Act for the national forests. Pocket vetoed last year, the Land and Water Resources Conservation Act would authorize the U.S. Soil Conservation Service to assess current soil and water conservation efforts and to develop long-range plans for the protection and orderly development of these basic resources.

Finally, there is the proposal to impose a new manufacturers' excise tax on the now-untaxed component parts of handloaded ammunition. This proposal missed enactment last year. One feature of it would require state fish and wildlife agencies to invest part of their apportionments in hunter education. Some groups last year seized on this feature as federal encouragement of hunting. They completely overlooked the larger goal of broadening the understanding and improving the conduct of all hunters entering the field. The plain arithmetic of the proposal is that it would generate more money for wildlife—which we all want—while accomplishing this additional worthy social objective—which every thinking person also should support. This year, with growing public endorsement, this proposal may be enacted.

How Much Are We Willing to Pay?

Lynn A. Greenwalt
Director, U.S. Fish and Wildlife Service
Washington, D.C.

It's very appropriate that we are gathered here in this magnificent facility because it offers a degree of symbolism that I think we ought to consider just a bit. When some of my staff and I arrived in Atlanta two or three days ago, we asked how to find the Peachtree Tower, and a lady said, "It's very simple. It's the tallest building in town. It's the one that sticks up in the clouds." And it does, as perhaps you've noticed. It's a building which, on this occasion, is occupied by a great many bureaucrats—federal and state, as well as representatives of private organizations from at least three nations and perhaps all the states. It occurred to me that the symbolism relates in this way. You're inside this building. Perhaps you awakened a morning or so ago and discovered a fog bank outside; not unusual in Atlanta at this time of year, I'm told. The symbolism is that this building, standing upright in this beautiful city, is like the bureaucracy. The higher up you are in the bureaucracy, the denser the fog seems to be, and it blows away less frequently to reveal stark reality. Conversely, of course, the lower down you are in this building, the more real life is because the fog density is less.

For 42 years, the discussion of wildlife and natural resources use has been centered in this annual forum. We have addressed and identified problems that have beset natural resources in this country. As a result, significant actions have been taken. Much has been accomplished in the furtherance of the conservation, the wise use, and the proper management of fish and wildlife and related resources.

However, problems continue to exist after all these years, problems that were readily identified in times past, problems that tend to beset fish and wildlife in a perennial sort of way. What is important now is to recognize that there has been an increase in the nature and variety and complexity of the problems that confront fish and wildlife and natural resources. There have been a number of events, a combination of events, if you will, which have created problems of staggering proportions.

National and worldwide populations are expanding rapidly. The peoples of new nations expect a quality of life that implies that they, too, will exploit the earth's natural resources. Not only living natural resources; they are now beginning to look at non-renewable resources. These activities throughout the world add to the almost incredible burden imposed on natural resources by the western world—the developed nations. Use of energy, land, water, and minerals are proceeding in this nation at an alarming rate; indeed, throughout the world.

We all recognize that petroleum, as an energy source, is on the wane. It is finite, and it is diminishing. Those of you who may have listened to the news this morning learned that even the mideastern nations are contemplating a major conference to discuss the consequences of diminishing petroleum resources. We are in a position to witness the eclipse of petroleum as a source of society's sustenance in terms of energy and the fuel that drives our social machine. Energy must be available if this world is to pursue its quest for improved living conditions and an enhanced quality of life, but it might not be petroleum energy much longer.

Water problems are before us, water problems that existed in the West long before the onset of the current drought which tends to focus attention on the real problems that are accruing. Problems become more visible when there isn't enough water to go around for all the needs that people perceive for it. A drought, that may be beginning in a good part of this nation, serves only to underscore the kinds of problems that are rushing headlong to confront us.

All of these things combine to focus on a fundamental question which we have to ask each other. It must be asked by all of us in this room, and it must be asked by the 220 million people that occupy this nation, and someday by the 3 billion that live on the face of this globe. Stated in the simplest terms I can muster the question is: How willing is this nation or any nation to pay for an environment that provides an acceptable quality of life for its citizens, today and in the future? How willing are we to pay the price, and what is that price? It's not a cost in dollars alone. It includes such things, I think, as the obvious necessity to sacrifice certain luxuries; perhaps, eventually, even certain liberties. Sacrifices such as having no more than one motor vehicle, giving up the luxury of going wherever you want in your own car at any time you wish, and not being prodigal in the consumption of things that cannot be renewed. A part of the price tag certainly includes a willingness to make choices now and not put them off, choices about what it is we as a nation want now and in the future. We must not cop out and pass these responsibilities on to the future when the choices will be even harder to make. We have an obligation, in terms of change, to look to the long term consequences and values of fish and wildlife in the environment rather than to short range profits.

We must accept the idea that our continuing responsibility to future generations is to give them the same heritage of opportunity that we were given. That heritage must include the chance to make the same kinds of choices in the future that we have today. Said in another way, we must pass along to future generations environments that are clean and that are occupied by a wide diversity of the fish and wildlife resources and habitats that exist today.

There's very little time in which to make up our minds about this. The luxury of delaying, debating, and contemplating for too long is not ours. The time is now.

There is a commitment emerging. We have a President who is clearly committed to these kinds of ideas. There is also a Congress which is more and more showing its concern about environmental problems, particularly those related to fish and wildlife and their habitats. Let me cite some examples to point out the opportunity that exists now.

As you may know, recently there has been a sharp increase in proposed funding for the Fish and Wildlife Service and the National Park Service. The proposals will be reviewed and acted upon by the Congress. Insofar as the Fish and Wildlife Service is concerned, for the next 5 years we have a commitment by the Administration to spend a quarter of a billion dollars on sorely needed maintenance and rehabilitation of the National Wildlife Refuge System. There also would be an additional 500 people for these invaluable areas, with additional funds to support them.

Further, the Fish and Wildlife Service would receive an increase of $10 million in the area of examining the possible and probable impacts of society's land use changes, including water and other developmental projects. This program would be funded at $10 million annually for 5 years; 100 new people would accompany that increase.

The Administration also has committed itself to increased funding of land acquisition programs of the Fish and Wildlife Service. There would be a sharp increase in funds available through the Migratory Bird Hunting Stamp Act and through the use of an expanded Land and Water Conservation Fund. Thus, within about 4 years the Fish and Wildlife Service may be dealing with acquisition funds in the amount of about $80 million each year.

A similar commitment has been expressed toward the National Park Service. A thousand people would be added to that fine organization, plus significant increases in funding for operation, maintenance, and rehabilitation of the National Park System. Also, a 600 person increase in allocation of manpower to the Environmental Protection Agency was recently proposed. This is the kind of Administration commitment for natural resources which, in bureaucratic tradition, is unprecedented in the history of this country.

There has been a Presidential commitment, as you know, to review 19 water development projects within the next 60 days; a commitment so strong that the President did not include funding for continued construction in the current budget. A few days ago the President indicated in a press conference that if he was not convinced after the 60-day review that these projects merit reinstatement, and if the Congress attempts to reinstate them anyhow, he intends to carry it to the last forum, the important forum, the American people.

Carrying out the mandates of the people in this new era will require teamwork—teamwork of the kind we've never had before. We represent a diverse community of people committed to what is essentially a common goal. We often disagree about the road to take to get there. But I suggest that together we consider the idea that we will support choices and take actions which will ensure future generations around the world the same opportunity that we have to use and enjoy renewable resources; that we will pass on to them resources and environments that have been wisely and not thoughtlessly used—fertile soil, clean water, clean air, and a diversity of plants and animals with which we share those basic resources. If we can accept that idea as the goal for all of us, then the concerns about the interim philosophies of how we get there become less important. We can recognize our differing philosophies and honor them through understanding while pledging ourselves to the goal. That's building teamwork.

Things must be done now and not put off to another time. We must know what's at stake and what's important. We must remember the final obligation we all have that makes us a team whether we like it or not: our obligation to generations yet unborn.

Needs for Conservation Practices

David G. Unger
Executive Vice-President
National Association of Conservation Districts
Washington, D.C.

Determining the needs for conservation practices throughout America is an enormous and complex task. For this reason, I will concentrate on the major aspects of this subject.

It has been 40 years since the origin of an organized soil conservation program in the United States dealing with privately-owned lands. These encompass fully two-thirds of the land in the 50 states and three-quarters of the land in the 48 continental states.

The program began with the creation of a federal agency—the Soil Conservation Service—charged with conserving soil and soil resources. Shortly thereafter, 3,000 local soil conservation districts were established under laws enacted by each state, Puerto Rico, and the Virgin Islands. The system that resulted is based on the development of technical expertise by the SCS, the encouragement by the districts of voluntary cooperation on the part of landowners, and the preparation and implementation of farm and ranch conservation plans based on scientific soil surveys and land capability determinations.

Much has been accomplished through this program. The latest inventory of conservation needs published by the Department of Agriculture indicates that one-third of the nation's cropland has been treated adequately from a conservation standpoint, one-third has been partly treated, and one-third needs substantial additional treatment. Perhaps one-half of the job on cropland had been accomplished at the time of this inventory (1967).

The soil conservation program has helped to reduce erosion, improve the condition of grasslands and forests, and improve water supplies and water management. The landscape testifies to many of these accomplishments, with vast acreages of contour strip cropping, miles of diversion terraces, healthier woodlots, thousands of ponds and watershed lakes, and improved range. Fish and wildlife have benefited too, because when agricultural land is properly managed under good conservation programs, fish and wildlife habitat is generally improved as well.

Where do we stand after 40 years? There are some indications that conservationists, and the general public, are concerned that we are not moving quickly enough to solve remaining problems. Some ask whether, in some respects, we may be standing still or losing ground. What are the reasons for this new concern? Among them, I would say, are the following:

Increasing demands for agricultural production. The current national drive to produce more food and fiber to meet domestic and international needs has resulted in more intensive use of land resources. Of 60 million acres of land formerly retired from production by farm programs, some 44 million acres have already been put back to the plow. Some of this land is especially subject to wind and water erosion, and some soil conservation practices, such as terraces and windbreaks, have been damaged or removed.

Changing technology. The progress of agricultural technology is continuous, and new techniques—including the use of chemicals—are leading to more single-cropping and less emphasis on crop rotations which help heal the land. Larger, heavier, and wider equipment is being used, and its use is sometimes not compatible with conservation measures designed and established for smaller equipment.

Trends in social and economic organization. There is a continuing trend to larger farm units and corporate ownership of farm land. Only recently, new proposals have been advanced for investment in farm ownership that would further isolate ownership from actual farm management. Land in such holdings, along with that in absentee and speculative ownership, seems less likely to be managed in accordance with concepts of stewardship than that in smaller, family-owned operations.

Population growth leading to specialized land uses. Problems of erosion and conservation are not confined to agricultural lands or croplands. Conditions of private and public pasture and rangelands are also of concern, as are significant erosion and sediment problems associated with surface mining and residential, commercial, and highway construction sites throughout the nation.

All of these factors have affected the progress of conservation programs. They have increased the hazards and damages resulting from erosion of soil by water, and, combined with the climatic cycle, have created new threats of wind erosion and a possible new dust bowl. Altogether, the nation is facing a situation in which new developments—and the lack of steady, consistent support for existing soil and water conservation programs—are threatening water quality, fish and wildlife habitat, the maintenance of soil resources, and the future productivity of agriculture.

For all of these reasons, you are concerned about the progress of soil conservation programs, and the needs for conservation practices. Our association, and our 17,000 conservation district officials, are also concerned. We are taking a new look at our program of local-state-federal cooperation to see what adjustments and changes are needed to accomplish the conservation task.

I would like to suggest that there is a need for action on six fronts, as follows:

Better identification of priorities. In the effort to achieve widespread participation by landowners, there has been a tendency to "spread the gospel" as widely as possible, and to work with those most receptive to change. In some cases, efforts have not been concentrated on the most serious problems. There is a need for conservation districts, which have the major responsibility for establishment of priorities, to examine current needs and allocate resources to the most critical problem areas.

More effective use of technical and financial resources. In some conservation programs, there is a confusion between those elements that are directed at production improvement, income supplementation, and conservation. These elements need to be delineated more sharply. As our association has urged for years, we should confine public investments to long-term, enduring conservation measures that have permanent value. Long-term contracts should be the vehicle through which technical and financial assistance is provided so that performance is ensured.

Improvement of conservation planning systems. An integrated, multidisciplinary approach is needed. Soil conservation is more than individual practices. It is more than windbreaks, terraces, range re-seeding, or whatever. It is a combination of needed practices that will accomplish a given objective.

A comprehensive, interdisciplinary approach has been the basis of soil conservation planning, but the process needs improvement. This is not an altogether easy matter. There is some criticism that conservation plans are already too comprehensive, that they go beyond the needs and desires of the farmer and rancher. On the other hand, each element of conservation treatment should be designed to complement each other element, and the comprehensive plan is useful in encouraging landowners to adopt practices such as wildlife plantings, forestry improvements, and the like.

Evaluation and modification of existing conservation practices. The current system of practices needs continuous re-evaluation and testing against current conditions. In some cases, practices may need revision and new practices may need to be developed. Minimum tillage is a good example of a recent technological development with important conservation implications.

Adequate incentives and performance guarantees. Diminished resources, in real terms, are being provided by the federal government for soil conservation programs. Over the past decade, the number of full-time personnel available to the Soil Conservation Service has been reduced about 16 percent by imposition of personnel ceilings. Cost-sharing funds have repeatedly been cut back, eliminated, and reinstituted. Energies of organizations concerned with these programs have been largely absorbed in the annual struggle for appropriations.

On the other hand, there is concern with finding ways to assure continued maintenance over time of conservation practices installed with public assistance. As methods and technology change, there is a tendency for conservation measures to be altered or ignored. Thought needs to be given to how landowners may be expected to maintain practices or replace them with equally effective practices.

Better method of measuring progress. This leads to my last major recommendation—that a system be established to measure land and water conservation progress in terms of the quality of the resource rather than in terms of a recital of individual conservation practices established. The beginning of such a system has been established by the Soil Conservation Service. Called the "quality standard," it is a system that identifies 16 different "resource management systems," such as cropland, pasture, woodland, stream systems, and many others. Criteria are set forth for adequate treatment of each system in terms of social, economic, and environmental factors. Such a system, if refined and adopted, would make it possible at any time to determine the condition of the resources involved, and the dimensions of the task ahead.

How can such changes be implemented? There are some tools already available in existing authorities. The authority to use new conservation practices and methods in watershed projects (such as non-structural measures) has been provided by Congress, but little is being accomplished. The Great Plains Conservation Program will expire in 1981; it can be renewed and extended. The Water Bank and Forestry Incentives Programs are annually proposed to be eliminated; they can be supported and extended also. The Rural Development Act of 1972 contains a variety of authorities for use of conservation practices for water quality improvement and animal waste disposal, and for establishing land treatment within watershed projects. But funds are not being requested by the Administration for these purposes.

There are additional opportunities for change. The new surface mine reclamation law, if enacted and approved, provides opportunity for progress in reduction of erosion and sediment on both newly-mined lands and on abandoned mined lands. Proposals are being developed by a widely-representative group for the improvement of the nation's pastures and rangelands—a neglected resource.

Changes are being considered for the upstream watershed program. Our Association has recommended that more stringent requirements for land treatment above structures be considered, and we have brought together the Fish and Wildlife Service and the SCS to plan establishment of mutually-acceptable guidelines for channel alteration.

There are changes being proposed in the Agricultural Conservation Program (ACP) under which conservation cost-sharing is provided. A bill now pending in Congress would give more emphasis to enduring, long-term practices and use of long-term contracts in this program.

There are two developments, however, that I believe to be of far more fundamental importance in achieving useful changes in the nation's conservation programs. They are the water quality management process and the proposed Land and Water Resources Conservation Act of 1977.

The water quality management planning and implementation process under way under Section 208 of P. L. 92-500 holds much potential for improving the condition of America's land resources. An essential phase of this program is the control of non-point pollution, that which reaches the streams in a diffuse manner. This includes sediment and many other materials associated with agriculture, such as animal wastes, pesticides, and excess fertilizer nutrients. A preventive approach is being developed to deal with non-point pollution, and the use of "best management practices" will be the mechanism used. This process, as will readily be seen, is similar to the process by which erosion and runoff are controlled through traditional soil and water conservation measures.

Conservation districts are working closely with local and state water quality management agencies, and with the Environmental Protection Agency, in the development of effective and practical non-point source control plans which are to be completed by November, 1978. A variety of different approaches, both voluntary and regulatory, is sure to be recommended for implementation around the country. Already in 15 states, conservation districts are participating in various aspects of regulatory erosion and sediment control programs established under state law for agricultural, construction, or a combination of land-disturbing activities. More laws of this kind are likely to emerge from the Section 208 process.

There is much potential for definition of new priorities, development of new and more effective conservation measures, and widespread performance of conservation practices under this program—if it is properly implemented. Federal support will be needed for technical assistance, cost-sharing and other incentives,and program administration. Here is an objective—the improvement of water quality—in which those concerned with soil conservation and fish and wildlife can wholeheartedly cooperate.

The other significant development is the anticipated passage of the Land and Water Resources Conservation Act of 1977. Enacted by Congress last year without a dissenting vote, the legislation was vetoed by the President. It has wide support again this year from conservation, agricultural, and environmental organizations. It would require a periodic appraisal of the status of conservation needs on the private and non-federal lands of the nation, and the development of a program—with participation from local and state governments—to meet those needs. It would help Congress determine the level of resources that would achieve a certain level of progress. It can be the foundation for a restructuring of land and water conservation programs in America that would have the support of all.

In conclusion, let me say that it is essential that we keep in mind the fact that the viewpoints of individual landowners and land managers throughout this vast nation are going to be central to any progress that is made in conservation of the lands under their control. They will need to be full participants in the development of constructive change, or they will not accept it. Programs of this kind cannot be imposed from above.

In America, our democratic system makes the way we go about things as important as what we do. We must bear this in mind as we look ahead, and we must recognize the power and force of ideas in shaping decisions. We must renew, and strengthen, and extend the concepts of responsibility and care for resources, the concepts of stewardship, as we seek beneficial change.

Species vs. Ecosystem Management: Concepts and Practices

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Introduction

I have really been asked to preach a sermon this morning, and I shall take as texts for this sermon two case histories of resource mismanagement. The first case, the decline of the California sardine, is well known to many people here and has been well chronicled by Garth Murphy (1966, 1967) of the University of Hawaii. In the early 1930s the sardine was a dominant, zooplankton feeder in the California current system of the west coast of North America, and supported a major fishery. Fish 2 years and older were estimated to aggregate a total biomass of around 4 million tons. The stock was overexploited, however. A combination of heavy fishing-induced mortality, and reproductive failure resulting from altered age distributions, drove the population down by the late 1950s to 5 or 10 percent of its earlier abundance (Fig. 1).

This reduction left a large, unexploited plankton resource in the system, a resource which had largely been used up by the sardine when at peak densities. Nature abhors a vacuum, and this feeding vacuum was soon filled by a closely related, and previously scarce fish, the anchovy. The sardine had apparently been the superior competitor between these two species and kept the anchovy suppressed to very low levels. But when its niche was vacated and the competitive pressure removed, the anchovy was able to increase rapidly to take advantage of the unused plankton resource. By the late 1950s, anchovy biomass was estimated at 4.8 million tons, very similar to the earlier abundance of the sardine. Murphy surmised that the anchovy had now assumed competitive dominance, and that the sardine would not recover its earlier position, even with relaxation of fishing, unless man or nature interceded to apply pressure on the anchovy.

The second case history is less well known, and concerns a sequence of changes in the biota of Great Basin areas in western United States. The most widespread vegetation type in this region is the sagebrush-bunchgrass type. Grading into the salt-desert shrub type at its warmer and more arid limits, and into Palouse grassland at its cooler and more mesic margins, it is probably an intermediate, semi-arid type within the higher-latitude moisture continuum of the West.

The vegetation composition of this type has changed during its occupancy by European man. Following settlement, livestock grazing, particularly in spring and summer, concentrated on forbs and grasses and placed these species at a disadvantage in their moisture competition with sagebrush. Shrub density increased, in many cases to form dense stands of over-mature plants with little understory except unpalatable, exotic forbs in the more mesic and disturbed situations.

At this stage, productivity of the type becomes very low in terms of most products useful to man: livestock forage, many kinds of wildlife, or whatever. In the past 3 to 4 decades, extensive areas of such vegetation have been rehabilitated in order to improve their productivity. Sagebrush is chained or plowed, and then seeded to monotypes of rather coarse, exotic grasses for livestock forage.

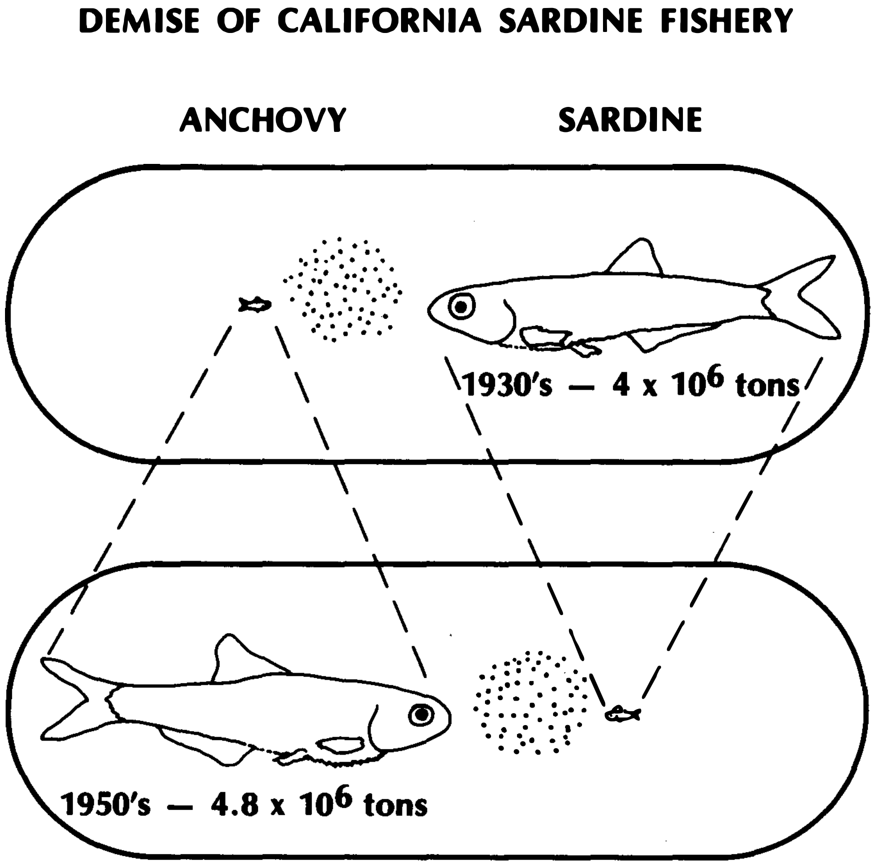

Figure 1. Decline of the California sardine fishery in the California Current system and its replacement by the anchovy in the 1930s to 1950s (Murphy 1966 and 1967).

It turns out that rodent and rabbit densities are low in these grass seedings. Desert Biome studies of the International Biological Program in northwestern Utah have shown more than twice the rodent biomass in sagebrush stands as in adjacent crested wheatgrass (*Agropyron desertorum*) seedings (Balph 1973; Anderson 1974). Differences in rabbit numbers are even greater.

Grass seedings often occupy a major share of the landscape, and the result must be reduction in rodent and rabbit numbers over extensive areas. Howard* has observed rather frequent abandonment of nests by ferruginous hawks (*Buteo regalis*) in the vicinity of such seedings, and Howard and Wolfe (1976) have explored the possibility that this land-management approach has reduced raptor numbers.

These are only two, random examples of a long list of domino-like case histories to which the title for this paper—"Species *vs.* Ecosystem Concepts"—is designed to call attention. Other examples could be: The effects of manipulating

*Richard Howard 1976: personal communication.

water levels on snails fed upon by the Everglade kite; the effects of certain forestry practices on rare woodpeckers, owls, and Abert squirrels; the role of an intensive fishery in the successive competitive release and subsequent decline of Lake Michigan deep-water fish species; the effects of prairie dog poisoning in the plains on black-footed ferret; the competitive release of medium-sized carnivores following reduction of coyote numbers; the effects of widespread pesticide use on Great Lakes salmon, California pelican, and worldwide raptor populations.

The common elements in all of these cases are two: one scientific and one administrative. The first is an ecological myopia, a tendency to focus narrowly on immediate, first-order problems. How can we convert sagebrush, low in value for livestock forage, to more useful grass forage? What is the best way to harvest Douglas fir to ensure reproduction of the stand and minimize harvesting costs? What is the maximum sustained yield of sardines, according to traditional population theory, and how can we obtain it most economically?

The second element is that of single-value decision making. Too often, our resource-management decisions have been made by a single agency, with a single resource and a single value of that resource in mind.

In both our science and our application we treat individual species and resources in isolation when in fact each is a part of an interrelated system. Manipulation of any one part is bound to affect other parts, and to elicit second-, third-, and fourth-order effects. Since most parts are of value to someone in our society, concentration on one value is likely to impinge on others.

I would like to dwell this morning on these two elements, and suggest some of the directions the science and practice of resource management should take, in fact, already is taking.

Species vs. Ecosystem Concepts

The Species or Population Perspective

Traditionally, a primary concern in fish and game management has been with the responses of individual species populations to exploitive removal. Terrestrial game management has had difficulty in "getting it all together" into an explicit exploitation theory. But fishery management has for some time approached individual species management with several variants (cf. Beverton and Holt 1957; Ricker 1958; Schaefer 1954) of a basic underlying theory: the logistic population growth model.

This model starts from the basic premise that density-dependent processes operating within a population produce a linear decline in the relative growth rate as population size increases. Such a population grows according to an S-shaped curve, increasing slowly at first, attaining its maximum growth increments at the intermediate growth stages, and then slowing its growth to gradual attainment of an equilibrium density. Maximum sustained yields can be taken at that population size intermediate between zero and the unexploited equilibrium density.

That this model has basic inadequacies as an effective representation of population behavior, (cf. Smith 1952; Ricker 1963) is somewhat beside the point of our discussion here. The germain issue is that concentrating on the species in this perspective fails to take into account the interrelationships between it and other components of the ecosystem in which it exists. The species may be a predator or herbivore, exerting significant pressure on a prey population or vegetation component. Under heavy exploitation of the species, these fed-upon components of the system may increase, and alter the prey or plant community structure, as the case may be.

Or, the exploited species may be enmeshed in competitive interaction with others. When reduced, its niche may be partially or largely vacated, and its competitors may move into the void, once again changing community structure and possibly blocking recovery of the exploited species. This appears to have been the sequence of events in which the anchovy replaced the sardine in the California Current system. One wonders if something similar may be going on in the case of mallards replacing black ducks in the eastern part of North America.

Concentration on the population behavior of individual species may produce other problems. Much of population theory was developed either in fish and game biology or in economic entomology, and heavy emphasis has been placed on the effects of exploitation, or the approaches to control. It may therefore tend to focus attention on economically important species to the neglect of other species in which our increasingly aware public is interested.

The manager with a narrow population focus may also fail to appreciate, and pay heed to, the complex habitat and ecosystem relationships which his species need to survive. The most careful population inventories and harvest regulations may be to no avail in perpetuating a species if external forces are eroding its life-support system. The most vital need is perpetuating the system, and only if this is accomplished is species management possible.

The Ecosystem Perspective

We have a growing body of theoretical knowledge which can alert us to these dependencies and side-effects. This knowledge resides in the other half of the ecological dualism which I was asked to address this morning: the science of ecosystems. Let us briefly consider some of the important concepts of this fascinating area.

I would like to review briefly two lines of inquiry in this subject which have seen tremendous development in the past quarter to half century. In both cases, Charles Elton in England and G. Evelyn Hutchinson in the United States pioneered early concepts and played important roles in stimulating others to develop new concepts.

The first is the area of ecosystem function in which the organisms of the system are conceptualized in terms of their energy content. Emphasis is placed on the rate at which plants fix solar energy, and at which the energy flows through the animals and is fixed in their own tissues. Since availability of chemical nutrients may act as constraints on plant function, that availability and influences determining it are conceptualized and measured in the form of biogeochemical cycles.

This aspect of ecology was importantly pioneered by R. L. Lindeman (1942), but significantly developed by Eugene P. and Howard T. Odum. It has expanded enormously in the past few years in the form of the U.S. International Biological Program biome projects, a major goal of which has been to develop complex simulation models of energy and material flow in both aquatic and terrestrial ecosystems. These models are designed to predict the effects of different land-management strategies on the different parts of an ecosystem.

Ecosystem functional concepts, of the sort described here, have perhaps had more application in aquatic systems than in terrestrial (Wagner 1969). Since most production of the lower aquatic trophic levels appears to be used by the higher ones (Raymont 1966; Steele 1974), production at the higher levels occupied by most of our game and commercial fish species proves to be a function of the lower. Furthermore, the manager of commercial fishery stocks may be more concerned with biomass or weight than with the number of individual fish, another influence concentrating his attention on energy-flow patterns. Nutrient shortage is a common constraint on aquatic plant production, particularly phytoplankton, and therefore on the productivity of the whole system. Thus, from several points of view, ecosystem concepts have occupied much of the attention of fishery managers.

Most terrestrial game species are herbivores with somewhat specialized feeding habits. While the large mammals may at times be limited by that portion of the vegetation spectrum which they consume, many of the smaller game species do not appear to be significantly food limited,and terrestrial species in general do not appear to take a significant fraction of the primary production. Hence, those ecosystem concepts dealing with energy flow have not had as much relevance to terrestrial game management as they have to fishery management.

A second, important line of development in ecology over the past few decades is one which I will broadly term community structure. It had dual roots in the 1920s and 30s in Charles Elton's writings on animal communities and his niche concept, and in the theoretical equations of Vito Volterra and G. F. Gause on interspecific competition. With important impetus from Hutchinson, this area of ecology has flourished in the past 20 years, particularly in the work of Robert MacArthur and colleagues. The field has emphasized the role of competitive and predatory interactions between species for available resources, and of niche structure and habitat affinities in determining community structure.

Application of this area of ecology to resource management lies in the effects of human perturbations on community structure, in the ways in which systems of different structure respond to human influence, and interestingly in the effects of size and location on the effectiveness of refuges. Its theoretical framework provides an explanation for many of the cases where our resource management has gone astray: demise of the sardine in the Pacific and the deep-water fishery in Lake Michigan, changes in range vegetation under different grazing practices, problems of raptor conservation.

Species and Ecosystem Management

This may now seem to have changed from a sermon to a classroom lecture in ecology. If it has, I make the change unapologetically because the management of renewable resources is applied ecology. The effectiveness with which we practice our profession is importantly a function of the thoroughness with which we grasp ecological pattern and process, and how well we understand the ecosystems which we manipulate.

I do not wish to leave any impression that I advocate abandoning our attention to population phenomena. It is still essential that we understand population behavior in order to predict the response of desirable species to exploitation or protection, and of economically detrimental species to control practices. In my opinion there is still considerable ambiguity in population theory, and frontiers waiting to be pushed back. The sophistication of population understanding among many of our professionals is still below what it should be. An official of one midwestern department of natural resources told me recently that some of its younger game biologists could not understand how a deer population could sustain a doe removal without going into indefinite decline.

Nor do I want to give any impression that I advocate some ecosystem panacea. Concentration on ecosystem energy-flow diagrams is not likely to help us solve the problems of waterfowl habitat loss in the Prairie Provinces, or declining pheasant numbers in the Midwest due to the intensification of agriculture.

What I *would* like to advocate is a broader ecological understanding in the practice of our profession. Ecological systems may be the most complex entities yet addressed by science. If we are to manage them effectively, our understanding of them must be equal to that complexity. We need to understand the population behavior of individual species as well as their mutual interactions, and the behavior of the system as a whole.

Management of Resource Systems

What I have said so far is platitudinous to most ecologists. It is no longer news that the components of ecosystems are interrelated, and that manipulation of one component is likely to ramify to others. And our resource management procedures are increasingly being revised to address broader, systems problems as I shall describe shortly.

The major problems as I see them today are in our approaches to policy decisions, and in fostering a systems perspective in the minds of the interest groups concerned with our resources. I would now like to turn attention briefly to this, my second major area of concern this morning.

The Landscape is a Resource System

Every tract of land can be considered a resource system (Fig. 2), with the term "system" used in the general sense of "an assemblage of objects united by some form of regular interaction or interdependence." The implication, once again, is that alteration of any one part will eventually lead to change in the other parts, and in the system as a whole.

Such a resource system is capable of producing a spectrum of resource and service mixes. The national forest which I contemplate daily out of my house window produces a certain mix of timber products, range forage, water, fish and game, areas for skiing and many other forms of recreation.

That mix is changing. The land has a use history, and the ecosystem is changing in response to that history. Forests are maturing, spreading, changing in composition. Range vegetation is changing in response to current grazing policies. Some wildlife is increasing, some is declining. Water yields may be changing. Ideally, these changes should not take place by management default. We should have a certain mix as our management goal and be steering the land toward that mix.

But here is the real rub. What *should* the mix be and *who* should decide on it? Since the resources compete to some degree with each other, decisions favoring any one are likely to be to the disfavor of the others. Someone is not going to get his or her wishes.

On private land this question is somewhat rhetorical. The land-owner calls the shots. But in the West where I live and much of the land is public land in which you and I have a stake, the problem is a very real one.

Ecumenism in Decision Making

There is no clear, existential solution to the problem. In a plural society, there is no way that all desires can be fully granted and all interests fully served. The answer inevitably lies in compromise.

The Spanish philosopher Ortega y Gasset wrote that the word civilization presupposes the " . . . desire on the part of each individual to take others into consideration. Civilization is, before all, the will to live in common."

If we wished to dream about the ideal situation in a plural, civilized society, we might imagine that there is some resource mix which is in its best interests. The orderly, rational approach to a decision on that mix might be:

1. All interests sitting down together and considering each other's desires.
2. All interests being apprised by the professional resource manager of the effects which granting of their desires will have on the others.
3. All interests agreeing on a decision which gives proportionate consideration to the desires of all parties—the greatest good for the greatest number.

In this framework the resource professional is not a policy maker. His or her job is to analyze the implications of decision alternatives, and to implement the decision eventually given him. Personally, he or she may have values and these should

THE LANDSCAPE IS A RESOURCE SYSTEM

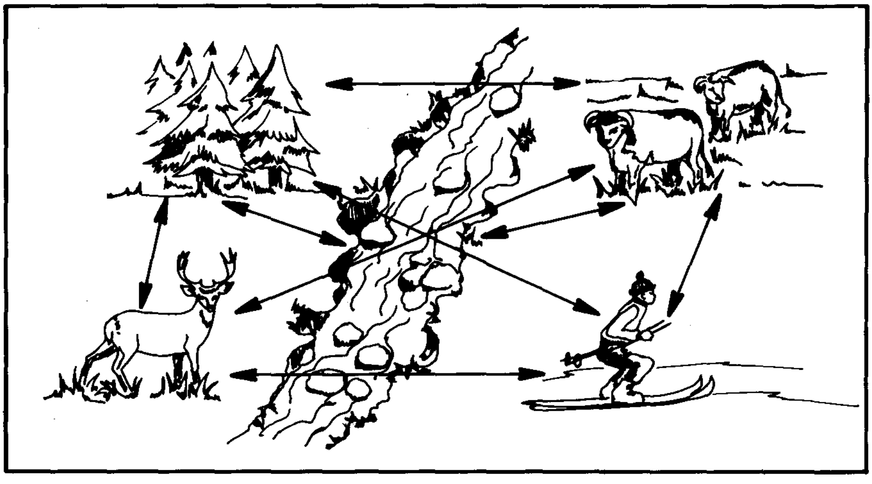

Figure 2. Every tract of land can be considered a resource system capable of producing a spectrum of mixes of products and uses. All are interrelated, many compete with each other, and management for any one resource or use is likely to affect the others.

be considered in the decision procedure. But they are introduced as personal desires and not as professional imperatives.

What I am describing is ecumenism in decision making. The words ecumenism and ecology both stem from the Greek word for house, but connote more broadly the togetherness of the household system. Not everyone can be entirely happy with the compromises of ecumenical decision making. But everyone can be apprised of the pros and cons of the decisions, and participate in them.

Of course, it is no news to anyone in this room that the way we have been operating is a far cry from ecumenism. If our science has been single-species science, our decision making has been single-value decision making.

Each interest group pulls independently for its own values, and to hell with the trade-offs others must make. In the process, single-value decisions are made because:

1. Interest groups get to power levers in government first and/or largely unseen.
2. Because, and let us admit it, public agencies too often cater to individual interest groups, and themselves make policy when their role should be executive.
3. Because the public is uninformed, too hesitant in asserting itself, or cynical over its ability to influence what it considers an alliance between economic interests and government.

All of us can think of examples: land-development groups, agriculture, the livestock industry, mining interests, timber firms, environmental groups, and yes, we professionals who at times become convinced that we know what is best for the populace. All pulling. All mistrusting each other. All communicating but rarely. Few thinking of compromise.

At this point I am into social psychology and political science and far from my area of expertise. I obviously cannot suggest how people can be induced to consider others, to be willing to constrain their demands in the interests of social well-being. It is outside both my ken and my job as a professional resource manager.

But there are a number of things we can do. One is to bring competing interests together in decision situations in an atmosphere of mutual respect, and in an attempt to improve understanding and communications. I have proposed one such attempt for the predator-control issue elsewhere (Wagner 1975).

Another is to improve the systems perspective of our professionals through training. There is an interesting contrast between the academic training, university curricula, research and management approaches, and general mind set of wildlife biologists on the one hand, and of foresters and range managers on the other. Wildlifers are heavily steeped in animal biology—ecology, anatomy, physiology, mammalogy, ornithology, etc.—and when they get on the job they want to band geese, telemeter bears, and examine deer teeth. Forestry and range management curricula are not without biology, but in addition they are likely to include resource economics, resource policy, decision theory, and perhaps law. In my own college, the faculty members who teach these people—and management-oriented disciplines—are in the forestry and range departments. Outdoor recreation has developed in our forestry department.

There are, of course, reasons for this dichotomy. Range managers and foresters manage economically important resources on tracts of land. They are in effect land managers and must make decisions on economic alternatives.

More often than not,the economic worth of a wildlife resource cannot compete with the value of the other resources, and the unique public ownership of wildlife may place it outside the decision array considered by a landowner. Too often, the wildlife manager can regulate the use of his resource, but he is either legally unable or economically powerless to manage the land for it. The result is to concentrate his attention on the biology of his species, and not on ecological *or* social breadth.

The economic worth of their resources has often tended to focus the attention of foresters and range managers on maximum, short-term gain from forests or ranges, and has not encouraged a broader systems perspective and consideration of other values. Hence, short-term economics in their case, and the circumstances promoting a species-biology focus in the wildlife case, seem to be one of the forces producing the single-value decision making that has pervaded so much of the professionals' approach to resource management.

At our institution, we are belatedly revising our curricula to include systems science; and quantitative aspects of resource management, decision making, and policy. Time will tell whether or not it is successful.

Ecumenism in Governmental Reorganization

Having ventured into religion, one of the two topics we are often advised not to discuss, I may as well like a fool rush into the other, namely politics. There is much talk these days about the new Washington administration reorganizing government and streamlining the bureaucracy. Surely we all applaud this goal and wish it every success.

Some of the reorganizations being considered are those of the resource management agencies, and one rumored series of changes would move the Bureau of Land Management into the Department of Agriculture, and the Environmental Protection Agency into the Department of Interior. There is certain logic in moving BLM into the same department with the Forest Service and the Soil Conservation Service where they could collaborate in that subset of their objectives which relates to agricultural production. There is also some logic in placing EPA in the same department with the Park Service, the Fish and Wildlife Service, and the Bureau of Reclamation.

But the gains, in my view, would be far overshadowed by the anti-ecumenical effects such moves would be likely to produce. The changes would group the production-oriented agencies in one block and the protection-oriented ones in another, and separate them in different departments. The result would almost certainly be to polarize them and promote single-value decision making.

As we have discussed, reconciliation of resource exploitation on one hand, and resource and environmental protection on the other, will require compromise. Such compromise will hardly be made by single-value agencies whose administrators are responsible only to a single constituency for their decisions, and who have little appreciation for the trade-offs involved in those decisions.

In the final analysis, what I believe is needed is a single Department of Natural Resources with a single secretary responsible for decisions that consider both resource use and protection. Perhaps it could also be called the Department of Ecumenism.

The Procession Has Started

My plea this morning has been for breadth of ecological understanding and multi-value decision making. Fortunately, this plea is somewhat anachronistic. Things are already moving in these directions, and this presentation is more one of urging on the procession than leading it out of the wilderness. Recent publications and events suggest that the move has started.

State wildlife departments are beginning to turn management attention to a broader array of species than just the game species alone; and their names evolve from departments of fish and game, to departments of wildlife resources, to departments of natural resources. Graul et al. (1976) describe an extremely interesting approach by the Colorado Division of Wildlife to the management of nongame species which in fact turns out to be ecosystem management. Beginning with the list of birds native to Colorado, biologists identify those species which have narrow tolerance limits for environmental influences and therefore are early warning indicators of changes in the ecosystems they occupy. These systems are identified, and given early priority for research on the nature of the change, and for conservation.

In May, 1975, a well-attended conference in Arizona on the management of nongame birds explored the gamut of ecological problems surrounding the management of numerous avian species. Bureau of Land Management and Forest Service officials reported on their growing efforts in this management area. Lee M. Talbot (1975), conference summarizer, congratulated the group on the ecosystem breadth of their views.

Earlier that same year, Talbot had himself convened two workshops on the management of wild living resources. Special attention was given to marine species in the hope of influencing the Law of the Sea deliberations. The key conclusions coming out of the workshops were that a population perspective alone is wholly inadequate to manage such resources, that a cardinal principle of proper management is attention to the effects on other components of the ecosystem, and that resource users bear the responsibility for analyzing the effects of their actions.

In Canada, Carbyn (1976) describes a procedure for setting research priorities in a national park research program which is based on the principles of systems organization. Regier (1976a), reviewing the management history of Canadian fisheries, advocates an interdisciplinary research approach which can transfer insights directly into administrative planning and decision making. He (Regier 1976b) proposes the title "environmental biology of fishes" explicitly for this approach.

These and other events suggest that things have begun to move in the right direction. But as Talbot (1975) remarked, progress is still not up to the pace we would all like. Until the states get new funding sources, they will have difficulty broadening their vistas from the game emphasis which reliance on license revenues prescribes. And we need new organizational innovations for bringing all relevant publics into the decision process.

Despite the slow progress, I am optimistic for the future. In total, we have made great strides over the past decade or two, and I am confident that our accomplishments will continue to grow.

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New Dimensions in the Management of Coastal Fisheries and Wildlife

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I am pleased to have the opportunity to convey some thoughts and concepts which are emerging today looking toward the management of our coastal living resources and the estuarine and marine environment in which they live. I have had the privilege to be involved in estuarine resource management almost all of my career. I have seen estuarine and marine areas changed by man's activities from clean water, undisturbed wetlands and bottom lands to those contaminated by heavy metals, DDT, PCBs and other chemicals, discovered and undiscovered. I have seen highly productive wetlands deteriorated to the point where they were useless as part of the ecosystem and in many cases the developments on the filled wetlands resulted in heavy contributions to pollution loads.

Thirty years ago the need for intensive resource and environmental management seemed limited. Neither the states nor the federal government were really structured to deal with such problems as changes came about. Substantial damage in many areas was the result. Things have changed for the better in recent years only because of the determined dedicated efforts of enlightened leadership such as is represented here, and an aroused constituency.

But, because these efforts have and are taking place and because "informed laymen" are becoming involved, I believe we can face the future with optimism. I want to emphasize the importance I attach to the phrase "informed laymen." Everything is possible when people are concerned and participating, since they reach the decision makers—be they administrators like some of you and me—or legislators who develop the framework in which we operate. So I feel we must keep the information flowing and seek the grass roots input. We must work together to involve those from the smallest coastal villages to the various state agencies and to the federal bureaucracy.

I think everyone here today would agree that ecological principles should form the planning basis for living marine resource management. However, translating such concepts into programs to solve fisheries problems has proven in the past to be difficult and, frequently, almost impossible.

A few major fisheries and wildlife dimensions of great importance have emerged. One is the management of fisheries stocks under the Fishery Conservation and Management Act (FCMA) of 1976 which became fully effective on March 1, 1977. A second is protection and preservation of marine and estuarine habitats which are of importance to the survival and development of both fish and wildlife. I believe the future well-being for living marine resources is based upon our ability to handle successfully these components. Both are equally important. Our experience has shown us that fisheries stocks will be depleted if we are unable to control fishing pressures. At the same time, if we are unable to maintain a healthy and productive marine environment, few stocks will survive to be managed. It's as simple as that.

Over the next few minutes I will discuss key issues under both of these dimensions, as well as describe a number of steps that we in the National Oceanic and Atmospheric Administration (NOAA) are taking to meet them. I want to report some of the progress that has been made, and to discuss some of the significant problems that remain to be solved before we attain the essential dimensions of an optimum management regime for our coastal fisheries and wildlife.

During the past two years, a major part of my time has been spent on policy issues concerning fisheries management. In NOAA, we had an all out effort going even before the FCMA was signed into law last April. Many of our efforts have focused on such topics as management guidelines, fee schedules, regional councils, the components of management plans, allocation decisions, enforcement strategies, as well as the research and programs needed in order to carry out the provisions of the FCMA.

The underlying purpose of the FCMA is to provide a basis in law for a strong national program for the conservation and management of our fisheries resources—to conserve our fish stocks, rebuild stocks that have been overfished, and as these things are accomplished to ensure that these stocks are readily accessible for taking by our commercial and recreational fisheries. Our new law recognizes among other things that fisheries are finite but renewable; that commercial and recreational fishing constitutes a major source of employment and contributes significantly to the economy and well being of the nation; that our domestic and international management regimes have not been effective in preventing the misuse of these valuable resources; and, that if sound management principles are applied, our fisheries can be restored, conserved and maintained.

Our major marine fisheries program goals today are: to manage the fisheries resources to assure our citizens maximum benefits in the areas of commercial and recreational opportunities, and to protect the habitat to sustain the stocks. The FCMA requires us to manage fisheries resources on a basis of continuing optimum yield. I suspect this is the first time that optimum yield has been adopted as the concept for fisheries management.

What does optimum yield really mean? Some have criticized and opposed the use of the term as too vague and therefore amenable to a wide range of interpretations. However, it is just this flexibility which has won considerable support in the United Nations Law of the Sea negotiations for the concept of maximum sustainable yield, taking into consideration relevant economic, social and other factors. The optimum yield as now specified in our law is the quantity of fish which: (1) will provide the greatest overall benefit to the nation with particular reference to food production and recreational opportunities; and (2) is prescribed on the basis of Maximum Sustainable Yield as modified by any relevant economic, social, or ecological factor. It is my view that the requirement that economic and social, as well as ecological factors be considered, is a significant step forward in making management decisions.

We recognize that fisheries resources may be subject to multiple uses which can be mutually incompatible. Problems undoubtedly will arise between commercial and recreational fishermen where sportsmen want management to produce more trophy fish, while commercial fishermen want the stock to yield the maximum pounds irrespective of size. We also have the problem of competition between commercial fishermen who desire the same stock at different ages as in the marine sardine-herring fishery.

What is the government doing to carry out the directives in the law? The law establishes a National Fishery Management Program which requires the preparation of "fishery management plans" by eight regional fishery councils. These plans are then subject to review, modification under certain circumstances, and ultimate approval by the secretary of commerce.

Appropriate input from user group representatives, from the commercial and recreational fishing industries, other interested groups, the public at large, as well as state and federal representatives is needed in the development of these plans. At present, the eight councils have begun to set planning priorities. The plans will include descriptions of domestic and foreign fishing activities, user conflicts, factors affecting the demands and supply of fisheries products, recreational uses, a determination of optimum yield, and the necessary regulations required to achieve the optimum yield from the fisheries management unit as well as the determination of whether a surplus is available for foreign fishing, given the intentions of domestic users of the resources. These items sound deceptively simple and easy to respond to, yet if done to satisfy the intent of the FCMA and provide sufficient information for sound management decisions, they each could represent a significant undertaking for many fisheries.

Our discussion so far has been almost entirely theoretical. What has really been done since the passage of the law in April 1976—10 months ago? The list of accomplishments is, in my opinion, impressive. All members of the regional councils have been appointed. The councils all have organized, elected officers, established a location for doing business, and each has appointed an executive director. Since there was not time for the councils to develop management plans before March 1, the Department of Commerce through the National Marine Fisheries Service (NMFS) has established 16 preliminary management plans designed to control foreign fishing until the councils can put together more permanent plans.

The Department of State has negotiated 10 governing international fisheries agreements, and based on stock analyses by NMFS scientists have allocated 1977 catch quotas to most of these countries. At the same time NOAA has analyzed and adopted a schedule of fees for foreign fishermen estimated to recover a major part of the costs of management required because of foreign fishing. Furthermore, NOAA has established guidelines and criteria so that the councils will be carrying out their functions along similar lines. While these things were being done the Coast Guard, in cooperation with the enforcement agents of NMFS, have worked out procedures to require compliance to the regulations.

More than this, the New England Council has just developed management plans for haddock, cod and the yellowtail flounder to provide a sound conservation framework for these species. We anticipate almost immediate approval of these plans by the secretary.

So much for the law and what has been done to date. What steps are needed now? We still need an adequate mechanism to deal with species which live near shore and migrate across state lines. We still must deal with those stocks which move back and forth across international boundaries and we will continue to deal with and solve problems of policies, jurisdictions and authorities between the states, the federal government and perhaps the councils. We still need an interstate mechanism for some fisheries within 3 miles. Cooperative endeavors between the states and the federal government such as the dungeness crab regulations may solve that problem but are not necessarily transferable to other interstate fisheries. Our territorial sea is still a most valuable fishing ground and includes the critical spawning and rearing habitat for many stocks of fish. The wetlands and estuaries are the source of nutrients that support the productivity of life in our waters.

This leads me to the second major dimension—protection and preservation of estuarine and coastal habitat. Marine environmental pollution involves many interests and agencies. Major social and economic problems must be overcome to achieve successful protection, preservation, and mitigation programs. The problems include pollution from point and nonpoint discharges, oil spills, ocean dumping and estuarine habitat destruction and degradation from dredging and filling. Pollutants include heavy metals, petroleum hydrocarbons, pesticides, and other chemicals. Some estuarine habitats are being destroyed by inappropriate development in the coastal zone and resource planners are faced with the knotty decisions of competing uses and how we can provide the maximum benefits for most of our citizens without doing violence to the environment itself.

There is a need to better apply existing federal and state water pollution laws. At the same time we should press to improve consideration given to fisheries, wildlife and habitats in key environmental decision-making processes under these laws. We must broaden our perspective and make better use of alternatives already open to us.

Under the Coastal Zone Management Act of 1972, administered by NOAA, the states are developing policies to control and guide future coastal development and to protect estuaries and wetlands. Very substantial progress has been made since this program began in December 1972. At the end of this year we anticipate having a number of completed and approved state coastal management programs, providing comprehensive and coordinated government policies at all levels for the rational use of coastal resources.

In NOAA, we have regarded the Fish and Wildlife Coordination Act program as an effective mechanism to protect our estuarine habitat. There are funds in the current budget for 1978 increasing the staff in NMFS to deal with this matter in the southeastern part of the United States. If we are successful in strengthening our capability there we would then hope to expand our efforts elsewhere so that we can handle properly the 40 odd thousand project and permit applications under Section 204 (National Pollutant Discharge Elimination System) and Section 404 (Permits for Dredged or Fill Material) of the Federal Water Pollution Control Act Amendments of 1972 and Section 10 of the River and Harbor Act of 1899. And yet, we must not be rigid in our approach but adapt all existing mechanisms to assist in dealing with this major matter.

There are other environmental matters which also need attention. Some are analyses and recommendations to assist in development of offshore oil and gas development areas in ways that avoid or at least minimize adverse effects. Greater emphasis is needed also in identifying, selecting, and managing ocean dumping sites, with the ultimate goal of eliminating ocean dumping whenever possible. While regulation of ocean dumping is the basic responsibility of the Environmental Protection Agency, we in NOAA feel it is necessary for us to assist by supplying the basic data for decision making. There is also a need to search for alternatives to ocean dumping which would reduce ocean pollution and we will carry out our legal responsibilities in this effort.

Establishment of sanctuaries is another mechanism for habitat protection and management. The Marine Protection, Research, and Sanctuaries Act of 1972 provides for the designation of marine sanctuaries. This mechanism for habitat protection has been little used because we have been unable to obtain direct funding. Consequently, NOAA has begun administration of this authority using existing funds. We have two such sanctuaries, one adjacent to North Carolina and one adjacent to Florida, and nominations or active discussion at present about sites in many coastal areas. We hope to obtain specific financial support to operate an expanded program in fiscal year 1979.

Finally, we need better methods to mitigate adverse effects of development and restore lost habitats. Both state and federal agencies must expand their capability to provide development agencies with technical information and assistance for enhancement and restoration programs for both major and minor projects which will disturb these aquatic ecosystems.

Decision makers need more reliable assessments of existing resources, natural processes, and effects of development actions on fisheries and habitats. The quality of supporting research programs ultimately will dictate the reliability of assessments. We must strengthen and expand the level of research as a basis for decisions. Equally important is to increase the relevance of ongoing research efforts to key information needs. The FCMA mandates that we expand our information base on coastal and estuarine fisheries ecology, including pollution impacts and the effects of the deteriorating quality of our wetlands and estuaries. This kind of information will be most important in environmental decision making in relation to living resources.

I am pleased to have been provided with this forum to present my views on these important dimensions. They are presenting major challenges for all of us as we carry out our various activities in fish and wildlife management, public information, research, impact analysis, et cetera. As I said before, I feel confident that over the next 5 years we can make substantial inroads into the challenges of these dimensions in a way that will ensure maintenance, enhancement, and wise use of our fisheries and wildlife resources for future generations.

I believe the United States has attained a major milestone in fisheries management and we can face the future with optimism. Over the next 5 years our goals should be to increase our commercial fisheries by at least 20 percent and at the same time provide better recreational opportunities to the ever expanding number of recreational fishermen. We have the tools to accomplish these goals through the new FCMA, the Marine Protection, Research and Sanctuaries Act and the Coastal Zone Management Act, as well as the old standby, the Fish and Wildlife Coordination Act.

As we amalgamate all of these forces we have every reason to believe the future is bright for the well being of our fisheries and wildlife in those areas we call estuarine and the coastal waters.

Evaluating and Maintaining Habitats for Fish and Wildlife

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Loss of Missouri's Lowland Hardwood Ecosystem

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When European explorers encountered the lowlands of southeastern Missouri, the flat landscape was laced with low ridges, sluggish streams and shallow lakes and was covered with a vast hardwood forest. Annual dormant season flooding, low sites with standing water, high temperatures and a long growing season provided ideal conditions for the growth of gigantic trees. Magnificent baldcypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), and ash trees (*Fraxinus* sp.) flourished in low sites. Elm (*Ulmus* sp.), red maple (*Acer rubrum*), sweet gum (*Liquidambar styraciflua*), overcup oak (*Quercus lyrata*), willow oak (*Q. phellos*), pin oak (*Q. palustris*), and hickories (*Carya* sp.) dominated the higher sites. After little more than a century of development, the once awesome hardwood swamps are all but gone, and the primeval grandeur of giant trees is evidenced in fragments of forest that remain.

Many early reports and estimates of wildlife may have been exaggerated, but without doubt, the swamps of southeastern Missouri had a rich fauna. As the lowland forest disappeared, the impact on the fauna was obvious. Not only did species composition change from those associated with forests to those found on more open lands, but species were extripated or became extinct. Passenger pigeons (*Ectopistes migratorius*), ivory-billed woodpeckers (*Campephilus principalis*), and Bachman's warblers (*Vermivora bachmanii*) were once residents of Missouri's southeastern lowland forest, but all are now extinct or near extinction (Widmann 1907:84, 119, 215). Red-shouldered hawks (*Buteo lineatus*), wood ducks (*Aix sponsa*), and swamp rabbits (*Sylvilagus aquaticus*) were abundant, but are now restricted to the remnant forest (Widmann 1907:37, 97; Korte and Fredrickson 1977). The mountain lion (*Felis concolor*) and black bear (*Euarctos americanus*) were last recorded about 1930 (Schwartz and Schwartz 1959:268, 332). River otters (*Lutra canadensis*) are now restricted to a few sites along the Mississippi and St. Francis Rivers in the southeastern lowlands (Schwartz and Schwartz 1959:308). Species of open areas such as the horned lark (*Eremophila alpestris*) are now abundant.

The large number of Indian mounds and gravesites also suggest that the primeval swamps had a rich fauna. The Osage, once a dominant tribe in the area, lived in west central Missouri but traveled to the southeastern lowlands twice each year to hunt (Forrister 1970). As late as the early 1900s gray squirrels were reported in mass migration in the swamps, and railroads regularly employed men to hunt squirrels to feed work crews (Bennitt and Nagel 1937:85). In 1893, 150,000 ducks were reportedly shipped to market from Big Lake in northeastern Arkansas (Widmann 1907:16). Clearly today's fauna is but a meagre remnant of the numbers and diversity of animals once common to the area.

The purpose of this paper is to present background information concerning Missouri's southeastern lowland hardwood forests, and to show chronologically how rapidly and completely an important, productive ecosystem can be lost through man's activities. We estimated the loss of lowland hardwood forests during ten year intervals for 11 southeastern Missouri counties. U.S. Census of Agriculture data (U.S. Census Office 1872, 1883, 1895, 1902; U.S. Bureau of Census 1910, 1922, 1932, 1943, 1953, 1962, 1970) from 1870–1970 were modified as follows. 1) Lowlands were distinguished from uplands by differing soil types as determined from a 1931 reconnaissance survey soil map prepared by University of Missouri Agricultural Experiment Station. 2). An Ott planimeter type 30/38 was used to determine vernier units for the total area in each county and for the lowland area in each county. Percentage of county in lowland was calculated from the vernier units and used to estimate acres of lowland in the counties. 3) U.S. Census of Agriculture data were compiled by county, but these data did not distinguish between upland and lowland. Because some counties are mostly upland, because early settlement was confined to uplands, and because in recent years uplands have been more heavily forested than lowlands, lowland forest acreage estimates derived from census data for these counties result in estimates that are too low for earlier dates and too high for later dates. To minimize these biases we derived percentages from lowland hardwood estimates for lowland counties (counties that are more than 95 percent lowland). These percentages were applied to lowland areas for upland counties (counties with less than 66 percent lowland) to obtain lowland hardwood acreage estimates for upland counties. 4) In 1973 we used aerial reconnaissance and on sight observations to determine the number, size, and condition of remaining tracts of lowland hardwood forests in southeastern Missouri.

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Historical and Geological Background

Geological History

A review of riverine history is essential to understanding the water regimen that dominated the lowland forest of the southeastern Missouri lowlands. The origin of landforms dates back to the Paleozoic Era, when the Gulf of Mexico covered much of what is now the lower Mississippi Valley including portions of southeastern Missouri. During the Pleistocene, cooling of the earth's atmosphere caused water retention in glaciers that spread southward into the northern United States. A subsequent increase in the earth's atmospheric temperature caused glacial recession, and melt-water flowing southward formed the Ohio and Mississippi River drainages. However, stream capture and flooding caused these rivers to alter their courses several times since the Pleistocene. About 45,000 years ago, the Ohio River ran through the Morehouse Lowland, east of Crowley's Ridge (Fig. 1). The Mississippi River then ran parallel to the Ohio River and carved the Advance Lowland through the eastern edge of the Ozark Uplift. Eventually Crowley's Ridge was separated from the main block of the Ozark Mountains and became a distinct landform.

After the Ohio River abandoned its channel through the Morehouse Lowlands for a more easterly course, the Mississippi River overflowed low divides in Crowley's Ridge and abandoned its channel through the Advance Lowland for the more direct route through the Morehouse Lowlands. The Mississippi River eroded portions of the sediments deposited earlier by the Ohio River and formed Sikeston Ridge, a low sand ridge on the eastern bank. Later the Mississippi River cut through saddles in Crowley's Ridge at least once more and eventually assumed its present course to the Ohio River at the southern tip of Illinois.

For thousands of years after the Mississippi River had reached its present course, periodic flooding of the old basins was caused by the Castor, St. Francis, and Whitewater rivers in the Advance Lowland, by the Little and Whitewater rivers in the Morehouse Lowland, and by the Mississippi and Ohio rivers in the Charleston Lowland. These floods played an indispensable role in the formation of the vast swamp wilderness encountered by early European settlers.

Early Ownership and Legislation

Several French explorers reached the lowlands between 1639 and 1650. In 1682 Robert de La Salle claimed for France a large expanse of wilderness that included Missouri, but settlement was limited to mainly hunters and trappers. In 1762 France ceded all of her holdings west of the Mississippi to Spain and, although Spanish rule was short-lived, it was responsible for the introduction of an agrarian lifestyle in southeastern Missouri. The area was retroceded to France in 1802 and obtained by the United States in 1804 via the Louisiana Purchase. For the next 50 to 100 years, activities were confined mainly to the ridges.

Prior to 1850 the Federal Government owned the swamp and overflow lands of southeastern Missouri. These lands were considered worthless and for 50 years Congress debated the disposition of these lands. The Swamp Act of 1850 (Nolen 1913:6) ceded all swamp and overflow lands to the states in which they were situated under the pretext that this would enable the states to accomplish the drainage necessary to reclaim these lands. Under the provisions of this act, Missouri received about 3.5 million acres (1.4 million ha), including about 2.4 million acres (1 million ha) in southeastern Missouri. State government attitude toward reclamation of swamplands paralleled that of the Federal Government. In 1851 and 1852, the Missouri Legislature passed laws that ceded to the counties all swamp and overflow lands within their jurisdiction and stipulated that revenues from the sale of swamplands must be used for drainage.

Adequate drainage was imperative for the establishment of agriculture and responsible for the ultimate demise of lowland hardwood forests in southeastern Missouri. Because land values remained low and drainage costs were high, the drainage provisions of the swamp-act laws resulted in little effective drainage. Possibly the most significant effect of these laws was to make swampland more readily available to private investors.

Early Transportation and Lumbering Activities

The lack of dependable transportation was a major obstacle to agricultural development. The first roads and railroads were confined to Crowley's and Sikeston Ridges because of the annual inundation of the intervening lowlands. Moreover, east-west transportation from the Mississippi River inland was limited to a few roads that were impassable during much of the year. Because dependable transportation for farm products was lacking, the incentive to reclaim the more remote portions of the lowlands was negligible.

In the 1860s lumbering interests were attracted to the lowland forests of cypress, gum, oak and tupelo that often could be purchased for less than one dollar per acre. In 1868 one 80,000-acre (32,400 ha) tract was sold for $443. In 1874 these land sales prompted the Missouri legislature to set a minimum price of $1.25 per acre on swamplands, but county courts often circumvented the law by granting large tracts of land in exchange for drainage. Land grants were particularly attractive to lumber and railroad interests that were more concerned with timber harvest than with drainage or developing the cut-over land. The apparent effectiveness of drainage systems varied considerably with weather conditions and time of year and companies could inflate expenses for drainage development in order to receive additional acreages from the counties.

Prior to 1870 there was little public support for railroads in southeastern Missouri. However, as the lumber industry grew, railroads were needed for efficient transportation of logs and lumber. Once the public accepted railroads, they became universally desirable (Willis 1933).

Early Drainage

Efficient ditching equipment was expensive, and many landowners had to rely on small horse drawn ditching plows to accomplish drainage. As a result, most early drainage attempts were small.

Moreover, adequate capital, equipment, and comprehensive plans based on accurate surveys were lacking. In 1890 extensive areas of the southeastern lowlands remained forested, but investors, businessmen and farmers were beginning to realize the potential productivity of the rich alluvial soils if drainage could be accomplished. In 1892 the state legislature passed a bill that legalized the financing of drainage systems by the sale of long-term bonds. For the first time, it was possible to secure adequate capital to finance sizeable drainage projects without surrendering large tracts of land to private investors, notably lumber and railroad interests (Ogilvie 1967). However, large scale drainage systems required careful planning based on accurate land surveys and efficient ditching equipment, and both were still lacking in the 1890s.

Around 1900 the dipper dredge was developed. This machine which was capable of moving 2000 cubic yards (1,530 m^3) of earth per day, made it possible to dig the large ditches necessary for effective drainage. The dipper dredge enabled Otto Kotchitzsky, a local resident with experience in surveying and drainage, to implement a plan to drain nearly 500,000 acres (202,000 ha) in the Morehouse Lowland. The plan was two-phased. The first phase was to restrict the flow of water into the Morehouse Lowland. This included Mississippi River levees to the east that prevented floodwaters from entering the lowlands. Runoff from the Castor, Little, and Whitewater rivers that flow from the Ozark Uplift to the north and west was diverted directly to the Mississippi River via a diversion channel. Once the lowlands were protected from outside sources of water, the second phase was the construction of an extensive system of ditches for internal drainage. In 1907 the Little River Drainage District was formed to administer and finance the project. Work was begun in 1914 and completed in 1920 (Ogilvie 1967).

Chronology of Disappearance of Forest

From the time of first European exploration in southeastern Missouri (about 1650) to the time of the first census of agricultural land use (1870), approximately 300,000 acres (121,000 ha) or about 12 percent of forest had been cleared for agriculture or lumber (Table 1). The cleared areas were located on the higher sites such as Sikeston Ridge (Fig. 1).

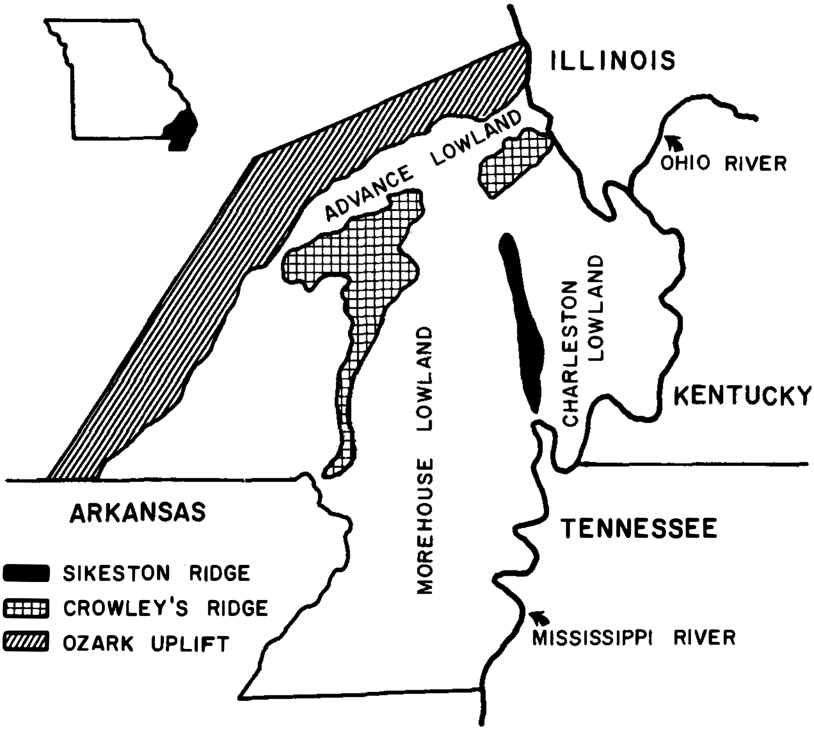

Figure 1. Landforms in Missouri's southeastern lowlands.

Table 1. Decline of Missouri's southeastern lowland forest by ten year intervals between 1870 and 1970 and estimated forest area remaining in 1975.

Interval	Influencing factors	Acres lost	Percent loss: Interval	Percent loss: Cumulative total
Before 1870	State and Federal Swamp Acts	300,000	12.5	12.5
1870–1800	Lumbering, railroads	115,000	4.8	17.3
1880–1890	Lumbering, railroads	142,000	5.9	23.2
1890–1900	Agriculture, drainage financed by long-term bonds	162,000	6.8	30.0
1900–1910	Lumbering, dipper dredge developed, Little River Drainage District formed	270,000	11.3	41.3
1910–1920	Lumbering	325,000	13.5	54.8
1920–1930	Cotton production	209,000	8.7	63.5
1930–1940	Depression, cotton production	133,000	5.5	69.0
1940–1950	World War II, agriculture subsidy, government assisted drainage, soybeans	216,000	9.0	78.0
1950–1960	Agricultural mechanization, drought, increased use of synthetic fibers, soybeans	61,000	2.5	80.5
1960–1970	Large farm equipment, expanding agricultural market, rapid population increase	237,000	9.9	90.4
1970–1975	Larger farms and fields, larger equipment, high soybean prices	132,000[a]	5.5	95.9
Total loss		2,302,000		95.9

Forest acres remaining in 1975

Total	98,000 or 4.1 percent of original 2.4 million acres
Total in blocks of 1,000 acres or more	27,000 or 1.1 percent of original 2.4 million acres

[a]Acres lost derived by deducting total forest left (as determined by aerial reconnaissance) and losses from all other periods from total lowland forest area before clearing.

From 1870 to 1880 the lumber industry grew and railroads were expanded to provide efficient transportation of logs and lumber. During this period about 115,000 acres (46,000 ha) or four percent of the lowland forest were converted to other uses (Table 1). By 1890 lumbering and associated activities resulted in the loss of an additional 142,000 acres (57,000 ha). Larger areas of forest were probably cleared during this period, but the lack of adequate drainage restricted agricultural development and stimulated second growth forests.

Although efficient equipment, accurate land surveys, and planning were lacking for effective drainage during the 1890s, about 162,000 acres (65,000 ha) of lowland forests were converted to other uses.

Between 1900 and 1910 forest lands decreased by 270,000 acres (109,000 ha) or about 11 percent (Table 1). The lumber industry was primarily responsible for the decrease because timber harvests and wood production were consistently higher for southeastern Missouri counties than for other counties within the state. From 1910 to 1920 the lumber industry continued to grow throughout southeastern Missouri and an additional 325,000 acres (131,000 ha) of lowland forest disappeared. Of greater significance than logging, successful large scale drainage by the Little River Drainage District caused land values to increase sharply as agricultural potential became obvious. These factors led to a rapid population increase and initiated a gradual transformation from a diverse swamp wilderness to the rowcrop monoculture that dominates the area today.

During the 1920s cotton became an important factor in southeastern Missouri's economy and cotton yields in this region were among the highest in the nation. As the lumber industry declined, the reliance on cotton increased to save the heavily taxed and debt ridden lands from foreclosure. For example, Stoddard County produced only 487 bales of cotton in 1870 and led all other counties in cotton production. By 1921, seven counties in the lowland area had devoted 104,228 acres (42,000 ha) to cotton production. Because the market price of cotton increased, the reliance on cotton continued and by 1924 cotton was grown on 442,933 acres (179,000 ha) in the seven counties in southeastern Missouri (Ogilvie 1967). More acres were devoted to cotton in 1925 than in any year previously, and cotton continued to dominate the economy for many years. Although the lumber industry declined between 1920 and 1930, an awareness of the region's tremendous agricultural potential resulted in the conversion of an additional 209,000 acres (84,000 ha) of forest to farmland.

In the late 1920s poor crop production, low market prices and heavy tax burdens led many large landowners to default on drainage tax payments for their "unimproved" lands that were unproductive. Such defaults often caused financial difficulties for drainage districts because the remaining members of the district could not cover these large deficits. In many cases the districts defaulted on bond payments and maintenance of ditches and levees stopped. Because drainage efficiency decreased and because limits were placed on production of cotton and other crops in the early 1930s, landowners had little incentive to expand their reclamation efforts during the Depression. Therefore, only about 133,000 acres (54,000 ha) of forests were converted to other uses between 1930 and 1940 (Table 1, Fig. 2).

Government assistance for drainage, agricultural subsidy payments, and war and post-war prosperity brought economic stability to area agriculture (Ogilvie 1967). Cotton continued as the major crop in the southeastern lowlands in the 1940s; however, soybeans were increasing in importance. In the northern portions of the southeastern Missouri lowlands the length of the frost-free growing season is marginal for cotton, and crops sometimes were damaged or lost by late-spring or early-fall frosts. The soybean had the distinct advantage of a shorter growing season and provided farmers with an opportunity to consistently produce a cash crop. The shorter growing season also made soybeans an attractive alternative on low sites where late-spring rains prevented early planting or early-fall rains prevented late harvests of cotton. This advantage became more important as farm mechanization increased. During the 1940s favorable economic conditions and general feeling of prosperity led landowners to expand farming operations, and 216,000 acres (87,000 ha) of lowland hardwoods were converted to farmland (Table 1, Fig. 2).

During the 1950s agricultural expansion was severely depressed in southeastern Missouri. Serious droughts in 1952, 53, and 54 cut farm profits sharply and little money was available for clearing land. The economic recession with attendant tight-money policies also contributed to a general reluctance to expand farm operations. However, there was a trend toward increased mechanization and greater time efficiency in planting and harvesting of crops, and a market was developing for synthetic fibers that affected cotton prices. Between 1950 and 1960 only about 61,000 acres (24,000 ha) of lowland forests were converted to agricultural production (Table 1). This was less than 3 percent of the area in lowland forests in 1870, but it represented nearly 11 percent of the area remaining in lowland forests in 1950. Swamplands were becoming a scarce commodity in Missouri.

During the 1960s agricultural expansion continued and an additional 237,000 acres (95,000 ha) or about 43 percent of the remaining forests were cleared (Table 1). Bigger equipment, bigger farms, commercial fertilizers, pesticides, and an expanding market for agricultural commodities resulted in increased profits and the desire to convert the remaining forests into productive rowcrop fields. Soybeans became the major crop. In addition to the advantages of a shorter growing season, the demand for soybeans increased dramatically because of a heavier reliance on protein-enriched feeds for livestock and poultry, a switch from animal oils to vegetable oils in cooking and processing, and rapid growth of the plastics industry. In addition, the textile industry accelerated its shift away from natural fibers. The effect of these market shifts was magnified by a burgeoning world population and an economy that encouraged exports to less productive and often overpopulated foreign countries.

The total forest area in 1975 was about 98,000 acres (40,000 ha) and few large blocks of forest remained. Our aerial reconnaissance and on-sight observation indicated that about 27,000 acres (10,900 ha) remained in tracts larger than 1,000 acres (400 ha) (Table 1). Other remnants of forest were small woodlots and along ditches, fields and natural drainages. The attrition of small holdings is a constant process that accelerates during dry periods. Fence rows and small forested areas are removed as farmers develop large fields for efficient use of large equipment. More recently, field leveling to improve drainage or to facilitate irrigation has become a common practice. These changes remove the subtle elevation differences that induce a diverse plant community.

Unfortunately, no extensive surveys were made of wildlife populations in Missouri's southeastern lowlands. Obviously forest game has been reduced to a small fraction of its previous abundance. Some forested areas between levees are less desirable for wildlife than is apparent on the basis of acres of habitat. Because water levels between levees may be unusually high for long periods during annual flooding, many animals are forced onto adjacent uplands or levees where they are vulnerable to predators and poaching.

The demise of the lowland forests of southeastern Missouri was a slow but steady process that was not adequately recognized until much of the forest was

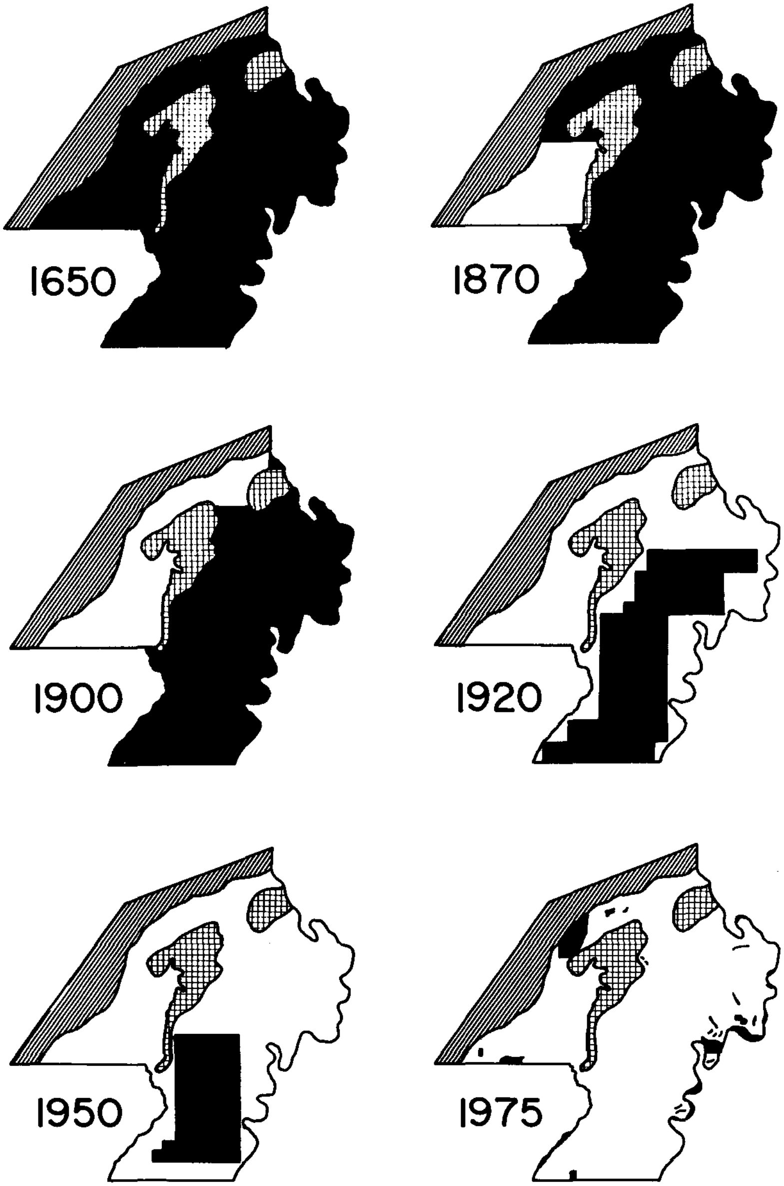

Figure 2. Loss of Missouri's lowland hardwood forest for selected intervals between 1650 and 1975 that reflect man's impact as follows: 1650—forest area when French explorers arrived; 1870—220 years of agricultural development on low ridges; 1900—30 years of intense timber harvest; 1920—legalized sale of public bonds for drainage, development of dipper dredge, formation of Little River Drainage District, and construction of Castor River diversion and internal drainage ditches; 1950—intensification of agriculture, especially cotton, and agriculture and drainage subsidies; 1975—continued intensification of agriculture, consolidation of farms and use of large equipment.

eliminated. The process continues today even though only about 4 percent of the original forest acreage remains. Only those forests in public ownership are relatively secure from exploitation. Today the best examples of the original fauna and flora of the Missouri swamp system occur on a 0.6 percent forest remnant held in public ownership. The 14,500 acres (5,900 ha) of forest on the state and federally owned lands on the Duck Creek Wildlife Area and on the Mingo National Wildlife Refuge are managed, in part, to preserve this forest system. The ever increasing use of these areas attests to the value of swamps to provide consumptive and nonconsumptive experiences for the public.

Because of modern technology, an increasing world population with its attendant demand for food and fiber, and economic pressures on farmers to maximize production, no ecosystem seems safe from total exploitation. The attrition of valuable natural ecosystems proceeds with little notice, but can result in the total loss of a system in a relatively short time. Natural systems should never be considered free of exploitation in view of the constant technological changes associated with man's activities. To maintain a few examples of our natural heritage, the importance of publicly-owned land becomes increasingly clear.

Summary

1. Missouri's southeastern swampland covered 2.4 million acres (972,000 ha) when European settlers arrived in the 1780s. By 1870 a diverse agricultural development had reduced the forest to 2.1 million acres (850,000 ha). Census of Agriculture data were used to document forest loss by 10 year intervals from 1870 to the present.
2. Swamplands were originally in federal ownership, but were ceded to the state and then to counties by 1852. Large acreages were purchased at nominal cost by railroad and lumbering interests in the 1860s to the 1880s and land clearing accelerated.
3. By the early 1900s technological advancement, legislative actions and a strong economy resulted in the construction of a successful drainage system.
4. Only 1.3 million acres (526,000 ha) remained in forest by 1920, but losses decreased during the 1920s and 1930s because of a slow economy. After World War II, forest losses accelerated as a result of agricultural subsidies, government assisted drainage, increased soybean production and agricultural mechanization.
5. By 1975 only 98,000 acres (39,700 ha) of forest remained, but much of this land was in blocks of less than 1,000 acres (400 ha). Loss of forested habitat continues as farms and fields increase in size to accomodate large farm equipment.
6. The best example of the original forest occurs as a 0.6 percent remnant (14,500 acres; 5,900 ha) held in public ownership. Today no ecosystem is safe from exploitation. Losses occur constantly and may not be recognized until only small parcels of the original system remain. Publicly owned lands provide examples of our natural heritage and assure valuable sites for consumptive and nonconsumptive experiences.

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Harry S. Truman Dam and Reservoir—A Case History of Problems in Fish and Wildlife Coordination

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Introduction

The Harry S. Truman Dam and Reservoir project (HST) in west-central Missouri resulted from plans for dams in the Osage River Basin proposed in the early 1930s as part of a system to alleviate flood conditions on the lower Missouri and Mississippi Rivers (U.S. Congress, House 1934). Studies of the Osage Basin were conducted in the 40s and 50s, and the Kaysinger Bluff Reservoir (renamed HST in 1968) was authorized by Congress in 1954 as a single-purpose flood control structure (U.S. Congress, House 1954). In 1962, the project became "multiple-purpose" with the addition of a 1,040,000 acre-foot permanent pool for recreation and hydropower purposes (U.S. Congress, House 1962). This transition from a flood control structure to a complex project with a 55,600 acre (22,120 ha) permanent pool, and a flood pool that will extend to more than 209,000 (83,600 ha) acres suddenly made this project a major threat to significant natural resources of a magnitude surpassed by few other water resource projects in the United States.

The HST project is complex in every way: in its political background, its engineering aspects, the magnitude of its biological resources, its socioeconomic conflicts, and virtually all of the other classic problems with water developments as outlined in *Water Policies for the Future,* the 1973 Report of the National Water Commission. Few projects have been as clearly documented prior to completion as the HST project, and many more need public exposure to ensure that future development decisions are not at the expense of our natural resources.

Only selected references will be cited here because the public record on the HST project contains thousands of standard references, plus letters, agency reports, and affidavits of numerous experts. Most of the documentation is filed in the United States District Court, Western District of Missouri, and in the United States Court of Appeals for the Eighth Circuit, in St. Louis, Missouri. The HST project was under litigation during 1972 and 1973 in a lawsuit brought by the Environmental Defense Fund, Missouri Chapter of The Wildlife Society, and several citizens of Missouri.

The objectives of this paper are to: (1) summarize the nature and magnitude of resources to be lost or adversely affected; (2) identify major questionable aspects of the project, including socioeconomic problems; (3) identify major problems in coordination efforts between agencies responsible for fish and wildlife resources; and (4) relate this case history to other regional and national resource development problems.

The record upon which this paper is based was provided by experts from many disciplines across the United States. Some of the wording is taken directly from documents prepared for input into the *Environmental Statement (EIS), Harry S.*

Truman Dam and Reservoir, Kansas City District, Corps of Engineers, January 1973. My involvement occurred while I was Assistant Leader, Missouri Cooperative Wildlife Research Unit.

Natural Resources Affected by the Project

Terrestrial Wildlife and Their Habitats

The area to be flooded by HST includes two ecological types, the Western Prairies (tallgrass prairie) and the Western Ozark Border (oak-hickory hills), which meet in a broad ecotone across the project area. Five basic plant communities provide a proliferation of edges between habitat types, to produce a diversity of habitats not duplicated elsewhere in Missouri

The diversity of habitat types provides an environment inhabited by approximately 145 species of nesting birds, 95 species of wintering birds, 90 additional migrant species of birds, 19 species of resident amphibians, up to 46 species of resident reptiles, and approximately 55 species of mammals, of which 12 are bats which may migrate. Species of note in the project area include the bald eagle *(Haeleatus leucocephalus)* and up to 22 bird species found on *The Blue List* of declining species prepared by the National Audubon Society. Many species common to the project area are dependent upon bottomland forest habitats, and will vanish from the region with inundation of the bottomland (U.S. Army Corps of Engineers 1973b: Appendix D: 10–15).

A new dimension was added to the controversy over biological resources at the HST project site in 1976, when the presence of a maternity colony of gray bats *(Myotis grisescens)* was confirmed well within the flood pool. This species is listed as an endangered species under the 1973 Endangered Species Act. Preliminary estimates of population density in this colony range between 18,000 and 35,000 individuals, and bat experts believe that flooding of this colony's cave would result in high mortality (LaVal 1976). As a clear indication of the widespread effects of inundation of river bottom habitats, the gray bat is also a central issue in the controversy over the Meramec Park Lake project in eastern Missouri.

Permanent flooding will remove all wildlife which inhabit bottomland and associated upland in the 55,600 acres to be permanently flooded. Periodic flooding during the growing season will negatively affect formation and maintenance of stable plant associations or communities in the 153,400 acre (81,360 ha) flood pool area, and will correspondingly reduce wildlife populations and attendant recreational values. About 48,000 acres (19,200 ha) of the flood pool area will be inundated once every four years, and additional adverse effects may occur on the remaining 105,400 acres (42,160 ha) of flood pool habitat. For planning purposes, a 50 percent loss in productive capability of the flood pool area may be used to calculate potential wildlife production and its utilization, but the effects may be more severe on certain species (U.S. Army Corps of Engineers 1973b: Appendix D: 38–39).

The magnitude of the difference in productivity between bottomland and adjacent upland is important. For example, flood plains are characterized by bird densities of 400–500 pairs per hundred acres (40 ha), versus 300–350 pairs per hundred acres for upland forests, and species composition is more diverse (Karr 1968). Flood plain species would therefore be especially depressed by flooding.

Further, even highly mobile species, such as white-tailed deer *(Odocoileus virginianus)* and wild turkey *(Meleagris gallopavo)* may depend upon bottomland habitats for critical parts of their life cycle. The loss of bottomlands may therefore substantially decrease the carrying capacity of adjacent uplands, which is a significant secondary impact of inundation (U.S. Army Corps of Engineers 1973b: Appendix D: 38–39).

In 1970, data on deer harvest indicated that almost ten times as many deer were killed on bottomlands as on uplands in the project area. Turkey populations in the "Land Between the Lakes" area in Kentucky and Tennessee dropped from approximately one turkey per 16 acres (6.4 ha) to one turkey per 200–250 acres (80–100 ha) after two dams were constructed which destroyed bottomland habitat. Related secondary effects on turkey populations occurred around Lake of the Ozarks and Table Rock Lake in Missouri, where human disturbance due to resort and recreational development resulted in low turkey populations even though the area appeared to be good habitat (U.S. Army Corps of Engineers 1973b: Appendix D: 39–46).

The Missouri Department of Conservation (MDC) owns and operates the 8,633-acre (3465 ha) Schell Osage Wildlife Area which lies largely within the flood pool. This area, with diverse habitats including open marsh, oxbows, croplands, flooded timber, upland forests and brushland is a vital public use area. More than 100,000 waterfowl wintering each year (one-third of the total state wintering population) depend on pin oak and pecan mast for food. Significant acreages of bottomland marshes and timber that flood periodically are located on private land and play a major role as waterfowl habitat in the project area. Reduction in the role of the Osage Basin as wintering habitat would be a serious loss, since wintering habitat has been drastically reduced throughout the Midwest.

Aquatic Life and Habitats

The Osage River above Lake of the Ozarks is the largest remaining stream in Missouri significantly unaltered by impoundment, channelization, or pollution. The large and diverse fish fauna supported by this stream reflect the diversity of habitats in the area, and at least 74 of the 103 species native to the Osage Basin occur in the upper Osage River (U.S. Army Corps of Engineers 1973b: Appendix D: 50–52; Pflieger 1975). Studies of other sites in Missouri indicate that the principal impact of HST on the aquatic fauna will be a marked reduction in faunal diversity among fishes, perhaps to less than half those now present.

The paddlefish *(Polyodon spathula)* is a unique element in the fish fauna of the upper Osage River where one of the few remaining stable populations of this species remains. Paddlefish were formerly abundant in most large rivers of the Mississippi Valley, but are now drastically depleted because of dams and other river modifications. Both the Lake of the Ozarks and the Osage River above the lake support substantial resident paddlefish populations, and sexually mature adults from the Lake of the Ozarks populations migrate into the Osage River during their spring spawning run and return to the Lake of the Ozarks once spawning is completed (Pflieger 1975). About 15–20,000 anglers annually snag for paddlefish in the Osage River and, in 1976, these anglers took 3,600 fish, averaging more than 30 pounds each (Missouri Department of Conservation News Release, October 1976). HST will inundate all of the known spawning areas for the paddlefish in the Osage River Basin above Lake of the Ozarks, and thus will ultimately eliminate the fishery and significantly reduce the total paddlefish population.

Large populations of the blue catfish *(Ictalurus furcatus),* walleye *(Stizostedion vitreum),* and many other common game and forage fishes will change drastically. The invertebrate fauna of the upper Osage River is poorly known, but it supports a large freshwater mussel fauna, perhaps including some species that are considered to be endangered nationally (U.S. Army Corps of Engineers 1973c: E–9). Dams elsewhere have resulted in the extirpation of freshwater mussels, and this will likely occur once the Osage River basin is further inundated.

Ancient Humans and Associated Wildlife

Areas to be flooded permanently and periodically by the HST project contain about 4,000 vital archaeological and paleontological sites. Spring bog deposits in the Pomme de Terre Valley within the project site have an excellent record of Pleistocene and post-Pleistocene environments. Few places in the world have greater potential value for documenting climatic change as reflected in the flora and fauna, including humans, since the time of the Ice Ages. Because of its location at an interface between the tallgrass prairie and the Ozark Uplift, the archaeology and paleontology of the project site are unique (U.S. Army Corps of Engineers 1973c: Appendix D: 21–24). Some of the spring bog deposits along the Pomme de Terre River in the project site have yielded Ice Age mammal bones that rival in importance those of Rancho la Brea, California, and Big Bone Lick, Kentucky. These deposits are ideally suited for study and retain a remarkably complete record of organic life in the form of fossil plant remains, pollen, and mollusks, as well as the bones of large extinct animals. The long history of human habitation (10,500 years), coupled with an even longer record of plant and animal changes (40,000 years) make this an especially valuable area for further scientific study (U.S. Army Corps of Engineers 1973b: Appendix D: 21–24).

Of particular interest are questions regarding overlaps in time between representative species of flora and fauna in relation to climatic change. Cave deposits are dominated by the remains of dire wolves and extinct bears and peccaries. The faunal record of spring deposits includes mastodons, with 27 mastodon skeletons being recovered from only one spring. These specimens, together with those from unexcavated sites, could provide paleontologists with a unique sample for population studies (U.S. Army Corps of Engineers 1973b: Appendix D: 21–24).

The relationships between past human population growth, technological efficiency, and environmental potential are essential problems in understanding human development. The prehistoric cultures that occupied the proposed reservoir area were uniquely adapted to the local environment. Roger's Shelter, a habitation site within the project boundaries which was occupied by humans for more than 10,500 years, is on the National Register of Historic Places. Excavation of this site has been accelerated with Corps funding in an attempt to avoid total loss of its scientific potential.

Until HST was under litigation, very little funding was made available for archaeological and paleontological research. Under the influence of NEPA and litigation, more funds have been supplied, especially for research at Roger's Shelter (U.S. Army Corps of Engineers 1973c: Exhibit 10). Accelerated salvage programs will be unable to fully utilize the archaeological and paleontological resources of the entire project area, since analysis is limited to current techniques and concepts.

Questionable Aspects of the Project

Flood Control

The HST project is a component in a flood control plan for St. Louis and other downstream flood plains which was part of the so-called "Pick-Sloan Plan" proposed in 1944 for the entire Missouri River basin (U.S. Congress, Senate 1944). The basic reliance upon structures such as dams and levees, which offer a false sense of security to residents below dams or behind levees, has generally induced development and occupation of flood plains. Such general policies have been identified as economically and socially disastrous by the 1973 Report of the National Water Commission and numerous other large-scale federal studies. The Black Hills flood of June 1972 (Orr 1972), Tropical Storm Agnes (New York Times 1972), and the 1973 flood on the Missouri and Mississippi River (Belt 1975) have added additional support to these conclusions.

Agricultural areas along the lower Osage and Missouri Rivers are part of the area to be protected by the HST project. Dollar benefits over 100-year projections are calculated as benefits to be accrued from flood protection, but few dollar values are similarly assessed as losses, and thus project costs, for the many potential uses of the area to be inundated, or from downstream areas that will be developed for urban uses. The major urban area, St. Louis, has developed its flood plains unwisely as, for example, "Earth City" which has recently begun to cover several thousand acres of bottomland with industrial and other urban uses. These unwise developments in the flood plain now add to project justification, continuing the circular pattern.

The "Standard Project Flood" used for hypothetical flood planning for the St. Louis area, and thus for HST, is one which will be equaled or exceeded approximately once in 5,880 years on the average (Eisel 1972). Since flood control is one of the major reasons for development of this project, congressional or agency decision makers should be well aware of this planning framework, but they are not. Other planning efforts for flood control in the United States currently use the approximate 100-year average flood frequency. A GAO report (1975) concluded that national attempts to reduce losses from floods by controlling the uses of flood-prone lands have met with only limited success, and that such efforts should be intensified to decrease flood losses. This is a desirable alternative to dams and structural protection.

Hydropower

Hydropower was authorized at the HST project by the Flood Control Act of 1962 although financial feasibility had not been demonstrated by the Corps in its authorizing study (U.S. Congress, House 1962). In 1966 the Corps approved the installation of turbines to provide a pump-back hydroelectric power unit at the HST site, even though revenues from the sale of power could not adequately recover the cost of the federal investment within the required 50-year repayment period. The whole question of the suitability of hydropower at this project site is significant because the flow regime and operation of the reservoir will be influenced by the power unit.

It is expected that the power plant will generate power for 7 hours each weekday from June through September. Power may also be generated on demand during other times of the year, or during periods of high rainfall when excess water is available. Water will be run out of Truman Reservoir to turn the turbines, and be pumped back during the night. Water will enter the Lake of the Ozarks at 6 feet (2 m) per second and begin forming a wedge of water that will elevate Lake of the Ozarks waters about 5 to 6 feet (1.7–2 m) at the dam site, about 4½ feet (1.5 m) near the town site of Warsaw 2 miles downstream, and 1 to 1½ (.3–.5 m) feet 16 miles downstream (65 km). Needless to say, the level of Truman Reservoir will also drop as the water flows out, and then the reverse situation will occur at night during pump-back.

A 1970 study of HST projected power operations by Black and Veach, Consulting Engineers, revealed that Corps data indicate drawdowns which would reduce the permanent pool area by 30 percent on a weekly basis. Adverse effects would result on the entire littoral zone of the reservoir, exposing mudflats, affecting riparian vegetation, making fishery management uncertain, and greatly reducing recreational values. This flow regime may increase lake turbidity, and downstream fluctuations would have similar negative consequences for the Lake of the Ozarks and riverside habitats below the dam.

A General Accounting Office study dated January 24, 1973, of cost estimating procedures used by the Corps concluded on page 21 that "the Corps presented misleading data to Congress on estimated power costs and revenues for the Truman Reservoir and did not update and furnish full information of the recoverability of the power costs." The Southwestern Power Administration of the Department of the Interior generally concurred with GAO's findings, and suggested a review of the decision to go ahead with the power facilities at the HST site.

It is apparent that even though the hydropower unit will produce some of the most severe environmental hazards associated with the operation of the project and that costs may exceed benefits from power production, Congress was never presented with full information on which to base decisions which may have affected the viability of the entire project.

Recreational Markets and Transfer Use

The HST project will destroy 248 miles (397 km) of free-flowing water of the Osage River and its tributaries, and will adversely affect an additional 30 miles (48 km) of the river channel downstream. Additional adverse effects from the highly uncertain water flow may affect recreational values on Lake of the Ozarks. Recreational and aesthetic values for the existing riverine area are not adequately accounted for in balancing costs and benefits for this project, even though economic returns from recreation at the reservoir are projected over a 100-year period (U.S. Army Corps of Engineers 1973b: VIII–38). These one-sided projections provide one-quarter of the economic justification for the entire project (U.S. Army Corps of Engineers 1973c: 24).

Estimates by the Corps of Engineers for expected recreational usage of Truman Reservoir exemplify a serious problem with reservoir development throughout the country. Potential recreational use of a reservoir is difficult to estimate, and may be affected by such things as the character of the reservoir, the type of fishery it produces, and the proximity of other recreational attractions. Most serious in this case is the matter of "transfer use" from or to other existing reservoirs in the area, which means essentially that a substantial segment of the "demand" used as a basis for recreational projections would simply involve a transfer of use from one lake to another, such as from Lake of the Ozarks to Truman Reservoir.

Corps experience with 9 reservoirs near Tulsa and Oklahoma City, Oklahoma, and 10 reservoirs near Dallas and Fort Worth, Texas, led to the selection of a visitor days per person factor of 8.0 which was used to calculate projected visitations for the HST project, and many others in Kansas and Missouri. Details on Corps recreational projections are in an affidavit by Amos C. Griesel, dated May 24, 1972 and in the files of the United States District Court, Kansas City, Missouri. The diversity of recreation potentials available in Missouri does not occur near these large cities in either Oklahoma or Texas. Further, public land is so scarce in Texas that any kind of publicly available recreational resource will draw people out of proportion with the normal drawing power in areas of greater diversity. These examples are not representative of Missouri recreation potentials.

With Texas- and Oklahoma-based visitation rates, the population of the Kansas City metropolitan area (about 2 million) is used as a major basis for projecting approximately 4 million visitor use days annually during the first years of the HST project, and up to 7 million per year later (U.S. Army Corps of Engineers 1973b: III–41). Lake of the Ozarks is assumed to receive approximately 4.5 million visitations annually and, within a 100-mile radius of Kansas City there are completed, under construction, or fully authorized 32 reservoirs which include recreation as a large measure of their justification. The population of the Kansas City metropolitan area is a major basis for recreation usage projections for all of these. If all of these reservoirs are built, they will provide more than 293,500 acres (117,400 ha) of water within 100 miles (160 km) of Kansas City. More than 120,000 acres (48,000 ha) are currently available for recreation within 100 miles of Kansas City, and about 187,000 acres (74,800 ha) will be available within a few years.

For 23 of the above mentioned 32 reservoirs, Corps data for expected annual visitation is in the neighborhood of 28 million visitor use days annually. Using the current population of the Kansas City metropolitan area, even if half of the estimated visitations were from outside the area *every* Kansas City resident would have to visit a reservoir about seven times a year. Substantial numbers of Kansas City people visit Oklahoma and south Missouri lakes each year, and like to do many things other than going to reservoirs. The Kansas City population is currently being used beyond any reasonable limits as the major factor in justifying reservoirs. The key to the problem is the re-use of this metropolitan area in an incremental fashion for each reservoir proposed, without attention to transfer use, as if only the single reservoir in question were to be available to water-hungry recreationists who have an insatiable demand for more flat water. These figures *do not include* Truman Reservoir, which would add 55,600 acres (22,240 ha) of water and is being estimated initially at 4 million visitor days use annually.

Effects on Local People and Their Economy

Many of the more than 500 farm families to be displaced by the HST project have family histories in the Osage Basin which go back more than 150 years. These people inhabit a pleasing and diverse landscape of cropland, pasture, woodland, overflow bottoms, and rivers and creeks. Their uses of the land are fairly stable, and it is unlikely that there would have been any acceleration in development for agriculture because of limitations in soil quality.

Corps data show that an estimated 2,341 families, representing almost 8,300 people, will be displaced by the project (U.S. Army Corps of Engineers 1973b: XIII–58). This is more people than 13 Missouri counties have within their boundaries. The first 685 families forced to leave their homes in the early stages of the project before 1971 were paid an average of $390 in resettlement assistance (Corps' letter from Paul Barber, June 26, 1972). While this assistance has gone up in the later years of the project, no real provision has been made to attempt to accommodate the terrific shock to individuals, families, and communities in the project area. Previous experiences in the development of TVA lakes, and in the movement of native Americans from the river bottoms along the upper Missouri River indicate severe effects on people and social institutions in the area. No hard information is available on the fate of these people, but with the scarcity of land and lack of any significant assistance in relocation a tragic outcome is predictable.

Studies of the local economic effects of three lakes developed near the HST project in Missouri revealed that many of the benefits predicted by developers have not materialized (Campbell 1972). Short-term increases in local income and employment occurred in relation to construction of the projects, but the real effect on family incomes and occupations, and industry was not great. Related studies of reservoir effects in Illinois concluded that projected economic benefits may be largely imaginary (Ballard 1974). Real effects of large water projects on local people need to be examined closely.

Long- Versus Short-term Potentials

Project completion essentially removes all other future alternative uses of the area. Recreational values, flood control, hydropower, and all the economic aspects of the project are based on highly risky estimates of future "needs" which are subject to extreme variation. If benefits are to be calculated over 100 years of potential project life, so, too, should costs be calculated from loss of productivity of the land and its biota for that same 100 years. Socioeconomic studies are beginning to show that many promises of large Federal developments are never realized.

One resource in the Osage River Basin exemplifies development without clear appraisal of future potentials. With the first reservoir, the Missouri part of the Osage Basin lost 130 miles (208 km) of floatable stream. The second took 46 (73 km), the third 65 (104 km), and HST will take 150 (240 km) more. The Missouri part of the Osage Basin will now have one-third its original amount of floatable stream.

The Osage Basin covers slightly more than 15,000 square miles (39,000 km^2), mainly in Missouri, but partly in Kansas. The HST project will be the sixth large project in the basin, with four others authorized. In a 1970 study of the "conservation needs'' of the Osage Basin, the Soil Conservation Service identified 161 possible small reservoir sites on various parts of the basin. In the early 1970s, the Corps conducted studies and held public hearings on 12 additional reservoirs in the upper part of the Osage Basin. Fortunately, most of these will not be seriously considered.

This incremental nature of water developments is a serious problem in balancing long-term versus short-term use potentials. Whereas, a single reservoir in the Osage Basin might be justified on the basis of flood control, recreation, and production of hydroelectric power, the HST project is part of a developmental overkill which continues to foreclose future options.

Efforts Toward Fish and Wildlife Coordination

Agency Participation in HST Planning

The HST project was originally planned under a land acquisition policy of minimum fee-title purchase, with emphasis on flowage easement (U.S. Congress, House 1954). Residents of the basin and responsible state agencies involved in project studies approved the project plans expecting a single-purpose flood control structure, minimum permanent pool size, little or no acquisition of privately owned land, and substantial mitigation for wildlife and recreation values in the form of land for management and a large waterfowl refuge. When the project was redesigned in 1962, it included the 55,600 acre (22,240 ha) permanent pool, but Corps policies had switched to include fee-title acquisition at project sites, and the proposed federal waterfowl refuge was deleted from requests for project authorization (U.S. Congress, House 1962). At this point this project became very controversial.

In correspondence files of the Missouri Department of Conservation, Conservation Federation of Missouri, U.S. Fish and Wildlife Service (FWS), and other agencies there are written records which reflect the consistent lack of coordination as required by law under the Fish and Wildlife Coordination Act (16 U.S. Code 661–667e).[1]

The failure to afford equal consideration to fish and wildlife resources was not the fault of any single agency. Political activity not in the public record contributed to coordination problems which influenced key decisions about development of the HST project. I have interpreted only those highlights of project history which are available in the public record, and which bear directly on requirements of the Coordination Act.

As early as March 1960, representatives of the Missouri Department of Conservation (MDC) wrote the Corps of Engineers to ask if rumors about a proposed dramatic increase in the size of the project were true, and expressed concern about the effects of the project on the Schell-Osage Wildlife Area. By November 6, 1961, MDC still had not received complete information from the Corps, and again expressed its concern in writing. By late-November, 1961 the Conservation Department had concluded ''it is very possible the (Schell-Osage) Area may be totally destroyed with regard to operating it for the purposes intended.'' On De-

[1]Copies of much of this correspondence are also available in the files of the United States District Court, Western District of Missouri, Kansas City, Missouri, as a part of the court record in the HST litigation.

cember 26, 1961, the FWS[2] expressed concern to the Corps for the impact upon the "unique paddlefish fishery," and indicated that spawning areas used by the paddlefish would be destroyed. The FWS also expressed concern over the general impact of the project, including the Schell-Osage Area.

On June 13, 1962, the Office of the Secretary of the Interior wrote to the Corps of Engineers and expressed regret that action by the Corps in requesting Congress to reauthorize the project with significant changes was done without allowing a reasonable time for FWS to complete its study of the effects of the new project, in order that FWS's detailed report, including a justification of the proposed waterfowl refuge, could have accompanied the final report that went to Congress. Such coordination is specifically required by Section 662(b) of the Coordination Act, but was not done in this case.

The proposed waterfowl refuge had been considered an essential component in nationwide plans for providing a secure network of wintering areas. All negotiations regarding the changing plans for reservoir development in the Osage Basin had included specific recommendatons to include such a refuge in any water development in the basin. In a public statement at Warsaw, Missouri in 1963, the Missouri Conservation Commission stated that agreements between their agency, the Corps of Engineers, and the Fish and Wildlife Service regarding the project had included 120,000 acres (48,000 ha) of land for wildlife and recreation, and a 40,000 acre (16,000 ha) waterfowl refuge. Reports from Corps' field staff had recommended inclusion of the refuge, but the Chief of Engineers deleted the refuge request from the reauthorization proposal, and suggested that Congress should separately consider the refuge questions (U.S. Congress, House 1962: viii). The Office of Management and Budget concurred, and the refuge proposal for HST became hopelessly entangled in arguments over whether FWS should first develop a nationwide plan for its refuge system, whether the Corps had the original authority to request that the refuge be added to the project plans, and the new problems developing around land acquisition by fee-title rather than easement (U.S. Congress, House 1962: viii). This complicated failure of established coordination mechanisms precluded effective "equal consideration" as required by the Fish and Wildlife Coordination Act.

Again, on November 30, 1964, FWS complained in writing to the Corps that evaluations of the project had been hampered by a lack of data from the Corps, and by insufficient time in which to comment on project proposals. This report cited the Fish and Wildlife Coordination Act, and furnished detailed comments on problems of water quality releases from the reservoir, impact on the Schell-Osage Wildlife Area, effect on the paddlefish, and on other wildlife and recreational aspects of the project.

In 1969, the Bureau of the Budget requested a review of recreation benefit calculations for a number of Corps' projects, including HST. There was considerable confusion between state and federal agencies regarding responsibility for this restudy, and MDC had to ask to be included. In this restudy, the previous misuse of figures by the Corps as far back as the authorizing document (U.S. Congress, House 1962) was realized by all agencies involved. The study revealed that in 1966, when a Corps restudy of the project resulted in the recommendation to include pump-back power as a part of the project, the Corps did its own analysis of

[2]Then known as the Bureau of Sport Fisheries and Wildlife.

fish and wildlife and recreation costs and benefits, without incorporating the information available in the 1964 FWS report. Again, a significant change in the project which markedly affects all of the fish and wildlife resources was done without affording the responsible agencies the appropriate amount of information and the time frame in which to make detailed comments, as are prescribed by law under the Coordination Act.

In a joint report on the restudy by the Bureau of Outdoor Recreation (BOR) and FWS, dated July 8, 1970, the two agencies reviewed the past history of coordination on recreation evaluations, concluding that for at least two critical major reports to Congress requesting significant changes in the project, existing information in reports by FWS to the Corps were omitted in favor of separate evaluations done by the Corps. Further, this 1970 report concludes that the Corps overstated the overall recreational benefits of the project by approximately two-thirds. The BOR and FWS are the federal agencies with primary responsibility to evaluate recreational and fish and wildlife data. Normally, they are consulted by the Corps and the Congress for evaluation of these aspects of Corps projects. The Corps has disagreed with this restudy, even under duress of litigation and exposure of highly questionable methods of estimating recreational values.

Another example of continuing lack of effective coordination is the potential fate of the paddlefish. In 1961, FWS and MDC expressed their acute concern about the fate of the paddlefish, and recommended that a small hydroelectric dam at Osceola, Missouri, be removed to allow access by paddlefish to the upper Osage River. Upper river stretches may be the only chance for new spawning areas, although even these possibilities are not promising (Russell et al. 1976). The MDC has repeatedly asked for a 2-year period without the Osceola Dam in which to evaluate the potential for spawning. Part of Osceola Dam was removed in mid-February, 1977, probably not in time for study of even one complete reproductive cycle before closure of the HST dam. Low water this spring could prevent access by fish to the upper river, and preclude any evaluation of the potential for continued natural reproduction.

Possibilities for Meaningful Mitigation

The original Kaysinger Bluff project was accepted by state and federal conservation agencies partly because of promises of significant mitigation. The current mitigation plan provides a total of 30,800 acres (12,320 ha) in 13 areas for fish and wildlife management, and is not based on any known acceptable method for determining the need for mitigation lands. Further, 10 percent of the mitigation acreage would be water, 31 percent would be inundated every 5 years, and another 31 percent would be of low quality compared with the bottomland being lost to the project (U.S. Army Corps of Engineers 1973b: Appendix G). Current plans for mitigation ignore past promises and lengthy interactions of responsible agencies over several decades. They do not reflect the "equal consideration" clause in the Fish and Wildlife Coordination Act.

Under the influence of NEPA and litigation in the early 1970s, the Corps provided the first significant funding for research to try to alleviate the project's effects on paddlefish. Current research through the Missouri Department of Conservation has shown some potential for an artificial propagation program for the paddlefish, but little promise for development of new spawning habitat (Russell et al. 1976). No further funding has been made available to develop reliable propagation methods, so the potential for mitigating the loss of the paddlefish fishery is highly uncertain.

There has been controversy since 1960 over the potential loss in productivity in bottomland hardwoods at the Schell-Osage Wildlife Area. Corps data show that frequency of flooding on the area will not change markedly. Of critical importance, however, is timing and duration of flooding—especially during the growing season. Recent studies by the Corps (1973) and MDC (Dellinger et al. in press) have shown that tree species vary considerably in their ability to withstand flooding. Pin oak are highly vulnerable, and pecan only slightly less so, and both are important mast producers.

Of great practical concern is the Corps' continuing inability to guarantee anything about flow regimes at midwestern reservoirs. Rathbun and Redrock in Iowa, and Carlysle and Shelbyville in Illinois have flooded for higher and longer periods than expected, causing significant tree mortality above, and flooding below the dam sites. If this is any indication, the fate of Schell-Osage is likely to be difficult to predict and realistic mitigation will be impossible.

Correspondence during the period 1962–67 between the various state and federal agencies and private citizens concerned with the HST project revealed that accelerated land development for agriculture, the development of hunting clubs, and a general increase in land prices had made the potential acquisition of a waterfowl refuge highly unlikely for reasons of economy and public relations. Again, the original deletion of the refuge from the project authorization, and the ensuing controversy over who had the responsibility to even request authorization for it, precluded effective protection of wildlife resources. The dim prospects for the Schell-Osage Wildlife Area compound the impact.

Even under duress of litigation, with repeated careful inputs from agency experts and other citizens, all the years of planning have had little effect on the project, or on prospects for significant mitigation. In a 1973 letter responding to the Final EIS, MDC acknowledged the so-far unsuccessful attempts to solve the paddlefish and Schell-Osage problems, but concluded that the EIS presents a "lack of commitment to proceed with the evaluation and implementation of procedures and measures necessary to adequately mitigate other fish and wildlife losses." Likewise, the FWS review of the 1973 Final EIS concluded that lengthy, extensive efforts at coordination between conservation agencies and the Corps of Engineers to reduce adverse environmental effects of the project have been "essentially a fruitless exercise."

It clearly appears that agency interactions regarding the HST project under the Fish and Wildlife Coordination Act have been unsuccessful in providing equal consideration of fish and wildlife values. After 17 years of attempts at coordination and detailed NEPA review, no modifications have been made in plans for project implementation in order to alleviate potential impacts on fish and wildlife resources.

Relationship to Regional and National Developments

The extent of the problem with water resource development pressures on fish and wildlife habitats bears repeating here, even though it is well documented elsewhere. Extensive Congressional hearings on channelization and other stream alteration practices, evaluations of principles and standards for water resource development done by the Water Resource Council, the June 1973 Report of the National Water Commission, the proliferation of environmental impact statements, and litigation by public interest groups and private citizens against government agencies have all focused public and agency attention on a variety of water resources problems. These problems continue in spite of all of this public exposure. At the 1974 North American Wildlife and Natural Resources Conference, General Morris of the Corps of Engineers stated that more than 5,000 projects costing more than $19 billion were currently authorized for construction. Almost 9,000 small watersheds in this country have been designated by the SCS as needing PL-566 project developments. A recent report by the General Accounting Office disclosed that fish and wildlife resources have not received equal consideration in water project developments as is required under the Fish and Wildlife Coordination Act of 1958.

The significance of the resources to be lost to the HST project relates to much more than the single project. Adjacent areas in Kansas, Oklahoma, Arkansas, and Missouri include some of the most heavily developed areas of artificial reservoirs in the country. The Missouri River itself has been channelized, riprapped, and diked for more than 750 miles (1,200 km) of its length. Mainstem reservoirs up the Missouri have buried hundreds of thousands of acres of productive wildlife habitats and destroyed natural streams, with the result that flood plains continue to be developed and the American taxpayer continues to pay for any flood disasters associated with this development.

The certain loss of the tremendous resources to the HST project is only one increment in a much larger resource picture. The history of HST reinforces many current concerns about water resource development, and can serve as an example of what should be avoided in the future. When projects proposed decades before are finally constructed, they rarely meet current needs. Promises, compromises, and uncertainties at the time decisions are made about these projects haunt the people and resources of the project area when construction finally proceeds. Incremental consideration of single projects ignores adverse effects on natural resources over a wide area.

The Fish and Wildlife Coordination Act as amended in 1958 was an attempt to provide legislative guarantees for "equal consideration and coordination of wildlife conservation with other water resources development programs" (16 U.S. Code 661–667e). An important part of the Act, Sec. 662(b), provides that conservation agencies with responsibility for fish and wildlife resources must be consulted regarding any project development or major change in authorization, and that reports and recommendations from these agencies must be fully considered, and included where appropriate, in the request for project authorization and development. The example of the Harry S. Truman Dam and Reservoir project reveals ways in which this firmly stated protection has been unable to ensure that fish and wildlife resources receive equal consideration. While development agencies bear the brunt of criticism in such detailed analyses of individual projects, the fault is not theirs alone. The "system" established under the Fish and Wildlife Coordination Act is subject to political and other influences, and in this case the efforts of all responsible agencies have been deficient at certain times. Placing blame for the shortcomings of the HST case is fruitless. The real lesson of this example is that the effectiveness of coordination must be strengthened through changes in the Coordination Act, and improved methodologies and functioning of all responsible agencies.

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Contribution of Remote Sensing to Habitat Evaluation and Management in a Highly Altered Ecosystem

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Introduction

The Great Dismal Swamp National Wildlife Refuge, established in 1973, presently encompasses 53,000 acres (21,450 ha) of forested wetland within the Great Dismal Swamp of southeastern Virginia and northeastern North Carolina. Approximately 123,000 acres (49,800 ha) of the total 210,000 acres (84,890 ha) of swamp have been recommended for public ownership; the remaining acreage has been separated from the main body of the swamp and has been extensively ditched in preparation for agriculture. The U.S. Fish and Wildlife Service (FWS) has the responsibility for evaluating and developing management priorities for the primary 123,000 acre (49,800 ha) unit. The refuge cooperates with other federal, state and city agencies and provides educational opportunities for the general public.

The Great Dismal Swamp has been dated at 9,000 years B.P. (before present) by palynological and radiocarbon methods. According to Whitehead (1972), the transition from a boreal forest assemblage of spruce-pine, associated with mineral sediments, to the cypress-gum dominated hydric forests associated with forest peat and the present climate took place during a period of only 4,500 years. The swamp forest associations probably have remained stable for the 3,500-year period before colonial times.

Today, the soils of the Great Dismal Swamp are composed of organic deposits varying from a few inches to 12 feet (3.7 m) in depth in the interior* and by poorly drained and very poorly drained mineral soils at the periphery of the swamp (Whitehead 1972). These soils are confined within the following recognizable geologic features: the Suffolk escarpment on the west, the Deep Creek swale on the east, the poorly defined Churchland flat on the north and the Lower Pasquotank River drainage basin on the south. (Oaks and Coch 1973; Whitehead 1972). The gradient within the swamp is slightly less than one foot per mile from west to east. The major surface water inflow is from the west; the surface outflows are to the north, east, and south. Lake Drummond, approximately 2.5 miles (4 km) in diameter and almost centrally located within the swamp, supplies water for the operation of the Dismal Swamp Canal.

The purpose of this paper is 1) to explain why the Great Dismal Swamp is considered a highly altered ecosystem; 2) to illustrate how the formulation of

*E. Reber 1976: personal communication.

management policy is complicated by the habitat diversity resulting from physical alterations; and 3) to demonstrate how remote sensing has aided in both habitat evaluation and management of the swamp ecosystem.

Diversity

Although generally described as a forested wetland, the Great Dismal Swamp contains a remarkable diversity of vegetative communities. Because the swamp lies near the northern or southern limit of many plant species (Meanley 1973; Carter et al. 1977), the vegetative composition includes a variety of both deciduous and broad-leaved and needle-leaved evergreen trees, and evergreen and deciduous shrubs, vines and herbaceous plants. This diversity has been modified by the man-induced effects of fire, timbering, ditching, road building and changes in water availability. Consequently, plant dominants are "pioneers" rather than historic swamp forest species. The long-term impact of these imposed changes upon the vegetative composition has not yet been determined.

Water

The single most important environmental factor in the swamp is the water regime. The Dismal Swamp Canal, excavated in 1802, probably had a major impact upon this water regime and the resultant vegetative composition. This north-south canal with associated locks was dug nearly perpendicular to the west-east slope of the swamp (Shaler 1890). The spoil was placed on the west bank of the canal restricting the outflow of surface water from the swamp. Shaler (1890) and Kearney (1901) speculated that water level west of the canal thus was raised as much as 6 feet (1.8 m) above pre-canal levels for almost 100 years. If true, hydric plant species should have been favored over mesic species and well established when the canal was redug and water levels lowered around 1900. Since 1900 the construction of nearly 100 miles (161 km) of additional ditches and associated spoil bank roads has further altered the internal drainage patterns; the roads impede the movement of surface water and the unregulated ditches accelerate the removal of water. The lowering of the Dismal Swamp Canal and the construction of these ditches may be contributing to a general "drying" trend that favors the more mesic species (Meanley 1973; U.S. Fish and Wildlife Service 1974; Kearney 1901). Hydric communities are isolated in areas where water is either impounded by roads or the ditches have not extended their influence.

Timbering

The extensive timbering over the past 200 years has also resulted in the modification of successional trends with resultant changes in the composition of the present vegetation. Selective cutting of gum and cypress have allowed typical understory species such as red maple *(Acer rubrum)* and sweetgum *(Liquidambar styraciflua)* to become canopy dominants. Clear-cutting of dense Atlantic white cedar *(Chaemecyparis thyoides)* stands has resulted in only limited cedar regeneration. Many clear-cut areas are covered by an impenetrable thicket of broad-leaved evergreen shrubs and saplings, young pine, cedar and deciduous saplings intermixed with vines including the evergreen briar, *Smilax laurifolia*.

Fire

Fires have had an important role in shaping the vegetation of the Great Dismal Swamp. Most swamp fires result in the removal of the highly combustible organic soils in amounts ranging from a few inches to 6 feet (1.8 m). Deep fires create depressions or topographic lows which fill with water during the normal high-water periods. This results in conditions favorable to reforestation by hydric species. Shallow fires permit germination of Atlantic white cedar seeds in large numbers (Korstian 1924) and remove hardwood competition from mature pine and cypress stands. Prior to 1900, fires in the Great Dismal Swamp were uncontrolled and probably occurred mostly during periods of drought. From 1900 to about 1945, railroad and timbering activities increased the frequency of fires which continued to burn for extended periods. Since the mid-1940s, fire prevention and suppression techniques have reduced both the number and magnitude of fires within the swamp.

The impact of reduced numbers and size of fires within the swamp has not yet been fully assessed. In regenerating communities in dryer areas, heavy understory growth has increased the amount of above-ground combustible material. In wet communities, peat continues to accumulate, which should raise the soil elevation and eventually reduce the level of saturation. Cane *(Arundinaria gigantea),* Atlantic white cedar, and possibly evergreen shrub—pond pine *(Pinus serotina)* communities are perpetuated by fire (Buell and Cain 1943; Woodwell 1956), and may gradually disappear if fire suppression is continued. On the other hand, uncontrolled fires would probably destroy vast acreages and result in deep burns. Controlled burns would require intensive (and expensive) site preparation which may itself alter the environment.

Maintenance of wildlife populations depends upon an understanding of the vegetative communities; i.e. their origins, successional trends, interrelationships, and response to outside pressures and manipulation. The task of unraveling the natural versus the imposed mechanisms governing the present water availability and vegetative succession is monumental. Most of the present transient vegetative communities were established prior to any data collection. Assuming that the recent physical alterations within the swamp will limit plant succession, a "status quo" management policy is an active management decision. Immediate management decisions must be based upon fragments of information pieced together from present observations and scientific literature.

Remote Sensing

The traditional methods of ground sampling have proven too time consuming and costly to identify and describe the present vegetation and hydrologic regime. Initially, a broad overview of the entire swamp is needed in addition to detailed analysis of isolated plots or transects. As a result, we have used remote sensing technology for the required overview, to aid in directing our intensive field studies, to map the vegetation of the swamp, and to illustrate specific successional trends.

Satellite data

Landsat imagery provides an enlightening overview of the Great Dismal Swamp. On a snow-covered image from February 1973, (Fig. 1), we can clearly see: (A) the Suffolk escarpment on the west; (B) the man-made boundary of the Dismal Swamp Canal on the east; (C) the historic outflow drainage pattern of the Northwest River to the east; (D) the present drainage systems of Shingle Creek to the northwest; (E) the Elizabeth River on the northeast; and (F) the Pasquotank River to the southeast. In addition, we are struck by the tenacity of this ecosystem located in the midst of nearly 3 million people.

When we began to use these data in 1973, specific objectives for field reconnaissance were developed: (1) to sample in broad areas where differences existed; (2) to determine if these differences could be used to delineate boundaries between discrete plant communities; and (3) to relate these communities to degree of inundation. Species composition and density were recorded from sample plots within accessible areas. Dark areas where the snow had melted (for example, the longitudinal band just east of the Suffolk escarpment) supported hydric deciduous communities over standing water. Light areas where some snow remained (for example, around Lake Drummond) supported a greater population density of yellow poplar *(Liriodendron tulipifera)* and sweetgum, or consisted of dense evergreen shrub communities. The recent Atlantic white cedar clear-cut southwest of Lake Drummond was covered with snow, a strong indication that this species is growing in an environment where the ground surface was not inundated.

Photography

The need for more detailed information from an aerial perspective led us to investigate the use of high- and low-altitude color infrared (IR) photographs flown by the National Aeronautics and Space Administration (NASA). (Detailed information on date of coverage, altitude, film, lens and filters is on file at the Great Dismal Swamp National Wildlife Refuge office in Suffolk, Virginia.) On high-altitude winter photographs, peripheral land use or land cover can be identified, dendritic drainage patterns can be seen extending from the upland into the swamp, and the wet and dry areas can be subdivided on the basis of vegetation. Using these winter photographs supplemented by low-altitude color IR photographs, we can map evergreen versus deciduous canopy and understory. The color IR photographs have been used to identify numerous communities; cypress-gum; pure stands of Atlantic white cedar; groves of maple, sweetgum and yellow poplar; the evergreen shrub-pond pine community; small stands of old loblolly pine *(Pinus taeda)* (potential habitat for the endangered red-cockaded woodpecker); revegetating clear-cut areas and burns; roadside communities; open marsh; and mesic "islands" with characteristic upland vegetation.

Both the high- and low-altitude color IR photographs were used to prepare a 1:100,000-scale vegetative cover map of the Great Dismal Swamp (Carter and Gammon 1976). This map shows 10 canopy classes and 3 associated understory classes at a minimum mapping unit of approximately 22 acres (9 ha). These classes used in combination have given us over 40 separate canopy designations and 240 specific habitat delineations. Using similar techniques, two of six detailed 1:24,000-scale vegetative cover maps have been completed at a minimum mapping

Figure 1. Landsat image of the Great Dismal Swamp, February 13, 1973 (Image no. 1205-15150-5). A–Suffolk escarpment, B–Dismal Swamp Canal, C–Northwest River, D–Shingle Creek, E–Elizabeth River, and F–Pasquotank River.

unit of approximately 2.5 acres (1 ha). One of the most difficult tasks involved in this mapping was to determine whether evergreen species were in the canopy or understory, especially where timbering has resulted in a mixture of deciduous and broad-leaved evergreen shrubs, saplings, and vines. The methodology for preparing the maps is presently being documented.*

Timber records and state fire reports, in combination with early black-and-white (B/W) aerial photographs, were used to prepare maps showing the approximate dates and extent of timbering and fires. These maps for 1937–38, 1952, and 1971 were prepared at 1:100,000- and 1:24,000-scales to overlay the vegetative cover maps.

Mapping Applications

Map products can supply management information; management decisions are made through the creative, interdisciplinary application of this information. As an example, the 1:100,000-scale vegetative cover map shows red maple as the single dominant canopy species. We have made the basic assumption that maple is a transient dominant, released from the understory as a result of disturbance, and that this species has an extremely broad moisture tolerance. The first subdominant canopy species associated with maple gives an indication of the potential direction of succession either toward a hydric or a mesic community. Figure 2 illustrates selected canopy classes grouped according to their tolerance for water. Maple-dominated classes are separated into mesic or hydric categories according to the first canopy subdominant. Monotypic maple stands or maple-dominated classes which include subdominants without a clear water tolerance were not considered in this analysis. The map shows five major groups: (1) hydric dominants consisting of cypress *(Taxodium distichum)* and gum *(Nyssa sylvatica, Nyssa aquatica),* (2) mesic dominants consisting of pine, and the mixed hardwoods, yellow poplar, sweetgum, beech (*Fagus grandifolia*) and oak (*Quercus* spp.), (3) maple associated with hydric subdominants, (4) maple associated with mesic subdominants, and (5) a large group composed of unclassified maple, evergreen and grass communities.

This map suggests specific management possibilities and areas for concentrated study. To implement a decision to encourage the cypress-gum communities, maple areas with hydric subdominants would be investigated, concentrating on availability of water, and methods would be developed to manipulate the water regime in these areas. If, however, pine reforestation or an increase in beech and oak for mast production is desired, those areas in which maple is associated with mesic subdominants would be investigated.

The two species of pine found in the Great Dismal Swamp differ in water tolerance. Unfortunately, they could not be separated using either Landsat data or photographs. The pine hybrids are even difficult to distinguish in the field. All pine has been placed in the mesic class because loblolly pine is more widespread and generally considered mesic whereas the pond pine is most frequently associated with the evergreen shrub class which is not being considered in this analysis.

Preliminary analysis of the historical maps shows several patterns of regeneration following disruptive events. Two examples illustrate this point. Limited re-

*P. T. Gammon 1976: personal communication.

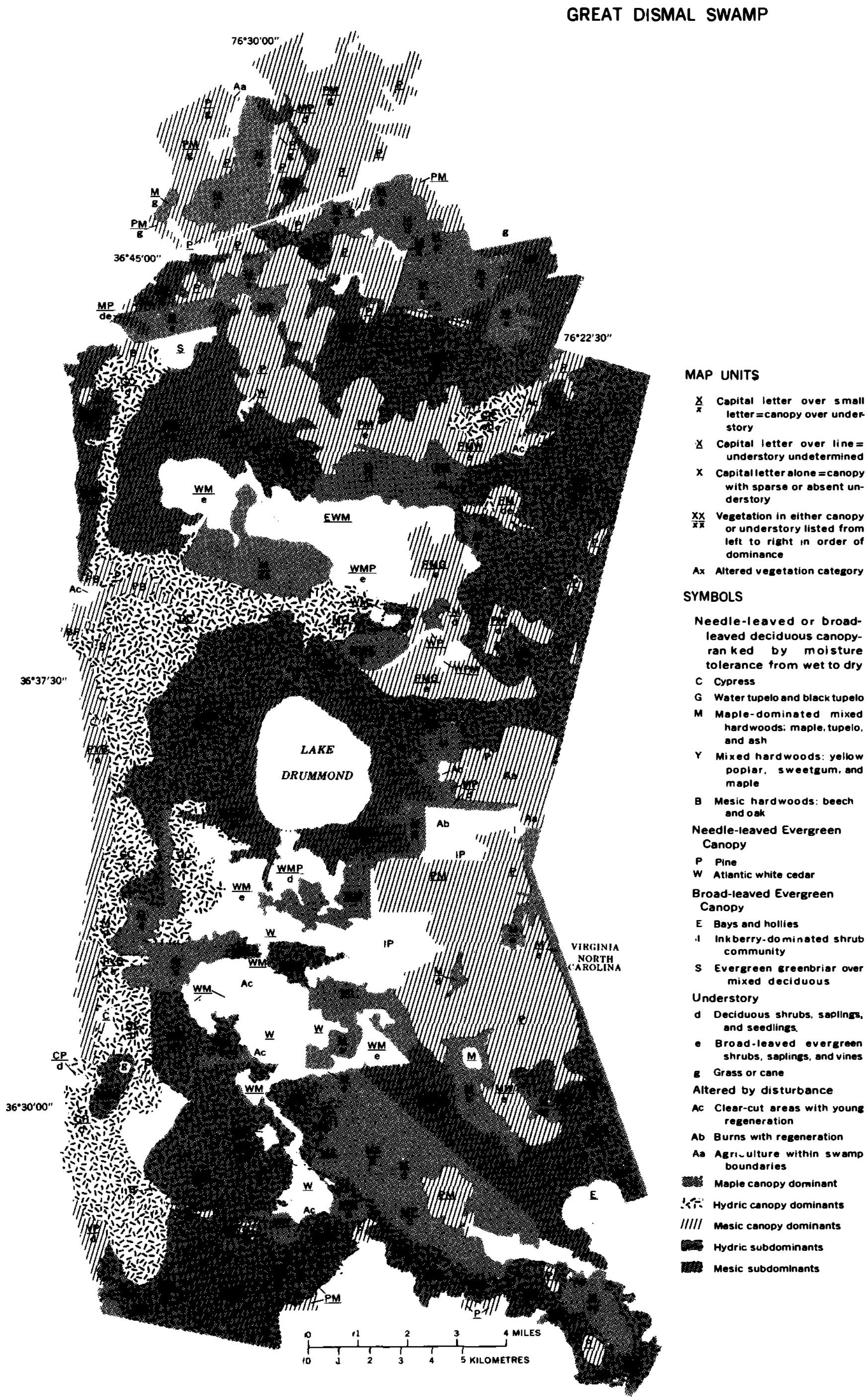

Figure 2. Vegetative cover map illustrating maple, hydric and mesic classes.

generation of Atlantic white cedar along the skid trails in clear-cut areas suggests an important management alternative. Although fire is the historical precursor for the pure even-aged stands, mechanical scarification may serve the same function.

The last remnant marsh in the Great Dismal Swamp, referred to as "Washington's rice field," has almost disappeared following the extension of Cross Canal through the north end of the marsh in the early 1950s. The 1953 map shows approximately 780 acres (320 ha) of open marsh; today (1977) only 60 acres (24 ha) are shown on the vegetative cover map. Reduced surface flooding probably permitted germination and survival of hydric tree species.

Remote sensing data and map products also are being used to increase the effectiveness of research programs in the swamp. Mammalogists, ornithologists, herpetologists and acarologists currently are using the color IR photographs supplemented by the interpreted map products to select diverse habitat types in which to study species composition and population densities. Results of these studies will aid in setting priorities and allowing choices to be made on maintenance of habitat for target species. Similarly, botanists are able to refine the vegetation maps through field observations in addition to locating sites where rare or endangered species such as the log fern *(Dryopterus celsa),* the dwarf trillium *(Trillium pusillum),* and the silky camellia *(Stewartia malachodendron)* may occur.

Because swamp vegetation is an indicator of the controlling hydrologic regime, we are attempting to correlate the vegetation maps with information being gathered on surface and subsurface water levels. A network of ground-water observation wells presently is being installed; their locations are being guided in part by the mapped vegetation communities and areas of standing water as observed in the high-altitude photographs and Landsat images. A preliminary hydrologic study (Lichtler and Walker 1974) suggested that the shallow aquifer lying beneath the swamp was partly responsible for the formation of the organic soils and may also be contributing to the present water regime. The ground-water observation well network was designed to: (1) investigate the relationship of the underlying aquifer to the swamp water table; (2) determine the effect of the ditches on adjacent ground-water levels; and (3) determine what correlation exists between ground-water fluctuations and the distributions of vegetation.

Rapid advances in satellite digital image processing technology have increased the usefulness of Landsat data as a management tool. The vegetative cover maps interpreted from aircraft photographs are being used to evaluate vegetation classes interpreted from geometrically corrected and registered winter and spring Landsat images of the Great Dismal Swamp. Both single-date and temporal (multiple-date) analyses have been made (Carter et al. in press; Gammon and Carter 1976) and the Landsat digital products supply information which can either substitute for or supplement the photographically-derived products. Landsat digital data can supply cost-effective repetitive information for future monitoring of vegetation trends and non-seasonal changes.

Summary and Conclusions

The maintenance of wildlife populations depends upon an understanding of the vegetative communities, i.e. their origins, successional trends, interrelationships, and response to outside pressures and manipulation. The Great Dismal Swamp is considered a highly altered ecosystem because natural vegetative diversity has been greatly increased by fire, timbering, ditching, road building and changes in water availability. This vegetative diversity resulting from 200 years of physical alteration severely complicates the formulation of management policy.

We have used aerial photographs and Landsat data to view the Great Dismal Swamp as a total ecosystem within its rural and urbanized surroundings. The seasonal color IR photographs were used to prepare vegetative cover maps at 1:100,000- and 1:24,000-scales. A comparison with maps made from historic B/W aerial photographs has provided information on successional patterns. With this baseline information, we are assessing the potential of Landsat to monitor future vegetative and hydrologic trends.

The staff of the Great Dismal Swamp National Wildlife Refuge is enthusiastic about the use of remotely-sensed data to enhance management capabilities. The transition from a doubt-filled "wait-and-see" attitude toward photographs and computer products to today's enthusiasm has taken place over a three-year period and has not been entirely smooth. It is difficult (1) to admit that the traditional approach of the classical biologist would not give adequate information in a timely fashion and (2) to achieve the capability to view the swamp from an aerial perspective. The limitations of remotely-sensed data must be understood; ground observations are still needed and the available scale and resolution are not always the most useful for management application.

There are other disturbed ecosystems which need FWS management guidelines; the Everglades is another excellent example of a wetland ecosystem under stress from human pressures. Land management requires subsidiary information to aid in decision making and remotely-sensed data is one of the available tools to gather this information. Whatever management policies eventually are adopted to deal with such diverse and highly altered ecosystems, the role of remote sensing is, and will continue to be, very important.

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Status of the National Wetlands Inventory

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Introduction

The need to consider and use sound ecological information in forming decisions concerning policy, planning, and operational management of our natural resources is a well-known concept of long standing. This concept has been the subject of significant laws, including the Fish and Wildlife Coordination Act of 1934 as amended, the Endangered Species Acts of 1966 and 1969, the U.S. Forest Service's Multiple Use Act of 1960, the Forest and Rangeland Renewable Resources Planning Act of 1974, the Marine Mammal Protection Act of 1972 and, of major significance, the National Environmental Policy Act of 1969.

Despite all this, instances of gross mismanagement of our natural resources still occur. We see the ecological systems comprising these resources being restructured and redirected to channel all their energy and nutrients into a single product. We see many of our ecosystems being mutilated or eliminated by pollution as well as by urban, industrial and agricultural development. Why?

Certainly, short term economic gain and its political implications are involved. However, we believe that most Americans, including the policy makers, planners, and managers, would like to do their best for future generations as well as meet our short term needs. The major problem is simply that the information needed to make environmentally sound decisions, for one reason or another, is not effectively used in the decision-making process.

This conclusion is not new. In fact, research is increasingly being directed toward the discovery of essential biological and ecological information. And, of considerable significance for resource managers, a plethora of information systems are being designed to accumulate, store, analyze and produce this information. These systems, designed to get the needed information into the hands of the decision makers, are a major step toward environmentally sound resource management. However, unilateral development of many different information systems, containing basically the same data and intended to satisfy the same kind of need, is not the most efficient or effective approach. We believe these systems should be coordinated into some measure of compatibility and structured integration, at least in terms of fish and wildlife habitat-related information.

Consequently, we have designed the National Wetlands Inventory to provide a single, universally applicable system of wetland information which will describe all wetlands on an individual and/or cumulative basis in terms of their ecological and physical characteristics, geographic location and natural resource values.

Further, we will use this endeavor to provide a base and guide for the development of an all-habitat-inclusive system designed to include classification, ecological characterization (Hirsch 1976), geographic location, and evaluative information needed in natural resource policy formulation, planning, and operational management.

National Wetland Inventory

The U.S. Fish and Wildlife Service, Office of Biological Services, is conducting an inventory of all the wetlands of the United States, including its territories and possessions. The National Wetland Inventory (NWI) will create a data base, in both map and computer form, in which wetlands data will be collected, interpreted, stored, and reproduced.

The last national wetland inventory, which surveyed only the lower 48 states, was completed in 1954 (Shaw and Fredine 1956). Since the 1954 inventory, many wetlands have been lost or modified. In addition, the importance of wetlands in the biological and physical environment is more widely appreciated, and a better methodology exists for classifying and inventorying this resource.

The Needs for Wetlands Inventory Data

There are at least 10 groups within the Department of Interior, as well as 9 other federal agencies (including Corps of Engineers, Environmental Protection Agency, and National Marine Fisheries Service) that have indicated a need for the data to be produced by the NWI. A wide range of regional, state and local governmental bodies, and private conservation groups have specific needs to apply this data to their own programs.

Within the Fish and Wildlife Service, there are three major uses of wetlands inventory data: (1) FWS is currently required to process approximately 35,000 permit applications per year for activities using wetlands. The recent court decision broadening the scope of Section 404 of the Federal Water Pollution Control Act of 1972 to include all waters of the United States will add to this workload. The NWI products will identify wetlands, help establish boundaries to controlled areas, and allow an area, region or flyway analysis. This will reduce costly field examination and time-consuming permit-by-permit procedures. (2) Each year a considerable amount of money is authorized for the migratory bird wetland acquisition program. The NWI products will allow critical areas to be identified in order to set priorities for wetland acquisition. (3) The federal-state cooperative migratory bird management program requires a continuing qualitative and quantitative analysis of wetland habitat. The NWI will provide an accurate, comprehensive data base for this analysis.

Goals and Long-Term Objectives

The NWI will (1) provide needed information that will aid the FWS, other interested agencies (state as well as federal), private organizations and individuals to achieve resource management and habitat preservation objectives; (2) develop an inventory system that can be easily and economically maintained; (3) develop the system and gather the basic informational needs in as short a period of time as is technically and economically feasible; and (4) present the information in a variety of products to insure its maximum usefulness to the user (maps, data bank, reports, and work materials).

Pre-operational Products

The National Wetlands Inventory project has now essentially completed its pre-operational stage. Five major pre-operational products are completed or scheduled for completion by March, 1977. They include:

1. *A new wetland classification system.* The system used in the 1954 inventory identified 20 wetland types, all of equal rank (Shaw and Fredine 1956). Other existing wetland classification systems use a similar ''horizontal'' system. The classification system developed for the NWI is hierarchical or vertical in nature. The uppermost levels are broad systems (marine, estuarine, riverine, locustrine, palustrine) and the hierarchy proceeds through several decreasing levels ending with highly detailed and specific wetlands characteristics.

   There are several advantages to this ''vertical'' structure, the principal one being the ability to utilize the classification system to levels of detail as required by the individual user. Thus, while some agencies may wish to describe wetlands in detailed fashion, others may only desire a general description.

   During the summer of 1976 the classification system was tested at 21 sites throughout the country to determine its ecological soundness and its applicability in inventorying the diverse wetland types found in the United States.

   Additional work also is underway to devise a systematic method for determining the value of the various wetland types (described in the classification system) as fish and wildlife habitat. This evaluation system ultimately will be combined with the wetlands data bank so that a user may have access to information on the type, location and ecological value of the wetlands in any area of interest.
2. *A survey of existing wetlands inventories.* This survey compiles information on wetland inventories conducted by federal, state and local governments, and private conservation groups since 1965. The National Wetlands Inventory will utilize these inventories to avoid duplication. This survey will also be of immediate value to other agencies that wish to locate detailed inventories of specific areas.

   The survey is published in two volumes. Volume I, representing each of the six FWS regions, contains 1:750,000 state maps showing the location and extent of major wetland inventories. There are six issues of this volume, one for each of the six FWS regions. Volume II contains a narrative description, by state, of all known inventories since 1965. Included in the narrative description is inventory information such as the classification system used, the purpose of the inventory, the methods used, the legislation involved, and how an interested user may obtain additional information concerning a particular wetland study.
3. *An atlas of recent, high altitude aerial photography.* The NWI will use, in part, aerial photographic interpretation techniques to inventory the wetlands of the United States including Alaska and Hawaii. Compilation of a graphical index of existing, high-quality aerial photography was a necessary step to locate the

imagery needed for the inventory. The atlas displays on 1:750,000 state maps, recent aerial photography (since 1970) subject to specific parameters based on the requirements of the National Wetlands Inventory. These parameters are: (a) scales of 1:24,000-1:130,000; (b) only blocks of imagery covering at least 50 sq. mi.; (c) exceptionally high quality (0 percent cloud cover, etc.); and (d) preference is shown in order for color infrared, color, black-and-white infrared, and black-and-white film emulsion types.

4. *A series of 1:250,000 maps delineating ecoregions, physical subdivisions and land surface forms of the United States.* The first levels of the wetlands classification system are ecoregions as defined by Bailey (1976) and physical subdivisions and land surface forms as defined by Hammond (1964). This series of 468 maps, covering the coterminous 48 states, displays the boundaries of these units on standard 1:250,000 USGS map sheets. Alaska, Hawaii and U.S. Possessions will be completed during fiscal year 1977.
5. *Wetlands protection guidebooks for use by local units of government, states and interested citizens.* Existing state and local wetland protection efforts will be summarized and alternative model statutes and ordinances will be drafted. Two guidebooks will be prepared. One will be a scientific and legal handbook detailing technical planning issues (including wetland inventories), legal issues, and regulatory and nonregulatory approaches to wetlands protection. A second guidebook, specifically for local units of government, will present model ordinances and a step-by-step approach in adopting local wetlands regulations.

Operational Products

The operational phase of the NWI was initiated in October, 1976 and is scheduled for completion in 1980. The inventory system and products are designed so that they can be continuously monitored or periodically updated. The current status of wetland modification or loss may be monitored and recorded in the future. The major products include:

1. *The National Wetland Inventory map series.* The maps will display wetlands, classified according to the system described in the preoperational products section, at a scale of 1:100,000 for the entire United States. Acreage of each wetland will also be displayed. In areas with a large number of small wetlands, as in the Florida Karst terrain or the Prairie Pothole Region of the Dakotas, maps of 1:24,000 scale will be produced. The base maps will be enlarged versions of the standard USGS 1:24,000 quadrangle sheets for the 1:24,000 series. These base map sheets display necessary locational information such as state and county boundaries and major highways.
2. *A NWI data bank.* All information gathered for each wetland, as displayed on the map series, will be digitized and stored in an "open-ended" computer data bank. Each wetland will be located by latitude and longitude, physical subdivision and ecoregion, major watershed, flyway, state, county and census district. This information can be retrieved and manipulated by the user to produce either tabulated printout sheets or computer generated maps at various scales.

   Due to a technological breakthrough in aerial photograph interpretation and information digitization (accomplished by project personnel working with one of our contractors), we have the potential for economically generating computer tape information that will allow products of superior accuracy. As an example, maps generated by NWI computer tapes will be better than the established "National Map Accuracy Standards."

3. *Regional and national summary reports.* These reports will summarize the findings of the inventory for the entire country by FWS regions. They will include tabulations of data for wetland type, political division, and natural physical division (such as land surface form, flyway and watershed).
4. *Work materials.* While conducting the inventory, a vast amount of collateral data, aerial photography, compilation maps, work sheets and field reports will be collected. These materials will be made available, on a limited basis, to those organizations that have a need for such information.

Implementation Strategy

Several criteria were fundamental to development of strategy: (1) the need to qualitatively standardize the results of the inventory across the country; (2) the need to establish a system of management control for a project of this magnitude; (3) the need to establish a system that maximizes the efficient use of fiscal resources; and (4) the need to develop inventory products that meet the needs of the largest number of potential users.

The following strategy meets these criteria and has been implemented. The central NWI Operational Group is the focal point for coordinating all activities concerning the inventory. This group, located in St. Petersburg, Florida, acquires all work materials necessary for performing the inventory, has developed a set of guidelines (operations manual), and provides technical assistance and guidance, as well as the work materials, to seven regional wetland coordinators (one now established in each of the six FWS regional offices, plus Alaska).

The regional coordinators are responsible for the inventory of wetlands within their region and the preparation of regional reports.

The collection of inventory data will be accomplished by contractors directly responsible to the regional coordinator. They will use the work materials supplied by the central office, inventory wetlands as directed, and provide the regional coordinator with completed final "field" compilations (summary reports and inventory maps). The contractors could be states, private industry, or branches of the federal government.

When geographic areas are satisfactorily completed, they will be forwarded to the central office where the materials are edited and the final products completed and made ready for distribution to users. This effort includes developing the data bank, completing narrative reports, and maintaining qualitative uniformity between regions and preparation of final maps.

The operational strategy also provides that other "interested" federal agencies would be invited to participate, at their own expense, in the operation of the central office. Although this is not critical to the operation of this facility, it accomplishes several things. Firstly, it facilitates the collation of existing collateral data that exist within other federal agencies. Secondly, it expands levels and scope of expertise, i.e., soils, hydrology, etc. Thirdly, it provides an interchange of ideas and a means for operational-level, interagency coordination and dissemination of information.

Because it was necessary to initiate operational activities in October 1976, and since the actual inventory is scheduled for completion in three years, it was appropriate to supplement the central office staff by a support/service contractor. This provided access to needed personnel in a short period of time on an as-needed basis, but did not require excessive permanent or temporary staffing by the FWS beyond the actual inventory period, i.e., when the inventory effort is complete the service/support contract is terminated. This contractor provides additional wetland inventory expertise, cartographic and graphic arts staff, computer software, digitization capability and some general office assistance.

The operational strategy for Fiscal Year (FY) 1977 has been to initiate inventory activities in October 1976 in the State of Florida and to proceed in all phases of activities so that by the end of that fiscal year the coastal wetlands of the coterminous United States, the lower Mississippi Flood Plain region, and a block of the Prairie Pothole Region are completed. In FY 1978 operations will begin in Alaska, the interior regions of the lower 48 states, Hawaii, Puerto Rico and the Virgin Islands. During FY 1979 the inventory will be completed.

The reasons for the above approach were: (1) We have started in an area where we knew at the time that we had a source of the needed work materials to initiate activities since approximately 150 days lead time was needed to locate and obtain those items in other regions. (2) Initiation of activities was started in a region where field activities were possible to train personnel and to resolve inventory operational problems early in the project. (3) The coastal zone is of extreme interest to the Corps of Engineers, National Marine Fisheries Service and the office of Coastal Zone Management (National Oceanic and Atmospheric Administration). The coastal zone plus the other FY 77 priority areas are of interest to FWS's migratory bird and permit review programs.

Summary

The United States Fish and Wildlife Service with the cooperation of other federal and state resource management, regulatory and services agencies is engaged in a major fish and wildlife habitat information project.

The National Wetland Inventory will produce a universally applicable system of highly accurate wetland information describing all wetlands on an individual and/or cumulative basis in terms of their ecological and physical characteristics, geographic location and natural resource values.

Pre-operational products include: a new wetland classification system; a national survey of existing wetland inventories; a national atlas of recent, high altitude aerial photography; a national series of maps delineating ecoregions, physical divisions and land surface form; and a wetlands protection guidebook (available March 1977).

The operational phase started in October 1976 and will take three years. It will produce: the National Wetland Inventory map series; a NWI data bank; regional and national summary reports; and an indexed set of work materials and collateral data available for limited use.

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Effects of Grass Carp Introduction on Waterfowl Habitat

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Introduction

Florida's wetlands, estuaries, and lakes are important to North American waterfowl and other water birds. Florida winters a large number of migrating birds, but recently, a noticeable decline has occurred in some areas. Migratory waterfowl are particularly responsive to habitat change since food availability is an important factor in where they winter (Bellrose 1976).

Numerous ecological blunders have reduced and destroyed valuable waterfowl habitat. For example much Florida marshland has been destroyed by drainage programs and establishment of mosquito control impoundments (Sincock, Smith, and Lynch 1964). Other portions have been dredged or filled to provide waterfront property (Marshall 1968). Nationwide there has been a reduction from 127 million acres (51 million ha) of wetlands originally to 83 million (33 million ha) by 1953 (U.S. Fish and Wildlife Service 1975) due mainly to drainage for agriculture.

Introduction of exotic plants and animals has been another continuous threat to Florida marshland and aquatic ecosystems (Courtenay and Robins 1975). The tropical climate coupled with introduction of exotic plants and nutrient pollution caused by increased urbanization have led to severe aquatic weed infestations in some lakes and rivers. Both submerged and floating plants are problems in some areas. Some weed control experts recommend stocking grass carp (*Ctenopharyngodon idella*) to control submerged vegetation in Florida lakes. Grass carp have a short digestive tract and a tendency to gorge food (Cross 1969; Gaevskaya 1969). Daily consumption of aquatic vegetation is often greater than the body weight of the fish (Cross 1969; Aliev 1963).

To determine possible environmental impacts of grass carp introduction, the Florida Game and Fresh Water Fish Commission and the Florida Department of Natural Resources jointly began a study on two natural ponds, a natural lake, and an artificially created borrow pit. This report documents resultant changes in potential waterfowl habitat (Fig. 1).

Study Area

Four study sites with diverse physiography and variable physical and chemical characteristics were chosen. The northernmost two sites, Suwannee Lake and Madison Pond, were similar in geographic location and chemical characteristics with pH between 6.0 and 7.0, but differed biologically. Suwannee Lake located on the University of Florida Agricultural Experiment Station had a drainage area of approximately 160 acres (65 ha), which was a mixture of upper coastal plain flatwoods and agricultural land. It was the largest water body studied, with a surface area of 30 acres (12.2 ha). The lake was only moderately vegetated. Marginal vegetation included panic grass (*Panicum hemitomon)* and floating pad communities of floating heart (*Nymphoides aquaticum*), spatterdock (*Nyphar*

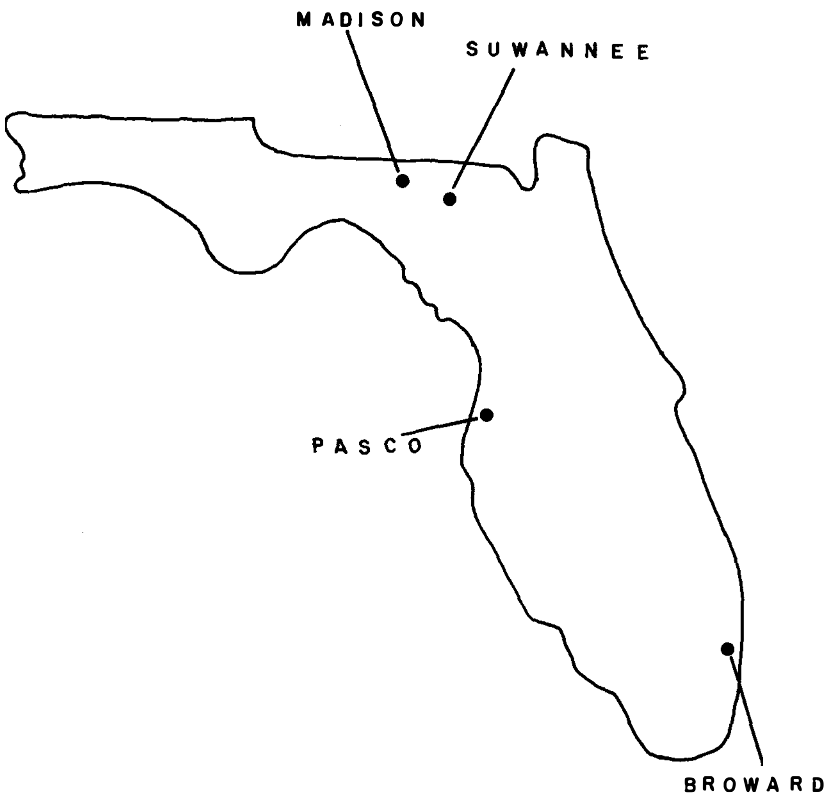

Figure 1. Location of the four study areas in Florida.

macrophylla), watershield *(Brasenia schreberi)* and fragrant waterlily (*Nymphaea odorata*). Slender spikerush *(Eleocharis acicularis)* formed a carpet on the lake bottom, extending lakeward from the shoreline.

Madison Pond was smaller, approximately 8.5 acres (3.4 ha), with a larger drainage area of approximately 456 acres (185 ha), consisting of woods and agricultural land. A densely matted periphery dominated by panic grass and alligatorweed (*Alternanthera philoxeroides*) extended from 30 (9m) to 70 feet (21m) lakeward from shore. The pond middle was densely vegetated with cabomba (*Cabomba caroliniana*) interspersed with bladderwort (*Utricularia gibba-fibrosa*). Both Suwannee Lake and Madison Pond were located in Atlantic coastal plain pine flatwoods habitat.

Pasco Pond in West Central Florida was a 6.5 acre (2.6 ha) pond having practically no drainage area and a very low pH (4.5 - 5.5). Cypress trees (*Taxiodium* ssp.) fringed the pond. Dominant aquatic vegetation included slender spikerush (*Eleocharis vivipara*), watershield, floating heart, spatterdock and bladderwort (*Utricularia purpurea vulgaris*). Pasco was intermediate between Madison and Suwannee in degree of aquatic vegetation coverage.

Broward Pond was a rectangular 5 acre (2.0 ha) borrow pit formed by the Florida Department of Transportation. The pond had a pH of approximately 8.0 and a five-acre (2.0 ha), highly urbanized drainage area. The climate of the region was tropical with a year round growing season. This pond was specifically selected because an exotic plant, Hydrilla (*Hydrilla verticillata*) seemed to be expanding. Water hyacinth (*Eichhornia crassipes*) comprised a major portion of aquatic vegetation at study initiation, but was removed mechanically by the Department of Natural Resources to encourage *Hydrilla* growth. Southern naiad (*Najas guadalupensis*) and narrow-leaved cattail (*Typha angustifolia*) were also present.

Materials and Methods

A three year sampling program was designed with the first year (1972) to serve as a control (without grass carp). Each site was stocked with 60 pounds of grass carp per acre (67 kg per ha). Because of differences in the size of fish, Suwannee was stocked with 120 fish per acre (298 fish per ha); Madison with 21 fish per acre (51 fish per ha); Pasco with 73 fish per acre (185 fish per ha) and Broward with 47 fish per acre (116 fish per ha).

Modified line transects were run quarterly on each site beginning in October, 1972. In Madison, Pasco and Broward transects traversed the pond; however, in Suwannee Lake transects were confined to vegetated littoral zones only. Permanent markers were established and a rope marked in 5-foot (1.5m) intervals was stretched between markers. At each rope mark, a wooden pole was submerged and plants that touched were recorded. At each 30-foot (9.1m) interval, a frame ($1m^2$) was lowered to the water and coverage of each vegetation species within the frame recorded. From these data, percent frequency of occurrence and percent relative cover were calculated for each plant species.

Control exclosures were constructed in each pond by screening an area to prevent disturbance of the plant communities by grass carp. Experimental remote sensing photography was also used to detect gross changes. Four fixed sampling stations, two shallow-water stations and two deep water stations were set up in Broward, Madison and Pasco Ponds to sample benthic organisms. Six stations (three shallow and three deep) were set up in Suwannee Lake due to its larger size. Organisms were collected monthly at each station with a 6 by 6 inch (15 by 15 cm) Ekman dredge. Samples were sieved using a U. S. series No. 30 sieve in the field and taken to Rollins College, Winter Park, Florida, for identification and counting. Organisms were identified as to genus and counted by Rollins College staff.

Means and ANOVA were computed using an IBM 370165 computer at the University of Florida and SAS program language (Barr and Goodnight 1972). Technical assistance was provided by Mr. Paul Geissler with the North Carolina State Cooperative Statistics Unit. A split plot designed was used with Madison, Suwannee and Pasco Ponds being replications and years being the plot. The treatment considered was stocking grass carp and objectives were to measure significantly affected responses. Broward Pond was omitted from analysis of variance because of lack of first year data and ecosystem disruption by mechanical means in the first and third years. We transformed benthic data to a logarithmic scale.

More detailed treatments of these aquatic plant and benthos data are given by Drda (1976) and Gasaway (1976). Figure 2 illustrates sample schemes for aquatic vegetation and benthic macroinvertebrates in the four study ponds.

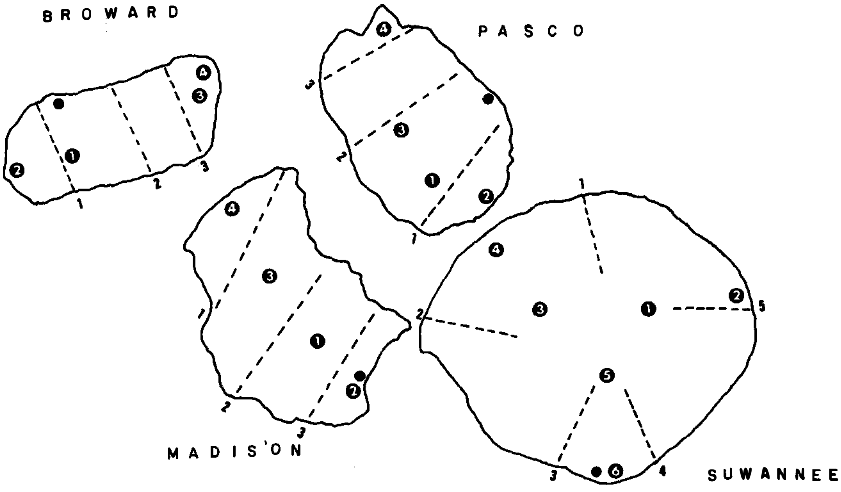

Figure 2. Location of vegetation transects (dotted lines), invertebrate sample sites (numbered circles) and exclosures (solid dots) for each of the four study areas.

Results

Suwannee Lake has a diverse flora with 23 species encountered in first year transects (Drda 1976). Spikerush and maidencane were dominant aquatic vegetation in the control year (Table 1). Some food plants known to be important to waterfowl were watershield, floating heart and fragrant waterlily. By the end of the first treatment year (after grass carp introduction), spikerush was eliminated from transects. Emergent vegetation showed slight change. Watershield declined in mean percent cover of occurrence from .63 percent in the control year to .03 percent. Percent frequency of occurrence also declined from 3.2 percent to .01 percent. Floating heart was more abundant in the first treatment year. Mean percent cover increased from 1.34 percent to 2.26 percent. Mean frequency of occurrence increased from 2.49 percent in the control year to 6.68 percent. Fragrant waterlily changed very little in mean percent cover with 1.48 percent the control year and 1.58 percent the first treatment year. Mean percent frequency of occurrence increased from 2.50 percent to 4.03 percent.

Water level fluctuation probably contributed to some third-year changes in the plant community; however, most vegetation had been removed along transects by the end of the study. Mean percent cover and mean frequency of occurrence was reduced to zero by the third year for watershield and floating heart. Fragrant waterlily was reduced to .65 mean percent cover. Mean percent frequency of occurrence increased to 5.30 percent. Figure 3 shows obvious effects of grass carp introduction on the total aquatic plant community of the lake. Submerged aquatic vegetation was totally eliminated. Aquatic vegetation in the screened exclosure remained intact.

In Madison Pond, 18 aquatic plant species were found along transects the control year. Dominant plants included alligatorweed, cabomba, and bladderwort (Table 1). The dense alligatorweed mat surrounding the pond periphery harbored

Table 1. Mean percent frequency of occurrence and mean percent relative cover of dominant aquatic plants found in each of the four ponds.

Pond	Dominant plant	Mean percent frequency			Mean percent cover		
		Pre-stocking	Post-stocking		Pre-stocking	Post-stocking	
		Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
Suwannee	Spikerush	53.14	20.44	0.00[a]	40.93	2.96	0.00[a]
	Umbrella grass	13.36	2.14	0.00	7.46	0.14	0.00
	Maidencane	18.74	18.04	16.74	3.0	4.43	3.18
Madison	Alligatorweed	30.58	32.32	27.21	23.19	22.49	13.99
	Cabomba	63.32	55.31	35.29	59.72	37.90	13.42
	Bladderwort	39.17	34.30	8.83	14.69	18.39	4.33
Pasco	Spikerush	37.46	2.48	0.00	26.15	0.11	0.00
	Bladderwort	15.86	12.60	0.21	3.11	4.46	0.00
	Watershield	24.72	7.33	0.00	10.72	1.43	0.00
	Floating heart	5.44	4.47	0.94	1.32	1.43	0.43
	Fragrant waterlily	6.04	3.20	1.55	3.04	2.84	0.35
	Spatterdock	8.07	7.00	4.67	4.41	3.91	1.33
Broward	Waterhyacinth[b]	7.71	0.00	0.00	6.47	0.00	0.00
	Hydrilla	12.26	26.52	0.00	6.11	18.3	0.00
	Cattail	0.21	5.20	4.92	0.25	0.84	0.49
	Bacopa	2.65	4.50	5.04	0.00	1.11	0.99
	Pennywort	0.35	1.41	3.00	0.00	0.00	0.08

[a]A small amount of spikerush was encountered along the transects; however, it was found only on exposed shoreline areas and was not found in the water where it would have been available to the grass carp.
[b]Water hyacinth were mechanically removed to prevent shading and competition with *Hydrilla*.

an associated plant community which was not readily accessible to grass carp upon introduction. The first year after introduction, cabomba and bladderwort were substantially reduced as reflected by change in mean percent cover. The alligatorweed mat and associated community remained essentially unchanged.

Substantial reduction in the cabomba-bladderwort community continued the third year. The alligatorweed community showed some decline. With exception of a large open water area in the center of the pond, the vegetation community was largely intact the end of the third year. The screened exclosure also supported substantial aquatic vegetation. Reduction of the aquatic vegetation community occurred gradually (Fig. 3) and would likely have continued if grass carp had not been removed the end of year three.

Sixteen plant species were encountered along transects in Pasco Pond the control year. Spikerush, bladderwort and watershield were the most commonly occurring plants (Table 1). These three plants were totally eliminated from the pond as well as along the transects by the end of the second year. The entire aquatic plant community was substantially reduced by the end of year three (Fig. 3). By 1975, fish entered the exclosure, but this had no serious impact on the study at this time.

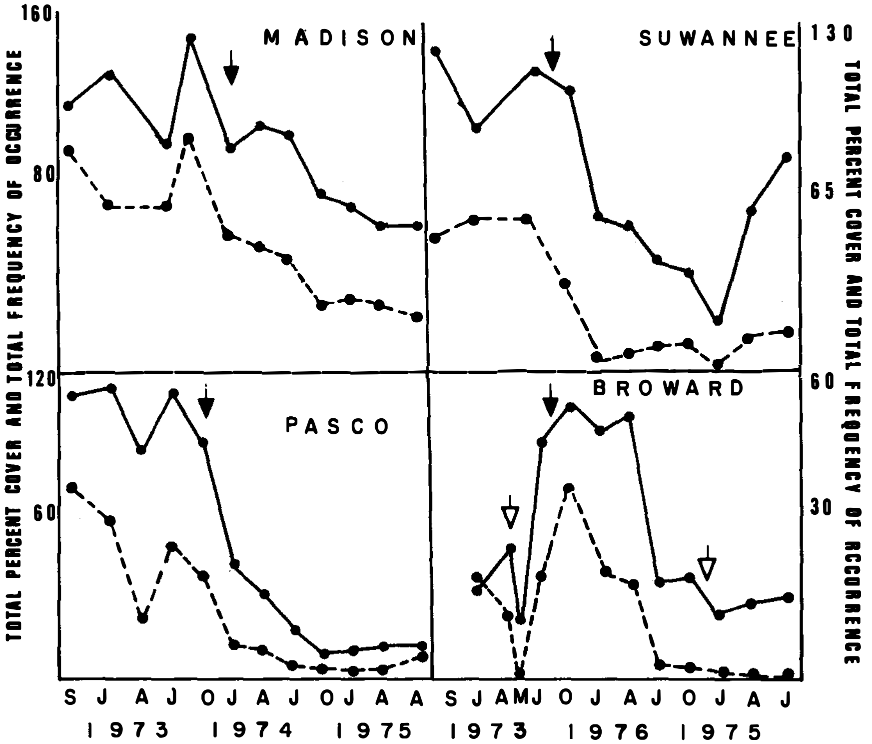

Figure 3. Total percent cover (broken line) and total frequency (solid line) of occurrence for the aquatic vegetation community in each of the four ponds. The arrows (◀) indicate where grass carp were stocked. The arrows (◁) indicate times when mechanical alteration of the environment occured in Broward Pond.

In Broward Pond, 14 plant species were encountered along control year transects. By the end of the second year, Hydrilla had been eliminated in all areas outside the exclosure (Table 1). In early February, the third year cattails in Broward Pond were mechanically removed. Increased water levels late that year exposed adjacent wet areas to the fish; however, all submerged aquatic vegetation was eliminated from the pond by year three.

Reduction in benthic invertebrates corresponded to aquatic vegetation reduction (Table 2). In Suwannee Lake, 16 genera representing 11 orders were considered prominent because they occurred in 20 percent or more of the months sampled during the prestocking year (Gasaway 1976). This decreased to 10 genera representing 5 orders the first treatment year, then to 6 genera representing 4 orders the second year after grass carp introduction.

In Madison Pond, 7 genera representing 5 orders occurred in 20 percent or more of the months sampled the first year. This decreased to 6 genera representing 4 orders the first year after introduction and then to 4 genera representing 3 orders the second treatment year.

Pasco had 6 prominent orders represented by 12 genera the control year. The first year after stocking carp 5 orders were prominently represented by 9 genera. In the final year, 3 orders represented by 4 prominent genera were found.

Table 2. Mean number per square yard (mn) and percent frequency of occurrence (%) of major benthic invertebrate groups collected in each of the four ponds studied from September, 1972 through August, 1975.

	Suwannee Lake					
	Year 1		Year 2		Year 3	
	mn	%	mn	%	mn	%
Ciliophora[a]	2.1	25	0	0	0	0
Annelida	0	0	0	0	1.5	9
Nematoda	2.1	16.6	0	0	0	0
Oligochaeta	20.9	76	5.5	41.6	2.5	27.2
Hirudinea	4.0	33.3	1.0	8.3	0.5	9
Cladocera[a]	5.5	25	0	0	0	0
Ostracoda	25.9	61	0	0	0	0
Copepoda[a]	2.5	30	1.0	8.3	0	0
Amphipoda	28.9	41.6	13.5	41.6	0	0
Decapoda	0.5	8.3	0	0	0	0
Ephemeroptera	23.5	70	6.5	61	14.5	63.6
Odonata	3.0	38	0.5	8.3	0.5	9
Trichoptera	5.0	30	0.5	8.3	0	0
Diptera	225.5	100	352.5	100	248	100
Hydracarina	43.4	100	15.0	100	9.5	77
	Madison Pond					
Oligochaeta	24	54	11.2	33	12.7	45.4
Hirudinea	0	0	0.75	8.3	0	0
Cladocera	0.75	7.6	0	0	5.3	18.2
Ostracoda	3	15.3	0	0	0	0
Copepoda	17.2	30	0	0	0	0
Amphipoda	36.0	38	8	41.6	7.4	18.2
Ephemeroptera	6.7	15.3	2.3	16.6	0	0
Odonata	6	23	2.3	25	0	0
Hemiptera	0	0	1.5	8.3	0	0
Coleoptera	0	0	1.5	8.3	0	0
Lepidoptera	0.75	7.6	0	0	0	0
Diptera	329.2	100	174.7	100	291.7	100
Hydracarina	54.8	100	34.9	100	9.8	64
Gastropoda	1.5	7.6	0.76	8.3	0	0
	Pasco Pond					
Nematoda	5.3	40	0	0	0	0
Oligochaeta	57	100	29.8	50	1.8	18
Hirudinea	0	0	0.75	8.3	0.75	9
Copepoda	3	23	0	0	0	0
Amphipoda	384.8	62	6.0	8.3	0	0
Decapoda	1.5	7.6	10.5	25	0	0
Ephemeroptera	6.7	38	0	0	8.2	27
Odonata	7.5	30	0.75	8.3	0.75	9

Table 2. Continued

	Pasco Pond (Continued) Year 1		Year 2		Year 3	
	mn	%	mn	%	mn	%
Coleoptera	0	0	0.75	8.3	0	0
Trichoptera	0.7	7.6	0	0	0	0
Diptera	321	100	454.1	100	368.7	100
Hydracarina	131.2	100	19.7	100	0	0
Gastropoda	0	0	1.5	8.3	0	0
	Broward Pond					
Ciliophora	21.7	10	0	0	0	0
Nematoda	6.3	20	0	0	0	0
Oligochaeta	32.5	70	15.7	50	76.5	90
Cladocera	11.3	10	0	0	0	0
Ostracoda	134.8	70	0	0	0	0
Copepoda	3.3	40	0	0	0	0
Amphipoda	20.7	30	12.8	16.6	0	0
Ephemeroptera	3.0	10	2.3	9	7.4	27
Odonata	1.5	20	0	0	0.75	9.1
Diptera	72.5	90	39.8	100	168.7	90
Hydrocarina	14.5	30	1.5	16.6	0	0
Gastropoda	5.3	40	0	0	0	0
Pelecypoda	0	0	0	0	0.75	9.1

[a]These were found in sieved detritus in some samples.

Pre-stocking sampling in Broward Pond yielded 8 orders composed of 12 prominent genera. The first treatment year only 2 orders composed of 3 genera remained prominent. In the second treatment year, the ecosystem showed some recovery with 3 orders composed of 5 prominent genera.

At study initiation, all four ponds had diverse benthic invertebrate populations. Oligochaeta, Amphipoda, Ephemeroptera, Odonata, Trichoptera, Diptera and Hydracarina were among prominent major groups represented. An analysis of variance for Diptera, Hydracarina, Ephemeoptera, Odonata and Amphipoda is presented in Table 3. The statistical analysis was applied to three ponds (Suwannee, Madison and Pasco) three years (one control and two treatment), months (12 to partition seasonal influence) and stations (classified as deep and shallow). Only Ephemeroptera varied significantly ($P < .05$) among sites due to the presence of the burrowing genus *Ephemera* in Suwannee Lake. This genera was prominent in Suwannee Lake the third year as well. Ephemeroptera, Odonata and Hydracarina varied significantly ($P < .05$) in control year versus treatment years comparison. All decreased in abundance after grass carp introduction. Amphipoda also decreased and varied significantly in the months and years interaction. Diptera genera compensated each other with an increase in *Chaoborus* and a decrease in other genera. No significant variation was found for this group in the years comparisons; however, Diptera and Amphipoda showed significant ($P < .05$) differences in the seasonal tests. Months and the interaction of months with the control year versus treatment years was highly significantly ($P < 0.01$) different.

Table 3. Analysis of variance for Diptera, Hydracarina, Odonata, Ephemeroptera and Amphipoda. Asterisks denote significance at $P < .05$ (*) or $P < 0.01$ (**); unmarked values represent non-significant differences. All data were transformed to logarithmic scale.

Source of variation	Diptera			Hydracarina			Odonata			Ephemeroptera			Amphipoda		
	Degrees of freedom	Mean square	F	Degrees of freedom	Mean square	F	Degrees of freedom	Mean square	F	Degrees of freedom	Mean square	F	Degrees of freedom	Mean square	F
Ponds (Madison, Suwannee, Pasco)	2	0.2094	0.3692	2	0.1870	0.5523	2	0.0007	0.4148	2	0.2012	107.0372**	2	0.3688	0.9255
Madison vs. Suwannee and Pasco	1	0.3078	0.5427	1	0.0153	0.0454	1	0.0002	0.1223	1	0.1413	75.1223**	1	0.2383	0.5980
Suwannee vs. Pasco	1	0.1532	0.2701	1	0.3387	4.3897	1	0.0012	0.6383	1	0.2183	116.1223**	1	0.5888	1.4776
Years (control, treatment year 1, treatment year 2)	2	0.3314	0.5843	2	2.9549	9.5730*	2	0.0110	5.8777	2	0.0110	5.8723	2	0.8654	2.1718
Control vs. treatment year	1	0.6455	1.1380	1	5.5541	17.9937*	1	0.0173	9.2180*	1	0.0173	9.2181*	1	1.3059	3.2773
Treatment year 1 vs. treatment year 2	1	0.0183	0.0322	1	0.3557	1.5236	1	0.0047	2.5319	1	0.0047	2.5319	1	0.1792	0.4499
Ponds across years	4	0.5672	Error ↑	4	0.3086	Error ↑	4	0.0018	Error ↑	4	0.0018	Error ↑	4	0.3984	Error ↑
Season (months)	11	0.8752	11.3962**	11	0.0496	0.6799	11	0.0032	1.7956	11	0.0300	2.6643	11	0.1380	10.8081**
Season interaction with control vs. treatment years	11	0.7012	9.1308**	11	0.1555	2.1299	11	0.0064	3.5359*	11	0.0101	.8946	11	0.1888	14.7877**
Season interaction with treatment year 1 vs. treatment year 2	11	0.0768	Error ↑	11	0.0730	Error ↑	11	0.0018	Error ↑	11	0.0112	Error ↑	11	0.0127	Error ↑
Deep water stations vs. shallow water stations with control vs. treatment years	1	0.7595	16.0405	1	0.5211	111.1100	1	0.0342	31.9810	1	0.0832	2.6500	1	0.6461	25.3579
Deep water stations with treatment year 1 vs. treatment year 2	1	0.0473	Error ↑	1	0.0046	Error ↑	1	0.0010	Error ↑	1	0.0314	Error ↑	1	0.0254	Error ↑

Discussion

Early work in Florida (Sutton and Blackburn 1972) was conducted to define species of aquatic weeds that grass carp would eat and to measure fish growth rate and plant consumption. These authors found that grass carp preferred *Chara* (Muskgrass), *Najas* (southern naiad), *Hydrilla* (hydrilla), *Myriophyllum* (eurasian watermilfoil), and *Vallisneria* (eel grass) in that order. The fish did not single out one species and eliminate it, but appeared to graze the entire plot. Size of the fish seemed to influence feeding. They concluded that grass carp appeared to be a promising biological agent for control of many aquatic plant species, particularly rooted submerged and free floating types. Older grass carp are less selective feeders and eat a greater variety of plants than younger fish and sometimes feed on coarse vegetation (Fischer 1968; Krupauer 1971; Prowse 1971; and Opuszynski 1972).

For a number of years, biologists have been concerned with effect of common carp (*Cyprinus carpio)* introduction on waterfowl food plants (Cole 1905; Smith 1957; Robel 1961). The ability of grass carp to totally eliminate aquatic vegetation is well documented (Alikunhi and Sukimaran 1964; Avault 1965; Terrell and Fox 1974). When comparing common carp to grass carp, Avault, Smitherman and Shell (1966) reported the grass carp to be far superior in its weed-eating abilities.

Several southeastern workers have reported importance of submerged vegetation to waterfowl. Florschutz (1972) illustrated importance of eurasian milfoil as well as other aquatic plants to waterfowl in North Carolina and Virginia. Duke and Chabreck (1976) classified coontail (*Ceratophyllum demersum)*, eel grass, eurasian watermilfoil, pondweed (*Potamogeton* sp.) among other plants as important waterfowl food plants in the Atchafalaya Basin in Louisiana. Other authors have reported importance of individual plants found in this study. Kerwin and Webb (1971) found the most important food consumed by dabbling ducks was *Najas guadalupensis*. The most important food consumed by volume and frequency by diving ducks was *Brasenia schreberi*. In Florida *Brasenia schreberi* and *Nymphoides aquaticum* were reported to be good waterfowl foods (Chamberlain 1960). Krapu (1974) reported high occurrences of spikerush achenes in waterfowl diets. Recent work reported heavy waterfowl usage of *Hydrilla* in Lake Wales, Florida (Montegut et al. 1976).

Several authors have demonstrated importance of aquatic macrophytes to other aquatic life, particularly invertebrates (MacGaha 1952; Smirnov 1959; and Rutner 1966). Other biologists have stressed importance of invertebrate communities to waterfowl (Moyle 1961; Arner, Wesley and Anding 1969). Holm and Scott (1954) and Cook (1964) reported the need for a high protein diet in the reproduction of waterfowl species. Cook (1964) also believed that breeding waterfowl and broods reject wetland areas where animal foods are scarce. Utilization of Amphipoda, Gastropoda, and Decapoda have been documented (Swanson, Krapy and Bartonek 1974; Kerwin and Webb 1971). Swanson and Sargent (1972) reported nighttime feeding on Diptera (Chironomidae) and Ephemeroptera. At least two authors (Krecker 1939; Rosine 1955) have reported densities and variation in aquatic invertebrate populations in various plant communities; submerged plant communities had more invertebrates per square foot than floating or emergents.

Scientists have long recognized the need for aquatic macrophytes to provide food both directly and indirectly for fish and wildlife resources (Wilson 1939;

Hotchkiss 1941; Penfound 1956; Mulligan 1969). The current concept in aquatic weed control is management as opposed to eradication. Food habits of grass carp are not selective; they will feed on whatever vegetation is available and submerged vegetation was the first to disappear. At these densities, grass carp did not perform as a tool for macrophyte management but more for total eradication.

In this study, submerged vegetation was eliminated in three of four research sites. Corresponding reductions in aquatic invertebrates valuable as waterfowl foods also occurred. Documented waterfowl foods were eliminated. The quality of waterfowl habitat deteriorated after grass carp introduction in three of four study sites. Trends in data indicate that the fourth site would also have suffered extreme adverse effects if the study had continued over a longer period of time.

Many factors will influence the overall effects of grass carp introduction in North American waterfowl. Among them are reproduction, movement, salinity tolerances, and success in establishment of this species. Stanley (1976) concluded that all of the conditions needed for successful reproduction of grass carp are found in most American rivers. Thus, grass carp are likely to reproduce in the United States just as they have in most other rivers of the world to which they have been introduced. Grass carp have the ability to tolerate and move through low salinity waters (Tanasitschuk 1961) and establish in rivers and reservoirs connected to rivers (Tang 1963; Sport Fishing Institute 1975). Because of its fecundity (over 1 million eggs per female) this species is likely to have a significant impact on North American aquatic ecosystems, and have adverse side effects similar to those reported after introduction into the Soviet Union (Vinogradov and Zolotova 1974; Stanley 1976).

There can be little doubt that if grass carp occur in densities similar to those found in these research ponds, waterfowl habitat degradation will likely occur. The ability of waterfowl to utilize other available habitat will become important. If habitat is a limiting factor for North American waterfowl populations, then mass stocking or probable reproduction of grass carp pose a definite threat to their well-being.

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Management Strategy for Bald Eagles

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Introduction

A substantial volume of literature has appeared pertaining to bald eagles (*Haliaeetus leucocephalus*) during the past decade. Much of this has been related to population ecology and life history studies. More recently, emphasis has changed to include management philosophies and protection schemes for this rare and symbolic bird.

Our purpose here is to describe a management strategy applied to a breeding population of bald eagles on the 1.6 million-acre (640,000 ha) Chippewa National Forest in north-central Minnesota. This national forest is an important breeding area for bald eagles, ranking among the top two nesting-density areas in the contiguous United States, with about 100 nesting pairs. The present inventory includes 180 nest sites, almost one-half of all known nests within the national forests of the Eastern Region of the U.S. Forest Service.

The strategy to be described is unique in that it represents an immediate integration of research results and management action. It provides a basis for insuring that the needs of nesting bald eagles are included in the over-all objectives of land use planning on public land and recommends these procedures on private lands. The evolution of this strategy began in 1962 when the Eastern Region of the U.S. Forest Service initiated management policy for protecting bald eagle and osprey nests in national forests in the Lake States and established surveys to assess breeding populations and monitor nesting success.

The Chippewa bald eagle population has been intensively studied. Annual status reports since 1963, describing nest inventories and reproductive success, have been prepared by Mathisen (1963–1967, 1969, Mathisen and Stewert 1970). Dunstan, Greichus, and Mathisen (1970) and Dunstan and Harper (1975) investigated food habits, pesticide relationships and post-fledging use of habitat. Harper (1974) studied post-fledging behavior and movements. Juenemann (1973) and Mathisen (1968) described effects of human disturbance on nesting activity. Kussman (1977) recorded behavior and nesting activity at selected nest sites. Graduate students, under the direction of L. D. Frenzel, are completing research on territorial activity, forestry practices related to nesting, and nocturnal behavior at nest sites. This array of research effort, together with 14 years of nesting activity records, provides a basis for intensive management planning.

The Rationale of Management Planning

The Chippewa Forest is an intensively managed unit of public land. Timber harvest and other forestry practices important to the area often make significant changes in the forest landscape. A combination of a high-quality scenic environment together with summer homes, resorts, and campgrounds provide facilities for a recreation-oriented public who utilize the forest at all times of the year.

The need and desire to perpetuate and protect the forest's breeding eagle population in the face of increasing forestry and recreational activity complicate the land managers' job. In 1963, policy was initiated to protect nesting sites in the national forests in the Lake States by establishing two buffer zones around nests where land use activity would be prohibited or seasonally modified. This served as the guide for eagle nest protection until 1974 when studies by Frenzel (unpublished) and Juenemenn (1973) indicated existing national forest nest protection policy was inadequate. Chippewa Forest management policy was then modified further to provide for more specific constraints and management actions, requiring a detailed management plan for each eagle territory incorporating the improved buffer zone specifications. Buffer Zone policy was subsequently changed in 1974 as follows:

330-foot zone (100 meters)	-	No activity.
660-foot zone (200 meters)	-	No activity from February 15 to October 1 and then little.
1320-foot zone (400 meters)	-	No activity from February 15 to October 1, no restrictions on activities subsequently.
1320 + foot zone (400 + meters)	-	Includes cases where the 1320 foot zone may be extended up to 2640 feet (800 meters) if justified in the management plan.

The management plan for each nest considers known responses of individual eagle pairs to various types of human intrusion. Some eagles pairs are more tolerant of human disturbance than others, and land management constraints can sometimes be adjusted to accommodate the sensitivity of individual nesting pairs. Specific hazards from disturbance also vary among nest sites as the biological and physical features of given sites vary, and these are recognized and dealt with in management plans.

Data on location of perch trees, feeding areas, flight patterns and movements of adults and juveniles are also available from research studies and can be incorporated in the plan of management to insure that these critical areas are preserved or enhanced.

Finally, a compilation of important data on eagle behavior and nest sites is needed. Included here would be pesticide studies and evaluations, mortality reports, historical records of nesting trees, banding information, land use history, and other research efforts. In some cases this work has not been summarized or reported.

Elements of the Management Plan

A management plan document is developed for each bald eagle territory on the Chippewa Forest. We use the term "territory" to mean the geographical location of nests and associated habitats occupied by breeding eagles over the years rather than the specific area defended by a pair of eagles.

Field Examination

The first step in management plan development is a field examination of each nest site in the territory to record the following:

Nest Location. The legal description of the nest location is recorded along with other geographic and physical features to assist in relocating the nest. This has been a problem in the past because of inaccurate plotting of nest locations. In some cases nests had never been reached on the ground, all observations being made from airplanes.

Nest Tree Characteristics. Species, height, and condition of the nest tree are measured and recorded and the height of the nest from the ground is also recorded. When possible, the tree is climbed and photographs are taken from the nest site in the four cardinal compass directions to document potential hazards in the area and form a baseline for future changes.

Special Hazards. The planner identifies and maps all potential disturbances in the territory, such as roads and trails, timber management activity and man-made structures.

Surrounding Habitat. Timber types, presence of known or potential roost trees and potential nesting trees are identified and recorded. The tree canopy is also measured in several directions to help assess line-of-sight potential from the nest to areas of potential disturbances.

Photographs

Finally, at least four low-level aerial photographs are taken of the nest area in each cardinal direction, with the nest in the center of the photograph. These photographs become part of the management document and are an important feature of the plan.

After field data are collected and the planner is familiar with all aspects of the eagle territory, all information pertaining to the nest and associated eagles are assembled. A 4 inch = 1 mile (10 cm = 1.6 km) overlay map (Fig. 1) is made of the territory, showing locations of nests, perch trees, feeding areas, roads and trails and other features of the area. The low-level aerial photographs are also marked to show important management considerations.

Narrative

The narrative part of the plan consists of six elements:

Description of Territory. This narrative is tied directly into the overlay map and describes some of the general territory features such as recreation-use activities in the area. This section also includes the locations of feeding areas, known or potential perch trees, potential nesting trees, land ownership patterns and post-nesting use of habitat, if known.

Nest Site Characteristics. Detailed information relating to the nest tree, such as species, height and condition, and features of the surrounding habitat are recorded on data sheets which become part of the permanent record. These data are obtained for all nest sites, regardless of activity status. Old nests are often rebuilt and occupied after years of inactivity.

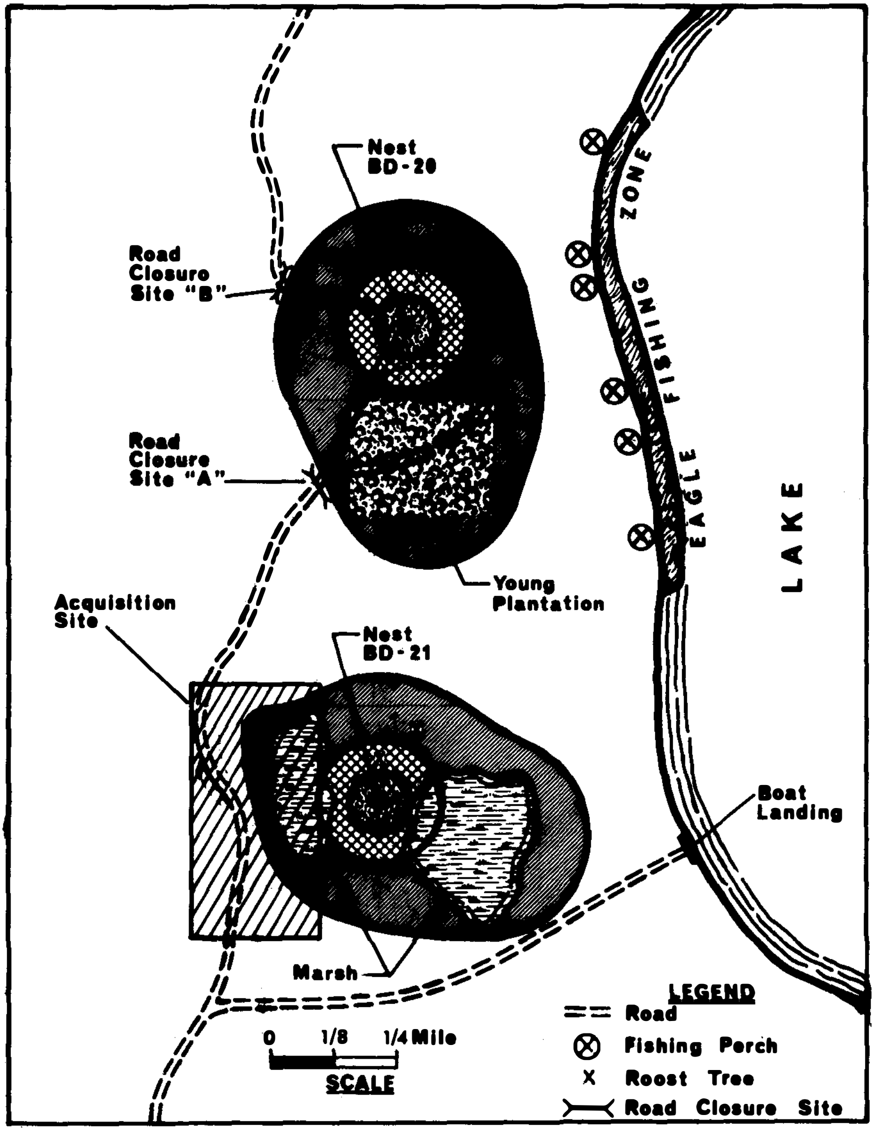

Figure 1. Typical overlay in eagle territory management plan showing two nest sites with buffer zones and features of the territory considered in the plan.

Pair Behavior. At many nest sites, data are available on the responses of eagles to human intrusion. Some eagles are more sensitive to people than others, and this section attempts to evaluate this facet of eagle biology. Known behavior and other relevant information are recorded for each nest site.

Nesting History. The combined productivity of the nest sites within the territory is summarized here. A comparison is made between the productivity of this site or territory and the long-term average productivity for the forest, encompassing 14 years for some territories. History of nesting activity and the number of young produced at each nest in the territory for each year that records are available are tabulated in the plan. Correlations are often made between nesting success, pesticide analyses and land use activities, when valid information is available.

Additional Research Data. All research data relating to the eagles, such as banding, habitat use as determined by color-marking and radio-telemetry, pesticide studies, blind observations, etc., are summarized and, when possible, referenced to publications in this section of the plan.

Management Constraints. This is the most important part of the management plan because it guides and limits the options for managing the land in and proximal to a designated eagle territory. Based on observed behavior of the birds and known hazard potentials previously identified, recommendations are made concerning travelways that should be closed, seasonally restricted or relocated. Timber stands that should not be harvested are identified, as well as those that should have seasonal restrictions on harvest activities. Land use activities that are permissible in the various buffer zones are described and, when necessary, the reasons for modifying these activities are given. Special hazards are identified that may substantially affect the eagles, such as road and powerline maintenance, trail and road utilization, hunting and other specific human activities.

Implementation

The ultimate value of a planning process must be assessed on the implementation phase. Management plans for eagle territories on the Chippewa Forest are proving of considerable value to the land manager. Knowing the exact on-the-ground location of nest trees, fully identified on low-level aerial photos, is of significant, practical value. Land use constraints are identified and justified in the plan which provides unit managers, both now and in the future, with practical guidance.

Recommendations for closing, seasonal restriction, or rerouting travelways have already been implemented in many cases. Road closures or seasonal restriction of travel will be imposed on at least 78 different travelways to provide security for nesting birds. However, future action will depend largely on availability of funds and special program assistance.

Management recommendations are being included in timber sale contracts, and involve seasonal constraints and preservation of perch trees and potential nesting trees. A total of 15,424 acres (6,244 ha), or 2.2 percent of the land area of the Chippewa National Forest is under modified management procedures resulting from the establishment of buffer zones around eagle nests. About 12,543 acres (5,078 ha), or 2.0 percent is commercial forest land.

The management plans also support the purchase of intermingled private land for critical eagle habitat such as roosting areas and buffer zones not controlled by the national forest. These acquisitions are made possible under the Land and Water Conservation Fund Act. A number of critical tracts have already been purchased, and a total of 1,526 acres (618 ha) have been identified for acquisition.

The management plan is a useful tool for involving other agencies and individuals in bald eagle protection and management. State and county officials have agreed to adopt the management scheme proposed in the plans where their lands are involved. The management plans form a permanent record of data for future reference and study, and offer some exciting opportunities for statistical analysis.

Such management planning requires the expenditure of time and money. The funds to carry on this project have come, in large part, from the Hunt-Wesson/Forest Service, "Save the Eagle" promotion which resulted in a significant cash donation as well as donation of eagle nesting land to the Chippewa Forest from Hunt-Wesson Foods, Inc. It required about 7.5 man-days per plan to complete the field work, prepare the various plan elements, and review. Research expenditures and time spent by researchers on review of draft plans is not included. Other costs include airplane rental, photography, and transportation. This required a total outlay of about $260 per plan or $26,000 for 100 plans.

Summary

Existing bald eagle nest protection regulations prior to 1974 on the Chippewa National Forest were shown to be inadequate for some nests and territories. Since 1974, additional constraints and management actions have been implemented on the forest to improve eagle nest protection and to enhance bald eagle habitat and other forest resources. Important among these implementations has been the requirement of a detailed management plan for those forest areas in which eagle nests occur. Development and applications of management plans have proven of considerable value in confronting the complex and varied problems associated with land management on the Chippewa National Forest. Careful integration of forest and bald eagle management has resulted.

Acknowledgments

A host of biologists, foresters and technicians contributed to bald eagle management strategy, planning and implementation. No less than 20 people, including professional biologists, graduate students and student interns have been directly involved with collection of field data and plan formulation. The excellent cooperation and interest of the Chippewa National Forest's professional foresters responsible for implementing the plans and coordinating land use activities to accommodate bald eagles has been a refreshing experience with interdisciplinary land use planning.

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Habitat Development Aspects of the Dredged Material Research Program

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Introduction

Principal responsibility for the maintenance and improvement of the navigable waterways of the United States is vested in the U.S. Army Corps of Engineers. With its own equipment or by contract, the Corps periodically dredges thousands of miles of waterways and hundreds of commercial port facilities and small boat harbors. Annual costs of waterways maintenance are approaching $250 million and annual maintenance dredging volumes exceed 280 million cubic yards (214 million m^3). New work dredging approximates $50 million and 80 million cubic yards (61 million m^3) annually. The large volumes of dredged material generated often present extraordinary disposal problems. In the past, economic criteria were paramount in determining disposal location and method. However, during the last decade, environmental impact has become a significant factor and, from a practical standpoint, the controlling one for many dredging projects.

As a result of environmental and economic concerns, in 1970 Congress passed legislation that called for a comprehensive, nationwide research program to develop environmentally, economically, and technically acceptable dredged material disposal alternatives. In response the Dredged Material Research Program (DMRP) was established as a multi-objective research program that would require five years and $30 million to complete. The DMRP, being conducted by the U.S. Army Corps of Engineers' Waterways Experiment Station in Vicksburg, Mississippi, began in 1973 and will be completed in March 1978.

The technical structure of the DMRP is presented in Table 1. As shown on that table, the program is divided into four project areas and 20 tasks. One of the four projects, the Habitat Development Project (HDP), was designed to evaluate the potential of wetland, inland, and terrestrial habitat development as a disposal alternative. This discussion will center on the work being conducted in the five task areas of the HDP.

Habitat Development Project

The project has two main objectives. These are to determine the environmental impact of habitat development and to evaluate habitat development as a disposal alternative. The HDP is divided into 5 tasks: Task 2A, The Effects of Marsh and Terrestrial Disposal; Task 4A, Marsh Development; Task 4B, Terrestrial Habitat Development; Task 4E, Aquatic Habitat Development; and Task 4F, Island Habitat Development. These tasks are closely related and often grade naturally into one another.

Table 1. Technical structure of the Dredged Material Research Program.

Project/Task		Objective
Environmental Impacts and Criteria Development Project		
1A	Aquatic Disposal Field Investigations	Determine the magnitude and extent of effects of disposal sites on organisms and the quality of surrounding water, and the rate, diversity, and extent such sites are recolonized by benthic flora and fauna.
1B	Movements of Dredged Material	Develop techniques for determining the spatial and temporal distribution of dredged material discharged into various hydrologic regimes.
1C	Effects of Dredging and Disposal on Water Quality	Determine on a regional basis the short- and long-term effects on water quality due to dredging and discharging bottom sediment containing pollutants.
1D	Effects of Dredging and Disposal on Aquatic Organisms	Determine on a regional basis the direct and indirect effects on aquatic organisms due to dredging and disposal operations.
1E	Pollution Status of Dredged Material	Develop techniques for determining the pollutional properties of various dredged material types on a regional basis.
2D	Confined Disposal Area Effluent and Leachate Control	To characterize the effluent and leachate from confined disposal facilities, determine the magnitude and extent of contamination of surrounding areas, and evaluate methods of control.
Habitat Development Project		
2A	Effects of Marsh and Terrestrial Disposal	Identification, evaluation, and monitoring of specific short-term and more general long-term effects of confined and unconfined disposal of dredged material on uplands, marsh, and wetland habitats.
4A	Marsh Development	Development, testing, and evaluation of the environmental, economic, and engineering feasibility of using dredged material as a substrate for marsh development.
4B	Terrestrial Habitat Development	Development and application of habitat management methodologies to upland disposal areas for purposes of planned habitat creation, reclamation, and mitigation.
4E	Aquatic Habitat Development	Evaluation and testing of the environmental, economic, and engineering feasibility of using dredged material as a substrate for aquatic habitat development.
4F	Island Habitat Development	Investigation, evaluation, and testing of methodologies for habitat creation and management on dredged material islands.
Disposal Operations Project		
2C	Containment Area Operations	Development of new or improved methods for the operation and management of confined disposal areas and associated facilities.
5A	Dredged Material Densification	Development and testing of promising techniques for dewatering or densifying dredged material using mechanical, biological, and/or chemical techniques prior to, during, and after placement in containment areas.
5C	Disposal Area Reuse	Investigation of dredged material improvement and rehandling procedures aimed at permitting the removal of material from containment areas for landfill or other uses elsewhere.
6B	Treatment of Contaminated Dredged Material	Evaluation of physical, chemical, and/or biological methods for the removal and recycling of dredged material constituents.
6C	Turbidity Prediction and Control	Investigation of the problem of turbidity and development of a predictive capability as well as physical and chemical control methods for employment in both dredging and disposal operations.
Productive Uses Project		
3B	Upland Disposal Concepts Development	Evaluation of new disposal possibilities such as using abandoned pits and mines and investigation of systems involving long-distance transport to large inland disposal facilities.
4C	Land Improvement Concepts	Evaluation of the use of dredged material for the development, enhancement, or restoration of land for agriculture and other uses.
4D	Products Development	Investigation of technical and economic aspects of the manufacture of marketable products.
5D	Disposal Area Land-Use Concepts	Assessment of the technical and economic aspects of the development of disposal areas as landfill sites and the development of recreation-oriented and other public or private land-use concepts.

NOTE: This technical structure reflects the second major program reevaluation made after the second full year of research accomplishment and is effective as of August 1975.

Task 2A: Effects of Marsh and Terrestrial Disposal

Task 2A is primarily concerned with the environmental impact of wetland disposal. This problem is being approached in three ways. First, a series of 3-year studies on marsh plant productivity, including the evaluation of the productivity of minor marsh species, the determination of plant substrate selective properties, and construction of a model to predict productivity, were conducted by researchers from the University of Virginia, the University of Georgia, and Louisiana State University [4A04A, 4A04B, 4A05, 4A06][1]. A synthesis of these findings coupled with the existing literature will aid in the quantification of the impact of disposal at a given site, permit the identification of least critical areas, and provide the necessary information for the design of highly productive man-made marshes.

The response of marsh plants to physical and physiological stresses also has been evaluated in this task area. A good example is research being conducted near St. Simons Island in Georgia in which the response of smooth cordgrass (*Spartina alterniflora*) to sand, silt, and clay dredged material deposition at 3-inch (8 cm) increments from 3 to 36 inches (8 to 91 cm) is being evaluated under controlled field conditions [Report 2A07]. To interpret seasonal impacts, the experiment has been repeated during the winter, summer, and autumn months. Preliminary data indicate substantial recovery in disposal depths to 9 inches (23 cm), but little recovery above 12-inch (30 cm) deposits. Recovery appears independent of the texture of the dredged material.

The potential for uptake of contaminants into plants growing on dredged material and the subsequent release of these contaminants into the environment through decomposition or grazing has formed the third category of Task 2A. This research was initiated by a study to determine the fate of various heavy metals made available to marsh plants in a hydroponic solution [Report 4A15A]. The results of that study have been verified through rigorous evaluation of marsh plants growing as volunteers on dredged material deposits and have shown that heavy metals generally did not concentrate in the leaves of those plants. Present research in this area is oriented toward development of a methodology to predict the possibility of plant heavy metal uptake from a given dredged material prior to selection of the marsh development disposal alternative [Report 2A05 and 4A15].

Task 4A: Marsh Development

The major objective of the HDP is the evaluating the feasibility of marsh development as a disposal alternative for dredged material. Research in marsh establishment has progressed through an initial assessment of the state-of-the-art to detailed laboratory analysis and field verification [Reports 4A01, 4A03, 4A08]. Field sites have been established or attempted at Branford Harbor, Connecticut; Potomac River, Virginia; James River, Virginia; Buttermilk Sound, Georgia; near Apalachicola, Florida; Galveston Bay, Texas; San Francisco Bay, California; Columbia River, Oregon; and Grays Harbor, Washington (Fig. 1).

Studies at Branford Harbor, Connecticut, and Grays Harbor, Washington, have been terminated, the first for sociological and the latter for engineering

[1]Bracketed numbers refer to appropriate DMRP research reports that are or soon will be available upon request.

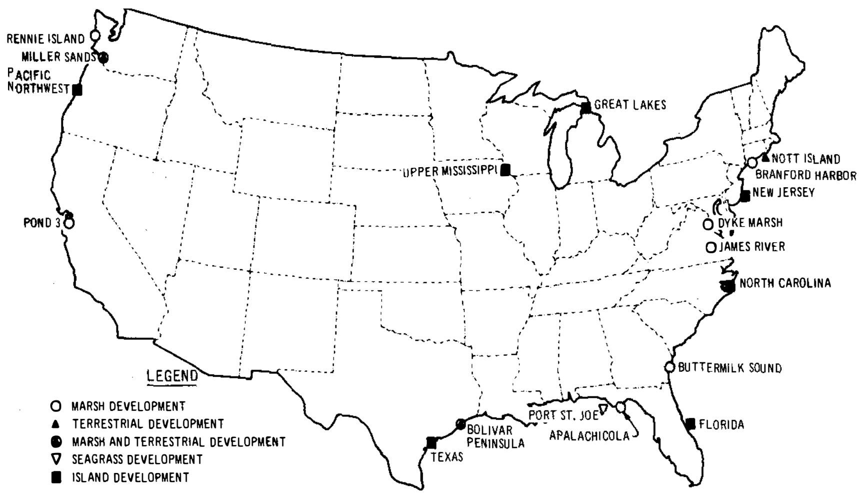

Figure 1. Location of the Dredged Material Research Program habitat development field studies.

reasons. The Potomac River site is designed but not yet under construction. All other sites are fully operational.

The field site at Branford, Connecticut, was terminated in October 1976 [Report 4A10A-J]. The plan entailed the development of an 8-acre (3.2-ha) salt marsh adjacent a 50-acre (20-ha) existing marsh, thereby disposing of 40,000 cubic yards (30,600 m^3) of fine-grained, contaminated dredged material from a nearby recreation channel. From its conception, this project met with substantial local opposition and despite numerous safeguards and assurances, community approval was never attained. The most common concern voiced by opponents was that the experimental marsh might, because of its experimental nature, threaten real estate values in the area. Other concerns were odor, danger to neighborhood children, and mosquitoes. Repeated delays finally placed the project in an untenable time frame, which resulted in its cancellation.

A 20-acre (8.1-ha) marsh-island complex in the James River, Virginia, was built in January of 1975 by taking 218,000 cubic yards (167,000 m^3) of contaminated fine-grained dredged material from the navigation channel and confining it within a rectangular, hydraulically placed sand dike [Report 4A11A-M]. The dike was breached in two places to allow water interchange between the river and the marsh. Artificial propagation was planned for this site, but natural invasion was so rapid that, by the end of the first growing season, the area had become fully vegetated with a desirable mix of wetland species including arrow arum, (*Peltandra virginica*), pickerel weed (*Pontederia cordata*), and arrowhead (*Sagittaria latifolia*). The main aspects of the research at the James River site now involve evaluation of the uptake of contaminants by plants growing on the polluted dredged material and documentation of the plant productivity and animal use of the site. These studies should result in important findings regarding the environmental impact and feasibility of freshwater marsh development on fine-textured materials. Old Dominion University and the Virginia Institute of Marine Science are the prime contractors for this study.

A 28-acre (11.3-ha) freshwater marsh has been designed for Dyke Marsh on the Potomac River just south of Alexandria, Virginia [Reports 4A17 and 4A17A]. This area, once a sizable marsh, was extensively mined for gravel from 1930 through 1970, and during these mining operations a considerable portion of natural marsh was destroyed. Ownership of the area has since passed to the Federal Government, and the National Park Service has a Congressional mandate to manage Dyke Marsh for fish and wildlife purposes. The Waterways Experiment Station has entered into a cooperative study with the National Park Service, the Corps' Baltimore District, and the U.S. Fish and Wildlife Service to evaluate the feasibility of using dredged material from the Potomac River as a substrate for marsh establishment at this site. An engineering evaluation of the site demonstrated the technical feasibility of marsh restoration, and detailed analysis of alternatives and impacts is now in progress. If this project is completed, approximately 10 percent of Dyke Marsh will be restored to near original conditions. As presently envisioned a 28-acre (11.3-ha) area would be inclosed by a sand dike and filled with sediment from the Potomac River. Subsequently the dike would be lowered to the intertidal elevation of the substrate. Natural invasion from surrounding marsh is expected to rapidly establish a new marsh.

A dredged material island at Buttermilk Sound near the Georgia coast was selected in 1975 for wetland creation, and subsequently a 3-acre (1.2-ha) salt marsh was developed there by shaping a mound of sandy dredged material so that approximately half was intertidal [Report 4A12A-C]. More than 800 plots have been established at this site to test the survival and productivity of seven marsh plant species (*Borrichia frutescens, Distichlis spicata, Iva frutescens, Juncus roemerianus, Spartina alterniflora, Spartina cynosuroides,* and *Spartina patens*), at three tidal elevations, under four fertilizer regimes, and using sprigging and seeding as propagative techniques. This project is also designed to obtain data on nutrient cycling in marsh systems, and investigate substrate stabilization and productivity in the algal mat that is often characteristic of marsh communities. The University of Georgia has been contracted to complete this research.

A small marsh creation project is being conducted at Apalachicola, Florida, to test the efficacy of planting smooth cordgrass and saltmeadow cordgrass (*Spartina patens*) on poorly consolidated fine-grained marine sediments [Report 4A19]. Optimal planting distances and the relationship of elevation and productivity are being evaluated at this site. The operational constraints encountered in the use of mechanical equipment on unconsolidated material are also an aspect of this study.

A major salt marsh site has been established on sandy dredged material on the Bolivar Peninsula near Galveston, Texas [Report 4A13A-K]. A 9-acre (3.6-ha) smooth cordgrass and saltmeadow cordgrass marsh was established along a sterile intertidal deposit by enclosing the area with a sandbag dike to provide protection from waves. The sandbags used in this experiment are 10 ft by 4 ft by 2 ft (3.0 m by 1.2 m by 0.6 m) and weigh about 7,000 lb (3175 kg) when full. These are cloth bags, laid in place empty and filled with a sand slurry. Such a dike structure provides a rapid and relatively inexpensive protective device suitable for use on solid soil foundations in areas of high wave and current energies.

The major emphasis at the Bolivar Peninsula site is to determine responses of smooth cordgrass and saltmeadow cordgrass to variations in elevation, nutrients, and propagation procedures and to carefully evaluate benthic and nektonic colonization of the artifically propagated area. Texas A&M University has the contract for the research at this site.

Marsh development on marine clay sediments is being tested in an abandoned salt production pond in South San Francisco Bay [Report 4A18]. In 1973, the Corps' San Francisco District filled a salt pond known as Pond #3 with 650,000 cubic yards (497,000 m^3) dredged clay with the intention of marsh creation. The material dried and consolidated for two years and was planted in 1975 with California cordgrass (*Spartina foliosa*) and Pacific glasswort (*Salicornia pacifica*). Approximately 5 acres (2 ha) of each species were hand planted (sprigged) and 5 acres (2 ha) of each species were seeded. The research at this site should evaluate salt marsh productivity on fine-grained material, optimum spacing for sprigging, planting season, seeding techniques, and benthic colonization of the newly planted marsh.

A salt marsh development project originally planned at Rennie Island in Grays Harbor, Washington, was terminated after a detailed baseline analysis [Report 4A14A-D]. These studies indicated that extremely high wave-energy conditions at the site would make marsh development unfeasible without a substantial protective and retaining structure. Foundation analysis indicated a weak, unstable condition that mitigated against a conventional rock or earthen dike. An evaluation of various alternative structures revealed that no economically feasible options were available, and the project was ended.

A freshwater marsh has been developed at Miller Sands in the Columbia River in Oregon [Report 4B05A-M]. Miller Sands is located approximately 24 miles (39 km) from the mouth of the Columbia River and is part of the Lewis and Clark National Wildlife Refuge. Miller Sands is a large dredged material island (approximately 160 acres [65 ha]) placed in the 1930s using sandy dredged material from the navigation channel of the Columbia River. A 250-acre (101-ha) cove was created by disposing of approximately 2 million cubic yards (1.5 million m^3) of material in a strand connecting and partially parallel to the main island. Six species of marsh grass, covering 8 acres (3.2 ha) are being tested at this site. The species under evaluation are Lyngby's sedge (*Carex lyngbyei*), broad-leaved arrowhead (*Sagittaria latifilia*), American bullrush (*Scirpus validus*), common rush (*Juncus effusus*), slough sedge (*Carex obnupta*) and tufted hairgrass (*Deschampsia caespitosa*). Should this prove successful, approximately 200 acres (81 ha) of marsh could be placed within the existing cove. Plant survival and productivity, wildlife usage, and benthic and nektonic colonization are being evaluated at Miller Sands. The principal researchers are Washington State University, The Wave Beach Grass Nursery, Oregon State University, and the National Marine Fisheries Service.

Task 4B: Terrestrial Habitat Development

Another major task area of the HDP is the development of biologically desirable habitats on dredged material placed on upland sites. The product of these studies will be guidelines for the reclamation of disposal sites for wildlife use. An important part of this effort will be a users guide for selecting target species and desired habitats based on edaphic factors, plant requirements, and target species management.

As in marsh research, the concepts of terrestrial habitat development are being evaluated on the basis of field verifications. Upland habitat development field studies are now underway at Nott Island, Connecticut; on the Bolivar Peninsula, Texas; and on Miller Sands in the Columbia River. The latter sites have been established in conjunction with the ongoing marsh research development studies mentioned previously. Each of these studies addresses the problem of establishing productive habitats on infertile, sandy, and often dry disposal sites.

Nott Island, an upland habitat development site in the Connecticut River, is located about 7 miles (11 km) upstream from Long Island Sound [Report 4B04A-G]. Upland disposal of dredged material from the navigation channel is a historic problem in this area, often producing mounds of sandy material of little or no biological value. An 8-acre (3.2-ha) goose pasture has been created at Nott Island by filling a diked disposal area with 23,000 cubic yards (17,600 m^3) of coarse-grained material from the navigation channel, and topdressing the area with 11,500 cubic yards (8,800 m^3) of fine-grained material from a nearby recreation channel. After consolidation the two materials were mixed and limed. A variety of grasses and legumes are being tested at this site, including tall fescue (*Festuca elatior*), white clover (*Trifolium repens*), red clover (*Trifolium pratense*), orchard grass (*Dactylis glomerata*), perennial rye grass (*Lolium perenne*), and timothy (*Phleum pratense*).

Another study at the Nott Island site involves the development of techniques for control of the common reed (*Phragmites communis*). This species has little wildlife value in that area and is a vigorous invader on upland disposal sites. Preliminary data indicate that control can be achieved with the herbicide Dalapon (trade name Dow Chemical Company) or by repeated mowings over a single growing season. Connecticut College is the principal contractor at Nott Island [Report 4B04D].

Reclamation of a dry upland disposal site was incorporated into the Bolivar Peninsula marsh-establishment project in Galveston Bay [Report 4A13A-K]. Research here is centered around the evaluation of the success of several desirable wildlife plant species under a series of fertilizer regimes. Upland plants include sand pine (*Pinus clausa*), wax myrtle (*Myrica cerifera*), live oak (*Quercus virginiana*), tamarisk (*Tamarix gallica*), sumac (*Rhus aromatica*), croton (*Croton punctatus*), bermuda grass (*Cynodon dactylon*), bluestem (*Andropogon perangustatus*), and beach panic grass (*Panicum amarulum*). The objective of this effort is to identify trees, shrubs, and grasses that are adaptable to similar disposal sites along the gulf coast.

A 50-acre (20-ha) upland habitat site, established in conjunction with the marsh development at Miller Sands in Oregon, has been planted to grasses and legumes in an effort to produce a nesting meadow. The infertile sandy soils at this site, combined with grazing pressures from a very large population of nutria (*Myocastor coypus*), has held this 40-year-old disposal area at an unproductive vegetative stage. Fertilization, introduction of desirable wildlife plants, and an intensive nutria control program are designed to improve the desirability of the area for nesting birds. Upland species being evaluated at this site are white clover, red clover, tall fescue, creeping red fescue (*Festuca rubra*), hairy vetch (*Vicia villosa*), tall wheatgrass (*Agropyron elongatum*), hannchen barley (*Hordeum vulgare*), and bentgrass (*Agrotis oregonensis*).

Task 4E: Aquatic Habitat Development

Two concepts are behind the aquatic habitat development task: first, habitats such as tidal flats, oyster beds, and seagrass meadows could be established on dredged material: and second, elevating the bottom of a water body can increase light penetration to the bottom and potentially increase the productivity of that substrate. In many cases, elevating the bottom with dredged material would significantly increase the biological productivity of a site, and in the process a considerable volume of dredged material would be disposed.

The research in this task has taken the form of a state-of-the-art survey of the potential for dredged material stabilization by seagrasses and the impact of the disposal of dredged material on seagrasses [Report 4E01]. Species under consideration are turtle grass (*Thalassia testudinum*), eelgrass (*Zostera marina*), shoalgrass (*Halodule* spp.), manateegrass (*Syringodium filiforme*), and widgeongrass (*Ruppia maritima*). Additionally, a small field site has been established at Port St. Joe, Florida, where shoalgrass (*Halodule beaudetti*) was transplanted onto a disposal area. Research in the field of aquatic habitat development will receive increased attention should these initial efforts demonstrate that development of aquatic habitat offers a promising disposal alternative.

Task 4F: Island Habitat Development

The island habitat development task is designed to assess the importance of dredged-material island habitats to wildlife. There is a substantial body of evidence to indicate that dredged material islands provide exceptionally important nesting habitat for several species of colonial nesting seabirds, shorebirds and wading birds along the Atlantic and Gulf Coasts.

The island development task, like the aquatic habitat task, is a relatively new research area, and field studies have just been initiated. The selected approach is to quantify, on a regional basis, the patterns of vegetative succession and the wildlife importance of existing dredged material islands. This information will permit decisions on the optimal size and shape of dredged material islands and will provide recommendations as to the management and disposal on these areas. Regional studies of dredged-material islands are being, or will be, conducted in the Great Lakes, Texas, Florida, North Carolina, New Jersey, the Pacific Northwest, and Upper Mississippi River.

Summary

Habitat development using dredged material offers an alternative disposal method often feasible from biological, engineering, and economic standpoints. Careful implementation of this alternative could significantly increase the extent of wetland and wildlife resources in many parts of the United States.

Marsh establishment has received more attention than any other alternative, and techniques have been developed to enable careful planning, design, and propagation of these systems. Terrestrial habitat development is primarily the application of established wildlife management and soil reclamation procedures at a particular disposal area. The feasibility of the terrestrial habitat alternative has been documented at three sites. The development of aquatic habitats on dredged material appears to offer significant potential for the creation of highly productive biological communities and at the same time provide for large disposal quantities. However, aquatic habitat development requires additional research before it is implemented on a large scale. Studies currently underway on wildlife use and vegetative succession on dredged-material islands will provide the basis for guidelines for the design and management of those resources. These guidelines will be available in the summer of 1978.

Socioeconomic Dimensions in Fish and Wildlife Management

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Dynamics of the New Jersey Hunter Population

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Introduction

Recent years have seen an increasing number of studies directed at the consumer of wildlife resources, as opposed to the more traditional investigation of biological aspects of important wildlife species. Appropriately, a majority of these studies have been aimed at the sport hunter—the principal consumer of the wildlife resource and the primary source of the revenue that sustains wildlife management programs. Schole (1973), in a review of the literature on characteristics of hunters, cites 110 articles, 28 of which present original research data describing hunter attributes. The typical format of these studies is a description of hunters with respect to a particular state, group of states, area, or type of game. Samples are selected from license stubs within the defined population. Results include tabulation of standard socioeconomic and demographic parameters; discussions include explorations into attitudes, motivations, and preferences and comparisons with results of other studies.

While these studies have been important in providing insights into the nature of the predominant clientele of wildlife management agencies, the bulk of this literature has been discouragingly static and has provided little insight into the dynamic

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aspects of hunter populations. Hendee and Potter (1971) and Allen (1973) recognized this, but no studies to date have followed their suggestion for a dynamic approach to hunter populations. In a sense, this is most unusual, since wildlife researchers have been pioneers in the dynamic approach to population studies.

The purpose of this study is to provide a descriptive account of the dynamics of a population of sport hunters. The description will take the approach used in classical analysis of wildlife populations, including the presentation of a "life" table, "survival" curve and age structure, and consideration of "natality" and age specific mortality rates. The population is that of New Jersey sport hunters. In one sense New Jersey's may be atypical of hunter populations in general because of the unique pressures of high population and limited open space in the state; in another it may be most appropriate that such a study be made under circumstances that may ultimately develop throughout much of the country.

Methods

Collection of data for a description of hunter population dynamics requires some interesting modifications of classic techniques. The "life" we are interested in is simply the years of active participation in hunting, representing a subset of the chronological life of the hunter. "Birth" in this context is comparable to initiation or recruitment into hunting and "death" occurs when the individual ceases to hunt (desertion). An advantage in working with hunters is that "dead" individuals remain in the general population, capable of providing the data necessary for analysis of age-related desertion.

Data were collected from all active and inactive hunters identified in a random sample of New Jersey residents. The data were collected in the New Jersey Poll, a quarterly telephone survey of the general population of New Jersey conducted by the Eagleton Institute for Politics at Rutgers University. Each poll consists of a random selection of approximately 1200 residents of New Jersey over the age of 18 years. Details of sample selection and data collection are available in a previous paper (Applegate 1973).

For the present study, each respondent was asked "Have you ever gone hunting?" Respondents who had hunted were asked to give the age at which they began hunting. They were then asked "Have you hunted in the past two years?" Those who responded positively to this question were classified as active hunters. Negative respondents were classified as inactive hunters and asked to give the age at which they ceased hunting. This series of questions was added to four New Jersey Polls from May 1973 to March 1974 in order to obtain an adequate sample of active and inactive hunters. Additional questions on selected aspects of hunting participation were asked on several polls during the course of the study. These will be described as they are presented later in the paper. Chronological age of each respondent was recorded in 5-year age classes and used in the analysis of age-related desertion. Demographic and socioeconomic data collected for each respondent included sex, income, education, race, occupation, and residence (converted in this study to an index of township population density). Additional data presented in this paper were compiled from the records of New Jersey's Division of Fish, Game and Shellfisheries.

Table 1. Relationship to hunting among New Jersey residents (percent), tabulated by sex of respondent.

	Men (n = 2323)	Women (n = 2536)	Total (n = 4859)
Nonhunters	65.3	93.0	79.8
Inactive hunters	22.0	5.5	13.4
Active hunters	12.7	1.5	6.8

Results

General

A total of 4,859 residents of New Jersey were contacted in four polls between May 1973 and May 1974. Of these, 982 (20.2 percent) said that they had hunted at some time in their life. Three hundred and thirty respondents (6.8 percent) had hunted during the 2 years prior to the poll. In New Jersey, then, inactive hunters outnumber active hunters by 2:1. Distribution of these responses by sex (Table 1) reveals that more than one-third of the male population of New Jersey (34.7 percent) has had some hunting experience and that 12.7 percent continue to hunt.

Age of Recruitment and Desertion

The distribution of age of recruitment and desertion appears in Table 2. The general nature of the recruitment data is not new, since others have found that

Table 2. Tabulation of age of recruitment and desertion among New Jersey hunters.

	Recruitment			Desertion		
Age class	n	Percent	Cumulative percent	n	Percent	Cumulative percent
Under 10	63	6.4	6.4	10	1.5	1.5
10-14	353	36.0	42.4	36	5.5	7.0
15-19	350	35.7	78.1	165	25.4	32.4
20-24	117	11.9	90.0	110	16.9	49.3
25-29	57	5.8	95.8	81	12.5	61.8
30-34	18	1.8	97.6	73	11.2	73.0
35-39	6	0.6	98.2	44	6.7	79.7
40-44	6	0.6	98.8	40	6.1	85.8
45-49	6	0.6	99.4	40	6.1	91.9
50-54	2	0.2	99.6	22	3.4	95.3
55-59	0	0.0	99.6	6	0.9	96.2
Over 60	4	0.4	100.0	25	3.8	100.0
Total	982	100.0		652	100.0	

Table 3. Percent of hunters recruited prior to age 20 in various studies. The difference between the present study and all others is statistically significant (x^2 test, α = .05) with the exception of Davis (1967).

Source	State	Percent recruited by age 20
Applegate (present study)	New Jersey	78
Klessig and Hale (1972)	Wisconsin	92
Schole et al. (1973)	Colorado	90+
Bevins et al. (1968)	6 N. E. States	89
Davis (1967)	Arizona	65
Peterle (1961)	Ohio	90+

initiation into hunting occurs quite early in life (Klessig and Hale 1972, Bevins et al. 1968, Davis 1967, Schole et al. 1973, and Peterle 1967). The New Jersey data, however, show a lower proportion of hunters recruited before the age of 20 than was found in all other studies except that of Davis (Table 3). Data to be presented later in this paper relate desertion to ages at recruitment—hunters recruited at older ages tend to be more transient in the population. Samples selected from the population of active hunters have therefore apparently underestimated the actual proportion of hunters that begin hunting later in life.

Data on desertion in Table 2 are incomplete because of the method of data collection. There are many young hunters in the sample who have not yet had the opportunity to desert in the higher age classes. Nonetheless, the preponderance of desertions in early years of hunting is real and will be discussed later in this paper.

Factors Related to Desertion

Univariate analysis revealed the following factors to be related to desertion from hunting (Table 4): (1) age—percentage of active hunters decreases with increasing age; (2) sex—a higher proportion of men remain active in hunting; (3) occupation—a higher proportion of blue collar workers remain active; (4) income—active hunters are more common among lower income levels; (5) age at initiation of hunting—those who begin hunting earlier tend to remain active longer; and (6) the age of hunting companions during initiation[1]—a higher proportion of those who begin hunting with older companions remain among the active hunters. Of interest are those factors that were not significantly related to desertion from hunting, including population density of the respondent's home town (γ = .05; .05 < p < .10) and education (γ = .07; .05 < p < .10). These results differ from the only other published data on desertion from hunting (Klessig 1970). The data have been included in Table 4.

Age-specific Desertion

The life table, long employed by wildlife biologists in tabulating deaths in game populations, provides an appropriate format for examining age-related desertion

[1]In 2 of 4 polls, 437 active and inactive hunters were asked, "When you first went hunting, did you ususally hunt with people about your own age, with someone older such as your father or an uncle, or by yourself?"

Table 4. Relationship between selected factors and desertion from hunting.

Factor (γ)	Level	n[a]	% Active hunters
Sex (.39)[b]	Male	759	37.7
	Female	175	21.1
Age (.36)[b]	18–20	93	61.3
	21–29	235	42.6
	30–39	220	36.8
	40–49	178	27.0
	50 +	198	17.7
Occupation (.19)[b]	Blue collar	325	41.8
	White collar	393	33.1
Income (.13)[b]	Under $15,000	537	37.1
	Over $15,000	399	31.1
Age at initiation (.21)[b]	Under 20	694	38.6
	Over 20	173	28.9
Age of hunting compantions at initiation (−.22)[b]	Same age	121	24.0
	Older	318	33.0
Education (.07)	H. S. incomplete	164	32.9
	H. S. complete	379	39.3
	More than H. S.	385	30.6
Population density (.05)	Under 1000/mi²	170	36.5
	1000–2500/mi²	164	32.9
	2500–5000/mi²	182	37.4
	5000–10,000/mi²	231	31.6
	over 10,000/mi²	152	32.9

[a] Sample size of respondents who have hunted at some time.
[b] These factors are significantly related to desertion (α = .05) using the Gamma (γ) method of Goodman and Kruskal (1954).

rates in a hunter population. In this study, respondents were divided into cohorts of 5-year intervals (chronological age) for the purpose of developing a life table.[2] The youngest cohort represented individuals 18-20 years of age; the oldest age class was 55+. For each inactive hunter, the number of years of active hunting was determined by calculating the difference between age at desertion and age at initiation, plus one (an individual who started hunting at age 15 and stopped at age 15 hunted one year, thus the necessity of adding one year to the difference). Within a cohort, then, the number of individuals who deserted hunting within five years of initiation were counted. Calculating the proportion of the cohort that deserted during their first 5 years of hunting provided an estimate of the "mortality" rate for that hunting age interval (q_{1-5}). Repeating this process for each 5-year interval provided estimates of "mortality" rates for all age intervals for each cohort.

A unique problem with this approach to the development of the life table is that hunting "birth" does not occur at a constant chronological age for all individuals — a hunter may be "born" at age 12 or at age 20. The immediate complication is that estimation of mortality in the most recent time intervals is biased downward

[2]For the purpose of developing a life table, it is important to recognize that a respondent has a chronological age—the actual number of years he has lived—and a hunting age—the number of years he has been participating in hunting.

since all individuals have not had an opportunity to desert during that age interval. For example, the respondent may be an active hunter of age 20 who began hunting at age 14. He is therefore "alive" during hunter age interval 6–10. His desertion at age 22, which must be considered for an accurate estimate of q_{6-10}, will not be recorded using the methods of this study.

In examining each cohort life table, the interval in which the bias was manifested was easily determined. In the age class 18-20, for instance, q_{6-10} was estimated at 0.049 compared to q_{6-10} of 0.220, 0.197, 0.262, 0.250, etc., for subsequent cohorts. In generating mortality rates for a composite life table this more recent interval was not used in each cohort. "Juvenile" mortality (q_{1-5}) in the composite life table is therefore based on tabulated desertions within the first five years of hunting for all age classes; q_{6-10} for desertions in the second 5 years for age classes 21-25 and older; q_{11-15} for desertions in the third 5 years for age classes 26-30 and older, etc. It should be remembered that estimates of mortality are slightly conservative as a result of belated recruitment in a small proportion of hunters. When data are treated in this way, estimates of mortality in the life table are based on a declining sample size. For example, q_{1-5} is based on a sample of 928; q_{41-45} is based on a sample of 49. An insufficient sample size of older hunters prevents a meaningful estimation of mortality beyond hunting age 45. The life table is thus incomplete, leaving 165 of a hypothetical cohort of 1000 hunters still active after hunting 45 years. Expectation of life, normally included in a life table, has been omitted due to the incomplete nature of the life table.

The composite life table for New Jersey hunters, derived from the data in the manner described, is presented in Table 5. A survival curve based on the table is presented in Figure 1.

The data indicate that desertion rate (q_x) is comparatively high during early intervals (29 percent and 18 percent) and then declines to a relatively stable level (14-16 percent per 5-year period) over the midrange. The data also suggest increasing desertion with advancing chronological age (18 percent and 22 percent at hunting age 36-40 and 41-45, respectively). Also indicated is the fact that a substantial proportion of hunters have a relatively transient participation in the sport—almost half of the hunters (41 percent) had deserted within 10 years of initiation.

Table 5. A life table for the New Jersey hunter population. Sample sizes did not warrant extrapolation beyond 45 years. The incomplete life table precluded estimation of e_x.

Age class (Hunting age)	l_x	d_x	q_x
1–5	1000	287	0.287
6–10	713	126	0.176
11–15	587	85	0.145
16–20	502	81	0.162
21–25	421	58	0.139
26–30	363	53	0.146
31–35	310	47	0.151
36–40	263	48	0.183
41–45	215	48	0.225
46–50	167		

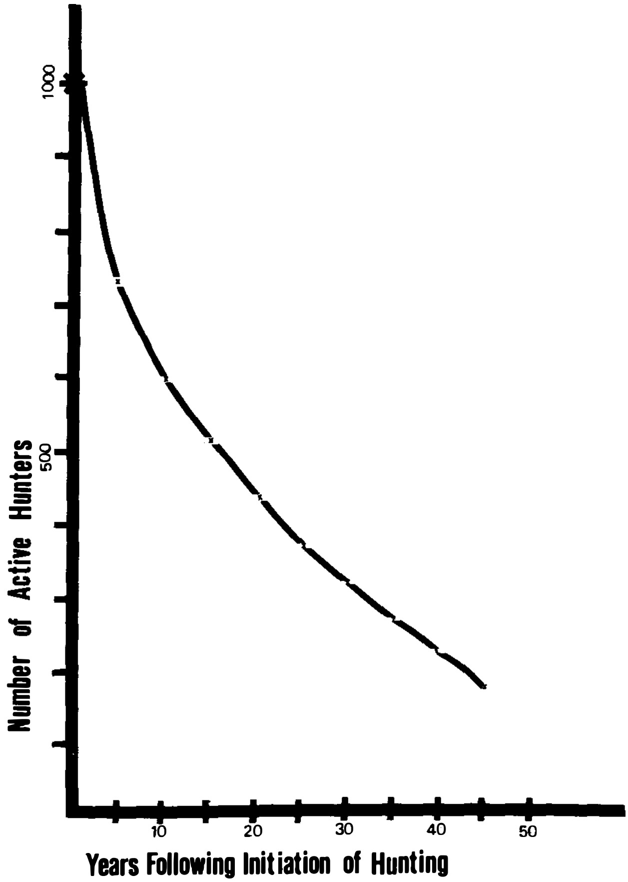

Figure 1. A "survival" (=desertion) curve for New Jersey's hunters.

Data collected from 1957 to 1973 by New Jersey's Division of Fish, Game and Shellfisheries during annual harvest surveys provide an estimate of the rate of desertion in the overall population of licensed New Jersey hunters. Samples were selected from licensed hunters in year t and questionnaires were mailed in years $t+1$ and $t+2$. Respondents were asked if they purchased a license for the current year. The data indicate that, on the average, 12.5 percent ($\overline{X}$ of 8 observations; maximum = 15.9 percent; minimum = 9.6 percent) of New Jersey's licensed hunter population drop out of the population each year. Over a 2-year period, the average desertion rate is 17.5 percent ($\overline{X}$ of 7 observations; maximum = 20.6 percent; minimum = 12.1 percent). Again, the data reflect a relatively high rate of turnover in the population of New Jersey hunters.

Juvenile Mortality

"Juvenile mortality" — desertion within the first 5 years of hunting — is related to cohort, to age at which an individual began hunting, and to age of the individual's hunting companions at the time of initiation (Table 6). Mortality rates are

Table 6. Relationship between selected factors and "juvenile mortality" (q_{1-5}).

Factor (γ)	Level	n	q_{1-5}
Chronological age (.25)	Under 30	291	0.375
	30's	194	0.299
	40's	177	0.254
	50+	266	0.203
Age at initiation (-.24)	Under 15	369	0.187
	15–19	313	0.319
	20+	183	0.306
Age of hunting companions at initiation (.25)	Same age	132	0.356
	Older	305	0.249

higher among those who began hunting in recent years, among those who commence hunting at an older age, and among those who began hunting with companions of their own age.

Reentry

Individuals can drop out of the hunting population and reenter at a later time. Discontinuity of life presents a problem not encountered in normal life tables. While this study presents no methodological breakthrough for a problem that has limited general application, an idea of the extent of discontinuity of hunting experience was obtained from a sample of respondents who were asked if they had hunted every year since their initiation. Only 21 of 237 (8.9 percent) hunters sampled during one of the four polls indicated a discontinuity in their hunting experience. Of these, 8 had their hunting interrupted by a change of life style during late teens or early twenties (college, military service, marriage),[3] 6 indicated a temporary lack of time or interest, and the remaining 7 had a variety of reasons for temporarily dropping out of the hunting population. While these data are very preliminary, they suggest that discontinuity of the hunting experience is not common. Development of a better data base, and a consideration of the impact of discontinuity on hunter populations dynamics, awaits a more definitive study.

Recruitment

An important aspect of hunter population dynamics is that of annual recruitment and time-related variations in levels of recruitment. Although this study is directed principally at desertion phenomena, a brief consideration of recruitment is appropriate. The best data on recruitment in New Jersey are obtained from records of hunter safety instruction. Since 1955 a hunter has been obliged to pass a standard course prior to obtaining the initial hunting license. The data indicate a gradual increase in annual recruitment over time (Fig. 2), which is most interesting in light of the low hunting participation rates in the Middle-Atlantic region (U.S. Bureau of Sport Fisheries and Wildlife 1972) and the general contention that sport hunting is declining in populous areas. Annual recruitment is presently on the

[3]Note the underrepresentation of hunters in the 18-22 age class reported in Figure 3.

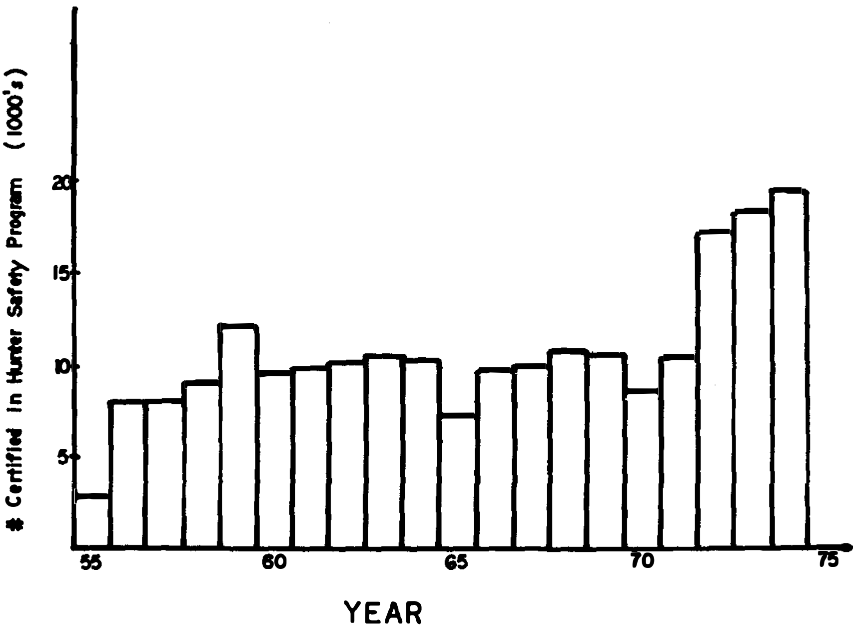

Figure 2. An index to recruitment into New Jersey's hunting population, 1956–1974: the number of individuals certified in hunter safety programs. Beginning in 1972, the program was expanded to include new hunters aged 10–13.

order of 17,000-19,000 per year, a figure which roughly balances annual desertion, yielding a population of licensed New Jersey firearm hunters that is relatively stable in recent years at 165,000-180,000.

Age Structure

Previous studies have reported age structures of hunting populations that reflect lower participation among younger age classes (Davis 1967, Folkman 1963, Garrett 1970, Kirkpatrick 1965, Klessig and Hale 1972, Lobdell et al. 1969, Nobe and Gilbert 1970, Peterle 1967, Sendak and Bond 1970). The reported modal age class is most often 30-39; less frequently, 20-29. Generally, the under-20 age class is well below the older classes.

Data collected in the present study (Fig. 3) suggest an age structure more in keeping with the dynamics of recruitment and longevity that have already been described.[4] An age distribution developed from a random sample of 1972 New Jersey hunting license stubs (Fig. 4) indicates the same phenomena; that is, the modal age classes are the youngest age classes. Older age classes decline in size as hunters desert and negligible recruitment occurs.

Inconsistencies between this and other studies may result from methodological differences. The data presented here have been collected from telephone inter-

[4]Note in Figure 3 that the youngest age class represents only 3 years compared to 10 years for other classes, due to sampling limitations of this study; i.e., phone interviews were only conducted with adults aged 18 and over. It is the author's belief that a study sampling respondents below the age of 18 would provide an age structure with the under-20 class being the modal age class.

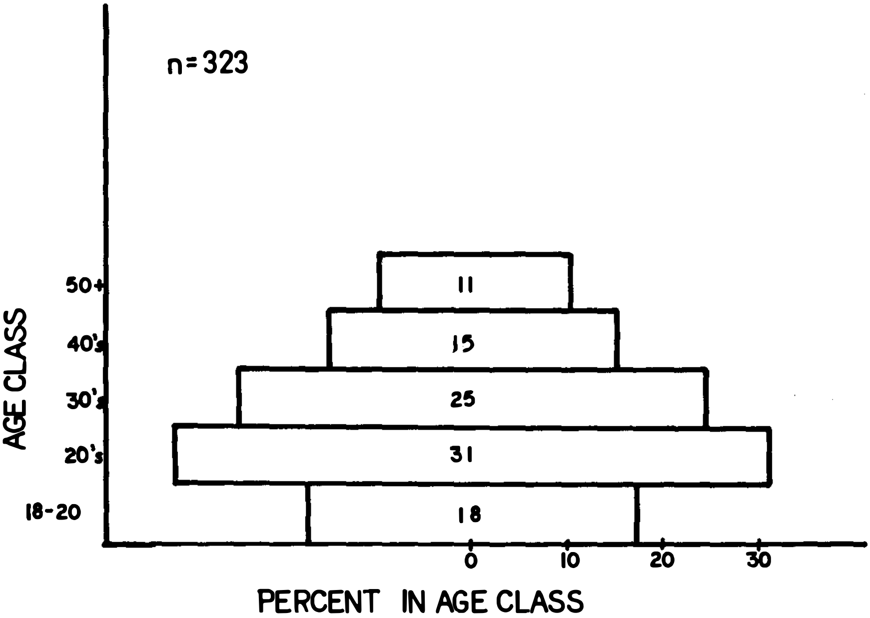

Figure 3. Age structure of New Jersey's active hunting population, based on phone interviews, 1973–1974.

views and from examination of license stubs, whereas most previous studies have reported data tabulated from respondents to mail questionnaires. I suspect that an age-related nonresponse bias may have affected earlier results. Folkman (1963) has reported this age-related nonresponse for hunters in California, but the age structure reported by him, based on hunting license data, showed a 30-45 mode with lower representation in younger age classes. The age structure of hunter populations in other states, and implications with regard to population trends, need to be re-examined in light of the present study.

Emigration

In each poll, active hunters were asked if they had hunted outside New Jersey during the previous two years. Among the 330 active hunters, 144 (44 percent) indicated that they had done so. Among 132 respondents identified as purchasers of 1972 New Jersey firearm hunting licenses, 38 percent had hunted outside New Jersey in either 1971 or 1972. While there are no comparable data in other studies of hunters, these figures reflect a substantial level of exportation of hunting demand from New Jersey.

Discussion

This paper has provided an initial attempt at describing dynamic aspects of a population of hunters. The value of this approach, and the relevance of the New Jersey data to populations in other states and at other times, remains to be seen. Nonetheless, this approach has provided an opportunity to consider hunter popu-

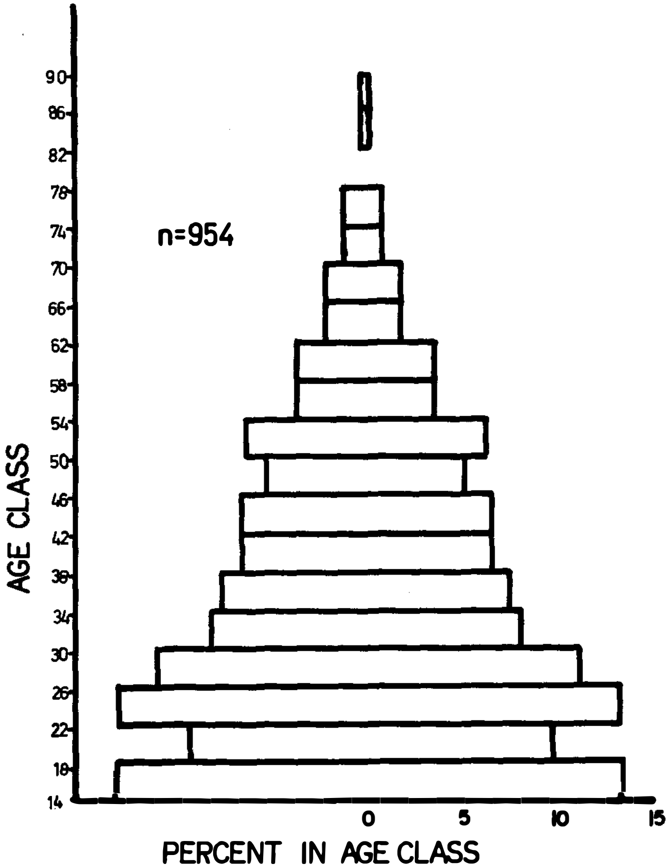

Figure 4. Age structure of New Jersey's firearm license purchasers, 1972.

lations as a continuing flow of recruitment, active hunting and desertion, and has stimulated the development of a conceptual model which may contribute to an understanding of present and future changes in hunting and hunter populations.

A Conceptual Model

The dynamics of a hunter population can be perceived in the context of an epidemiologic model. Infection is the analog of entering the hunting population. Probability of infection is a function of intensity of exposure: probability of initiation into hunting is related to the degree to which hunting is a cultural component of an individual's environment. There are age-specific and sex-related immunities operating: if a person has not been initiated by age 20, the probability of his becoming infected declines rapidly. Likewise, the intensity of infection, as reflected in the individual's hunting longevity, lowers with increasing age. Women of any age are less susceptible to infection, and if infected, have a more transient existence in the hunting population.

The core of the hunting population is built upon continuous recruitment of men, from generation to generation, within a social unit in which hunting is an important component of the cultural background. Such cultural units are analagous to endemic foci in an epidemiologic sense and, as in the case of a parasitic organism, the survival of the sport hunting tradition is dependent upon continual transmission in these endemic foci. Epifocal recruitment—infection of individuals outside this continuity of culture—occurs, and may ultimately be responsible for new endemic foci; but the probability of this occurring is low.

Against this contagion model for recruitment and longevity in the hunting population, let us consider hunter populations in a classical population ecology context; i.e. as a cybernetic system in which a population is regulated by the carrying capacity (K) of its environment.

I propose that hunter populations tend to be self-regulatory in response to the availability of quality hunting experience where quality is determined by availability of game, availability of open space on which to hunt, and the effective density of hunters on huntable land. In urbanizing New Jersey the availability of quality hunting is continually declining. While game populations on adequate habitat are substantial, the decline of habitat through suburban sprawl has reduced availability of both game and places to hunt. The effect of this apparent decline in K on dynamic aspects of hunter populations are several, and two have been presented in this paper: juvenile mortality of hunters has apparently been increasing over the past 40 years and emigration from New Jersey for the purpose of hunting is substantial. Both responses are common in a self-regulating population in which the population has exceeded the carrying capacity.

Nonetheless, other population forces are not responding in a manner predicted by population theory. Recruitment has not declined and the population itself has increased over recent decades and remained relatively stable in recent years. I suspect that this is because K itself is being redefined by New Jersey's hunters, for K is ultimately a state of mind–a psychological threshold of quality that is defined by each hunter.

For those who have access to the declining amount of huntable private land, there are rigorous attempts to define K by traditional standards. Private lands are almost universally controlled by hunting clubs, either formally or informally organized. Access to these private territories is rigorously defended against intrusion by nonmembers. Membership ceilings are the rule. Within a group there are strong pressures that define the hunting privileges of each individual. Pen-reared game is stocked by the club and state regulations reward this practice by extending legal seasons on stocked lands.

On public land, heavy stocking of pen-reared game, without the density controls exercised on private land, have led to hunter densities that would have been unimaginable 40 years ago. Acceptance of these densities by substantial numbers of hunters acknowledges a redefinition of K for New Jersey's sportsmen.

Future Research

The purpose of this and other descriptive studies of hunters has been to provide insight into characteristics of a constituency group, so that wildlife managers might integrate this information into programs designed to maximize benefits to that constituency.

Previous studies have addressed the description in a static sense; the present study has provided some dynamic insight into our understanding of this constituency. As future studies are conducted, I trust that a sharper understanding of the hunter will continue to develop. A deficiency of most hunter studies to date, however (and the present study does not escape this criticism) is that we tend toward describing the "average" hunter—a composite of the separate characteristics of many individual sportsmen. I argue that it will probably be more fruitful to think in terms of demographic attributes, behaviors, and attitudes of discrete subsets of the general hunting population.[5] The meaningful units of the hunting population are discrete groups such as the older, affluent, professional people who hire guides and hunt at preserves, and the rural teenagers who pore through sportsmen's magazines, save allowances for shells, and hunt anything that costs nothing and anywhere their legs or their buddy's pickup will carry them. To homogenize these groups is to strip them of their identity and to deny the manager any insight into the diversity of ways that hunting benefits can be maximized.

I suspect that, with regard to dynamic aspects of hunting participation, New Jersey's hunter population is composed of two parts. At one extreme is a group characterized by early recruitment and low desertion rates, with roots in a culture in which hunting is an important component, and with access to private hunting lands on which quality of the hunting experience is vigorously defended. At the other extreme is a group more transient in their pursuit of hunting. Substantial numbers of individuals take up this form of recreation, but are probably recruited from outside a strong hunting tradition. They do not have access to high quality experience on private land unless they are of sufficient social or economic status to warrant the uncommon invitation to enter such a group. More likely, they are limited to an infrequent invitation on private land, to the public lands, or to trespass. In most cases, the reinforcement received from this form of hunting is insufficient to warrant continuing participation over many years.

The New Jersey data suggest that substantial proportions of state residents are still being infected, through cultural contact, with the notion that sport hunting is an attractive leisure time pursuit. The data also suggest that an increasing proportion of new hunters are finding inadequate reinforcement for their recreative expectations. The long term effects of these phenomena on hunter populations and on wildlife management agencies may herald important changes in the future of wildlife management.

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Characteristics of Nonconsumptive Wildlife Users in Idaho

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Introduction

In the mid-nineteenth century, Henry David Thoreau lamented, "For one that comes (to the woods) with a pencil to sketch or sing, a thousand come with an axe or rifle" (Nash 1967). Statistically, he may still be quite close to the truth! However, he would be heartened indeed to observe an evolution in values that seems to be taking place today. As with the evolution of any phenomenon, a beginning point is difficult to identify with certainty. We do know, however, that the Leopold Committee on Game Policy believed that the opportunity to see and study game is just as valuable as the opportunity to shoot it (Leopold 1930). In their 1973 update of the Leopold committee's statements, Durward Allen's Committee on North American Wildlife Policy elaborated on the nonconsumptive values of wildlife, even recognizing the belief by some professionals that the aesthetic, nonconsumptive enjoyment of wildlife "is by far the greatest value of this resource" (Allen 1973). For the wildlife management profession, the implications of this evolution are significant.

It should be pointed out that *nonconsumptive wildlife management* and *nongame management* are not synonymous. They are, however, terms that are frequently and erroneously interchanged. *Nongame* management basically involves the biology and management of wildlife species that are not hunted or otherwise extracted from their natural habitat for sport. Endangered species and songbirds are common examples. *Nonconsumptive* wildlife management is actually the protection or provision of all wildlife *for recreational use* other than extractive sport. It may or may not involve game species; the emphasis is on the human experience and managing to provide certain wildlife-dependent satisfactions that do not "consume" the resource. The use of wildlife in this manner is variously termed "nonconsumptive use" or "appreciative use." It may involve songbirds, or it well may involve the same elk herd that has long been considered the sole recreational domain of hunters.

There has been much written on the increase in nonconsumptive use. Hendee (1969 and 1971), U.S. Bureau of Sport Fisheries and Wildlife (1972), Lime (1976) and others have adequately commented on the growth and there is no need to duplicate their evidence here. However, the assumed reasons for this growth in untraditional uses of the wildlife resource are worth repeating. Lime (1976) listed the following factors: shrinkage in the accessible land base for hunters; an expansion in agricultural acreage and urbanization resulting in a reduction in wildlife habitat; a decline in rural population, where hunting values had their origins; a decline in the quality of hunting experiences, caused in part by crowding; an increase in the number of people joining conservation and outdoor organizations; and an increased effort by anti-hunting interests to solicit public support.

Some wildlife managers are atuned not only to the increasing popularity of nonconsumptive use, but also to the results of U.S. Forest Service research on what is often referred to as the multiple-satisfaction model. When applied to wildlife management, the model essentially suggests that attention needs to be paid to a range of experiences which, in turn provides the satisfaction of, for example, displaying skill. Using the same resource, another individual might derive that same satisfaction through the experience of photography. Through such satisfaction, whichever way it was derived, human benefits[1] may accrue. In the long run, human benefits (physical and psychological) should serve as the ultimate objectives of management (Hendee 1974).

Assuming that human benefits are the ultimate management objectives, would it not be in error to provide only one way in which our clientele could reach that pinnacle? Should elk be managed to accrue benefits of mental or physical health only to those who gain satisfaction through shooting them? Additionally, since a single individual may reach our pinnacle (human benefits) in more than one way, barring constraints such as the budget, is it not negligent to restrict the individual to only one route (i.e. one kind of experience or satisfaction) to that ultimate goal?

In this study, we made the basic assumption that many managers are cognizant of nonconsumptive wildlife use, and recognize the political and social implications of its rise in popularity. Also, we believe there are an increasing number of managers who have the desire and are slowly gaining administrative approval to plan programs that provide for multiple satisfactions for their clientele. The general objective of our exploratory study was to obtain background information about nonconsumptive users in Idaho. We believe this kind of information is necessary to aid the manager in understanding this newly recognized recreationist. Not only will it help improve the services and benefits for this important segment of society, it will also contribute to the improvement of communication between managers and the publics they serve.

Methodology

A self-completed questionnaire was used to obtain data from a statewide sample of 1,000 Idaho residents during the spring and summer of 1976. The sample was drawn through a systematic random selection of names from all current telephone directories in the state. Advantages of this method were readily available names, lack of legal entanglements, and a generally current list. Importantly, 91 percent of Idaho's population has phone service (U.S. Bureau of Census 1975) and the great majority would be available for sampling. Because Idaho is predominantly a sparsely populated, rural state, it was not felt necessary to oversample rural areas to negate any possible urban bias.

Several techniques were employed to overcome the traditional problem of low return rates. Following Dillman's (1974) suggestions, the 12-page questionnaire was printed in an attractive booklet format using straightforward questions in a carefully ordered sequence. Commemorative first class stamps were used on individually typed envelopes. A cover letter on letterhead stationary was enclosed. A

[1]*Satisfactions* are the more specific, immediately gratifying pleasures from certain aspects of the recreation experience. *Benefits* are the more general and enduring improved conditions resulting from satisfactions (Hendee 1974).

postcard after one week and a letter with a second questionnaire after three weeks were the only follow-up methods allowed by our budget.

Questions were based on five research objectives concentrating on socio-economic characteristics of nonconsumptive users, the activities they seek, where and when they engage in the activities, and what activities are engaged in concurrently.

Data were analyzed using descriptive statistics, primarily frequencies, percentages, means, medians, modes and standard deviations. The independence of crosstabulated variables were assessed using the chi-square test and a significance level of .05. Strength of relationships were determined using the uncertainty coefficient programmed in the Statistical Package for the Social Sciences (Nie et al. 1975).

The Sample

Of 923 deliverable questionnaires, 50.9 percent were ultimately returned and useable, providing a sample size of up to 470 items completed by all respondents. Deviations of the sample from census data are discussed along with the affected characteristic.

Individuals who did not respond were randomly subsampled using a post-survey telephone interview. Interviews were completed with 23 nonrespondents, a 5.4 percent representation of these individuals. No difference in socio-economic background was found to be statistically significant except for sex. For that characteristic, we found a higher percentage of females among the nonrespondents (1 d.f., chi-square = 11.7357; p = .001).

However, a visual inspection of nonrespondent names showed little difference in percentage compared to responding females. We therefore believe the difference could be more a result of the sampling method than an indication of reluctance on the part of females to reply to the questionnaire.

Respondents were assigned to one of four user designations based on their reply to the question "how often do you go into the field specifically to participate in the wildlife activities listed?" Fishing, hunting and seven nonconsumptive uses were listed. Respondents were categorized as follows.

Nonconsumptive Users were defined as those participating in one or more of the nonconsumptive activities but not in fishing[2] or hunting. Table 1 illustrates the nonconsumptive activities considered in this study.

This class of "pure" nonconsumptive users was the smallest of the four with 9.2 percent (N = 43) of the sample.

Consumptive Users were defined as those engaging in fishing and/or hunting, but not in any other activities listed. Approximately 25 percent (N = 116) of the sample fell into the "pure" consumptive category.

Combination Users were so named for lack of a better term. These respondents were those who hunted and/or fished, but who also engaged in one or more of the nonconsumptive activities. They comprised the majority group with 53.6 percent (N = 252) of the sample.

Nonparticipants were the 12.6 percent (N = 59) of the respondents who indicated they did not go into the field specifically for any of the activities listed. For

[2]It is recognized that "catch and release" fishing may be considered "nonconsumptive," but no distinction between the two was attempted in this study.

Table 1. Participation in nonconsumptive wildlife-related activities by surveyed Idaho residents.

Activities [a]	Percentage of Respondents: Nonconsumptive users ($N=43$)	Combination users ($N=252$)
Observing birds (in the field)	53.5	39.3
Observing small game	51.2	62.3
Observing big game	41.9	72.2
Observing fish	39.5	42.9
Wildlife photography	25.6	32.9
Painting wildlife	9.3	4.4

[a]Another activity, nature crafts, was eliminated because of low response to the questionnaire item.

purposes of the discussion in this study, these respondents were not given further consideration.

Socio-economic Characteristics

In his presentation to the Thirty-Fourth North American Wildlife and Natural Resources Conference, Hendee (1969) generalized from previous studies and gave the following description of wildlife refuge visitors who would benefit from management for nonconsumptive uses. Favored would be "a highly educated, socially elite segment of society, characteristically raised and now residing in urban areas." He also cited documentation of consumptive users being predominantly male whereas the sex ratio of nonconsumptive users was more nearly balanced.

Sex

In our study, sex ratios tended to be consistent with other findings on hunting and fishing, and as expected, only 10 percent of the pure consumptive class were females. In the pure nonconsumptive class, however, the female predominance was a rather strong 60:40. Unfortunately there is a strong sex bias inherent to survey samples obtained through telephone directories (Dillman 1974) and females were consequently underrepresented from the Idaho population, so generalizations must be made with caution.

Age

Age categories in the sample were quite similar to the most recent census data for the state of Idaho except for undersampling teenagers and slightly oversampling individuals 60 years of age and older. No statistical differences significant at the .05 level of testing were found in crosstabulation of ages and user groups. A small tendency, however, was for nonconsumptive users to be in the older age brackets. While census data (U.S. Bureau of Census 1975) placed 34.6 percent of Idaho's population above 49 years of age, and the total sample in this study was 42.8 percent for that age group, 44.2 percent (N = 19) of the nonconsumptive users were 50 years old or above. The only age category that showed a higher percentage of pure nonconsumptive users than pure consumptive users was in the 15–19 age class. In this category, six of the ten individuals were purely nonconsumptive, and the small figures are reported here only as a clue for future investigators.

Education

No statistically significant difference in level of educational achievement was found, but again, there was an observable tendency. As levels of education increased, there was a greater percentage of nonconsumptive users represented. High school degrees were the highest degrees obtained by 60.7 percent of the consumptive users and 47.6 percent of the nonconsumptive users. Only 5.4 percent of the consumptive sample received graduate degrees, whereas twice as many or 11.9 percent of the nonconsumptive users were in that class. Again, the numbers in this category were very small with a total of only 11 individuals possessing graduate degrees.

Occupations

Like age and education, there was no significant difference between the occupational classes of consumptive and nonconsumptive users. One very noticeable statistic stands out, however. Consistent with the utilitarian attitudes attributed to the rural sector (Hendee 1969), not one nonconsumptive user listed an agricultural occupation. The modal occupational class of the nonconsumptive sample, with 29 percent of the respondents, was the professions.

Early Residence

The rural difference showed again in location of residence during the formative years of the respondents. We found that 29.7 percent of the nonconsumptive users were raised in rural settings (population under 500) whereas 39.3 percent of the consumptive class were from such areas. This contributed to a significant difference between these two user groups (3 d.f., chi-square = 8.2890; $p = .0404$). Also contributing to this difference was the finding that 24.3 percent of the nonconsumptive users were raised in cities having populations of more than 30,000, approximately three times the percentage of consumptive users in that class.

Income

In a study of 10 southeastern states, the Environmental Research Group (1974) at Georgia State University found that income patterns were generally the same for nonconsumptive users as for hunting and fishing recreationists. In Idaho, a statistically significant difference was found between family incomes of consumptive and nonconsumptive users, but no explainable pattern was observed. The mean and median family income brackets for both user groups was $7,000 – $9,999. The consumptive group had a strong mode (35.5 percent) at the $10,000 – $14,999 level, whereas nonconsumptive users were trimodal with 21.1 percent each in the under $5,000 category, $7,000 – $9,999, and $25,000 and above. No meaningful interpretation of the data can be offered, but with 58 percent of the nonconsumptive users having family income below $10,000, it appears that the related activities are not necessarily the domain of the wealthy.

Nonconsumptive Wildlife-related Activities

Knowing the preferences of recreationists for wildlife-related activities is essential to setting wildlife management programs and determining allocations for wildlife and other nonmarket recreational resources. First, however, must come the identification of the broad range of potential activities and experiences as products of wildlife management (Hendee and Schoenfeld 1973).

In this study, instead of stated preferences per se, we attempted to determine actual participation in a number of specified nonconsumptive activities. The results are ranked in Table 1 by amount of participation reported by the 43 nonconsumptive users in this study.

Table 1 shows that 252 hunting and/or fishing sportspersons also sought a widened range of activities. This suggests the importance of the so-called "combination group." Here is not merely a small minority group, but a very high percentage of the recreationists we have traditionally viewed as seeking only to bag game or catch fish. There was, in fact, no statistically significant difference between the pure nonconsumptive user's participation in the activities listed and the participation by respondents who are nonconsumptive users but who also hunt and/or fish. There are some tendencies, however, with observation of big game and small game appearing to be of much higher interest to the combination group.

Bird Watching

Since our approach in the questionnaire items was to investigate field activities, bird watching around the home was treated as a separate item. A distinction was also made between the casual observer and the more serious recreationist. Schweitzer et al (1973) used this separate classification in a study of Saskatchewan residents and found that 87.3 percent could be considered in the observer category and 34.1 percent in the "study" group. Interestingly, only 33.9 percent were found to hunt birds.

In Idaho, 100 percent of the nonconsumptive users were classified as observers, as were 95 percent of the consumptive users and 97 percent of the combination group. There was a significant ($p < .01$) difference, however, between the nonconsumptive users and either of the other two groups in the degree of participation. On a semantic differential scale, 65.4 percent of the consumptive users and 46.7 percent of the combination group listed themselves at the lower half of the scale. Their participation in bird observation around the home could be categorized as "very little" or "occasional." Nonconsumptive users placed along the upper half of the scale in 80.6 percent of the cases. These categories were "some", "frequently" and "very frequently."

Our classifications that approximated Schweitzer's (1973) "study" group were determined by respondents who made attempts at postiive bird identification or who maintained "life lists" of all species observed. In both cases there was a statistically significant ($p < .01$) difference between the nonconsumptive users and the consumptive group. 72.2 percent of the nonconsumptive users participated in identification activities as opposed to 45.5 percent of the consumptive group. "Life lists" were almost non-existent among either group, but four nonconsumptive users reported maintaining such records whereas only one consumptive user engaged in this activity. Once again there was no significant difference between the nonconcumptive group and the combination group, with the latter having 61.5 percent of its members listed as identifiers and 4.0 percent maintaining life lists.

Preferred Species

Respondents were asked to select from a list of 19 species or groups of animals and rank the three they would most like to watch, assuming they could be found. Spreading the preferences of only 43 respondents over a range of 19 choices seriously reduces validity. However, the results are shown in Table 2 along with a comparison to the preferences of the combination and consumptive groups.

If the stated preferences are believed, it is of importance to note that there is no strong relationship between nonconsumptive users and nongame species. Equating the two seems common among managers who would likely have predicted songbirds to be a top preference. Our data seem to indicate that preference among user groups overlap in many cases, conceivably setting the stage for competition. Deer and bear serve as good examples with approximately equal proportions of all user groups seeking to observe these animals. Consequences of the observations would presumably be quite different, however, with one user desiring to shoot the beast and another possibly wanting to photograph or merely watch it. Quite possibly both would yield a similar satisfaction to the respective observers and perhaps even identical human benefits.

Table 2. First and second choice selections (combined) of animals most preferred for observation by three wildlife user groups in Idaho.

	Nonconsumptive users		Consumptive users		Combination users	
Species	Rank	Percent (N=43)	Rank	Percent (N=116)	Rank	(N=252)
Deer	1	30.3	2	31.9	2	36.5
Bear	2	18.6	4	17.2	4	14.6
Eagle	2	18.6	10	4.3	5	12.3
Elk	2	18.6	1	38.0	1	49.3
Bass	3	14.0	9	5.1	16	0.4
Songbirds	4	11.7	11	2.6	12	2.8
Waterfowl	5	11.6	6	7.7	11	4.0
Salmon	6	9.4	11	2.6	9	5.6
Moose	7	9.3	7	6.8	8	7.6
Mountain lion	8	7.0	10	4.3	7	10.0
Upland birds	8	7.0	8	6.0	10	5.2
Bighorn sheep	9	4.7	3	19.8	3	21.0
Bobcat	10	2.3	13	0.9	14	1.6
Coyote	10	2.3	12	1.8	15	1.2
Hawk	10	2.3	11	2.6	12	2.8
Pan fish	10	2.3	10	4.3	15	1.2
Steelhead	10	2.3	12	1.8	13	2.0
Mountain goat	11	0	6	7.7	6	11.1
Trout	11	0	5	10.3	11	4.0
Other	11	0	0	5.1	-	3.2

Locale

It would appear from our data that nonconsumptive users travel shorter distances in pursuit of their field experiences than is the case for hunting or fishing recreationists.

To hunt and fish, 59.5 percent and 62.4 percent, respectively, of the pure consumptive users traveled one-way distances of over 40 miles on an average trip. The modal distance category in both cases was 41–125 miles. Nonconsumptive users in this study traveled less than that in pursuit of painting and to observe small game, birds or fish. The mode for these activities was 0–40 miles with users represented at 50 percent, 54.5 percent, 65.2 percent and 80.0 percent, respectively. They did, however, travel further to photograph wildlife and to observe big game. Seventy percent of the nonconsumptive respondents who went afield specifically to photograph wildlife traveled more than 40 miles. In fact, 50 percent (albeit only 6 photographers) reported their average trip to be in excess of 126 miles each way. Similarly, 93.3 percent traveled more than 40 miles each way when going afield to observe big game, with 46.6 percent traveling over 126 miles.

The destinations of nonconsumptive users in this study varied from city parks to national parks and commercial forests to fish hatcheries. However, despite scant appropriations which, according to the Advisory Committee on Non-Game Wildlife Policy (1974), have unbalanced the multiple use policies of the U.S. Forest Service to the disadvantage of nonconsumptive uses, it is the land under this agency's jurisdiction that wildlife-oriented recreationists turn to most frequently in Idaho. Purely consumptive recreationists reported using national forests the heaviest, with 51.7 of the fishing respondents going there "most often" and 44.0 percent of the hunters. Combination users were slightly higher for those purposes with 62.3 percent and 52.0 percent respectively.

National forests were used more than any other land area for nonconsumptive users' activities of wildlife photography (18.6 percent), observation of big game (39.5 percent), observation of small game (37.2 percent), and observation of birds (27.9 percent). In only two activities did the nonconsumptive sample report higher use elsewhere. Those areas were wildlife refuges and state parks for painting (11.6 percent each), and state parks for observing fish (14.0 percent). This pattern of use was followed closely by combination users except a relatively higher percent used national forests for painting, private land for observing birds and fish hatcheries for watching fish.

Besides national forests, the two next most important areas for nonconsumptive users were state parks and private land. For nonconsumptive activities by the 252 combination users, the next most used areas were private land, national parks, Bureau of Land Management areas, and wildlife refuges, respectively.

Of the 12 categories of destination points listed in the questionnaire, the most infrequently used by nonconsumptive recreationists were: game farms (least), commercial forests, city parks, state land other than parks, and land under the jurisdiction of the Bureau of Land Management. Again, low numbers of nonconsumptive respondents render these findings less than conclusive. Looking at the larger combination group, the least used areas were county parks (least), game farms, city parks, fish hatcheries and commercial forests.

No attempt was made to determine why destinations were selected, but undoubtedly opportunity was a leading factor. It should be pointed out that approximately 40 percent of Idaho consists of national forests and this land is easily within reach of the great majority of residents. County parks and game farms are few, and city parks are generally quite small.

Group Participation

Nonconsumptive users in our sample were not Thoreau-like, but neither were they prone to activities in large groups. The majority (51.7 percent; $N = 16$) engaged in their wildlife-related activities with three or four other individuals. These results suggest perhaps family groups, although our data could not be used to confirm this. Once again there was no statistically significant difference between nonconsumptive users and the combination group. A difference between nonconsumptive users and consumptive users closely approached our pre-established limit of significance. The chi-square test showed $p<.0591$ (5 d.f., chi-square = 10.6344) with the hunters and fishermen tending more toward participation with one or two others, and in groups of five or more.

Very few of the respondents in any user category participated in wildlife-oriented activities in organized groups, and there were no statistically significant differences found between users. In all cases, less than 10 percent of the respondents participated in organized groups. Those who did were usually involved with a youth group (scouting, etc.), as were all three nonconsumptive users who reported affirmatively to this item.

Supplementary Recreational Activities

In a study of auto campers in a Minnesota national forest, Lime and Cushwa (1969) found that wildlife was not the primary attraction to the area, but it was an important supplementary factor. Conversely, we suspect that when wildlife, or a wildlife-related activity, is the main attraction to an area, camping, picnicking and other recreational activities are important supplements to the total experience. Data for this part of the study were still being tested during preparation of this paper. However, initial analysis showed that many users indicated engaging in one or more of the 14 activities listed while afield for various wildlife activities. These activities are ranked in Table 3 by degree of participation by all users also engaging in nonconsumptive activities, regardless of the primary purpose of their trip afield.

The frequency of participation is compared in Table 3 by user groups, revealing some differences between nonconsumptive and consumptive users. The data also reinforce the pattern of similarity between the purist nonconsumptive recreationist and the much larger group of people who combine their appreciative pursuits with at least some degree of hunting and fishing.

Summary and Conclusion

Past documentation by other researchers has demonstrated the rise of interest in nonconsumptive wildlife use. Based on the reasons for this growth, nonconsumptive use will most likely continue to increase in importance as a use of leisure time and as a use of the wildlife resource.

Table 3. Participation by Idaho residents in miscellaneous recreational activities when also engaging in nonconsumptive wildlife activities.

Activities	Amount of participation by respondents also engaged in nonconsumptive wildlife activities (Percent)	(*N*)	Difference in use frequency between nonconsumptive (NC) users and: Consumptive users (C)	Combination users (CB)
Picnicking	69.8	328		
Camping	69.4	326		
Pleasure driving	67.0	315	NC>C	
Nature walks	38.7	182	NC>C	NC>CB
Day hiking	36.4	171	NC>C	
Motorboating	33.0	155		NC<CB[a]
Backpacking	32.3	139		
Four-wheel driving	28.1	132		
Motorcycling	20.4	96		
Motorless boating	20.0	94	NC>C[a]	
Snowmobiling	18.7	88	NC<C	
Snowshoeing	8.5	40		
Cross-crountry skiing	6.6	31		

[a]All differences are significant at the .01 level of probability except for motorboating and motorless boating which both had probabilities <.05.

In this study, findings about pure nonconsumptive users are limited by the relatively small sample of them and should be interpreted and generalized with extreme caution. Identified differences within the stated limitation, however, do exist between this user group and others, and they were documented by use of the chi-square test. None of these differences were strong enough to be predictive based on the uncertainty coefficient.

Less than 10 percent of Idaho residents surveyed may be termed pure nonconsumptive wildlife users. This group had more females than the comparison group of consumptive users. Idaho's nonconsumptive users tend to be either older citizens or under 20. They have more education and hold more post-graduate degrees than the surveyed consumptive user group. They are not necessarily wealthier than others and represent a cross section of occupations, but are highly represented by professionals and rarely have agricultural workers within their ranks. Few of these users were raised in rural settings.

The nonconsumptive user in this study was highly oriented toward birds, but showed an even higher interest in large mammals. In fact, with a high interest in game species such as deer, bear and elk, there is the possibility that increased competition with hunters for these species may become a problem if compatible methods of sharing are not developed.

Motivation for photographing wildlife and observing big game is strong enough to cause nonconsumptive users to travel long distances to pursue these activities, but generally they travel less than the hunting or fishing recreationist. Like consumptive users, they utilize national forests heavily, suggesting that the managing agency needs to be sensitive to the needs of these recreationists. Managers also need to be aware of supplementary activities engaged in by wildlife users, and picnicking, camping, pleasure driving and nature walks head the list.

Most importantly, we found that nonconsumptive wildlife use is not an interest possessed solely by a small number of purists. Instead, more than half our sample were recreationists who hunted and/or fished, but who also participated in nonconsumptive activities. Moreover, there were few differences in characteristics between this combination group and the purists as defined in this study. We believe this is significant and underscores the need for greater attention to providing for the nonconsumptive uses of wildlife. Whether it be to gain political support, improve public relations or to provide human benefits through multiple satisfactions, wildlife managers need a clearer understanding of nonconsumptive recreation. This study and similar ones before it and in the future should provide a first step toward that understanding.

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Congestion, Success and the Value of Colorado Deer Hunting Experiences

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Introduction

This paper reports estimates of the economic value of the 1974 Colorado deer hunting experience. Game managers and economists alike have acknowledged the usefulness of such information. However, since attributes of the hunting experience such as the level of hunter density and success ratio can be expected to vary over time, efficient management of environmental resources requires more than valuations of past experiences. Accordingly, this study also reports estimates of value for eight alternative combinations of hunter density and success ratio.

Decisions relating to management of game populations should take into account considerations of user preferences. Since it is reasonable to assume that a hunter's valuation of an experience will increase if the attributes of the experience become more closely aligned with his individual preferences, it appears that the provision of a variety of hunting experiences would lead to an increase in hunter benefits. A test of this hypothesis is reported and the estimates of economic value mentioned above are provided for different hunting experiences and also different types of hunters.

The Choice of a Measure of Economic Valuation

When goods and services are exchanged through formal competitive markets, market price established by the interaction of supply and demand is a direct measure of the commodity's economic valuation. Consumers cast their "dollar votes" in the market for commodities they desire. Producers react to market signals and adjust supply according to the registered desires of consumers. Thus, market price serves two functions: rationing available supply of commodities to consumers and allocating available resources toward production of commodities that consumers desire most. However, in order to utilize this method of measuring economic valuation "it is necessary to demonstrate (a) that the product being studied is priced; (b) that there are no free substitutes available that would tend to distort the pricing relationship; and (c) that a relatively competitive situation exists between suppliers" (Meyer 1974).

These criteria are not fully met in the case of deer hunting. Although some priced deer hunting exists through private game preserves and leasing of hunting rights by private land owners, a major portion of deer hunting takes place on public lands. In addition, it is not certain that those who utilize private game preserves are representative of the general hunting population. Therefore deer hunting fails at least the first and third criteria and an alternative method of economic valuation must be utilized.

Non-marketed commodities do not have an automatic rationing and allocating device such as market price. Rationing and allocating decisions generally are vested in an administrative or governmental agency. In the case of deer hunting, these decisions are usually made by a state division of wildlife. Without an adequate measure of user value the agency cannot successfully fulfill the desires of deer hunters. The concept and function of economic valuation are virtually identical in both marketed and non-marketed goods. The major difference is: in the former it is given but in the latter it must be inputed.

When commodities do not meet the Meyer criteria listed above, several alternative values may be used depending on the particular situation of interest. Nine such values are listed in a report by the Idaho Cooperative Fishery Unit (1973). Since this paper is directed towards estimation of user values, only net market value and consumer surplus alternatives will be considered.

Net market value is defined as the revenue gained by a nondiscriminating monopolist if this monoplist were able to charge a profit-maximizing price. *Consumer surplus* is that value gained in excess of the required expenditure, i.e. the area above price and below the demand curve. It may also be described as the extra amount the consumer would be willing to pay rather than go without the commodity. Net market value price, as defined above, is highly analogous to the concept of market price for a marketed good. The qeustion is whether consumer surplus should be included in the economic valuation of the non-marketed good.

It is maintained by some economists that commodity's value is given by market value alone, i.e. without including any consumer surplus. Lerner (1962) argues that consumer surplus should be included since we are not concerned with the marginal unit but either total provision or a substantial change in total provision of the commodity. If many substitutes for the commodity exist, the demand will tend to be highly elastic and change in provision levels will not substantially affect price. However, in the case of deer hunting, few close substitutes exist and the demand will tend to be inelastic and changes in provision levels will affect net market value price. Thus, net market value of incremental units will differ at the various discrete points. The "true" valuation of any substantial change would be equal to the total revenue that a perfectly discriminating monopolist could obtain by charging different prices for the various incremental units. In the absence of an income effect, this amount is given by the sum of the additional revenue that could be obtained by a simple monopolist (at the new net market value price) plus the change in consumer surplus caused by the change in provision levels.

Willingness to pay is defined to be the area underneath the demand curve up to the level of provision of the good. Thus it includes both revenue that could be derived at net market value price and consumer surplus. By the arguments in the preceeding paragraph, willingness to pay is the appropriate measure of economic valuation.

Two main empirical techniques exist for measuring willingness to pay: the travel/transfer cost approach (Hotelling 1949, Clawson 1959, and Brown, Nawas, and Stevens 1973) and the direct question approach (Hammack and Brown 1974). The travel/transfer cost approach uses observed travel/transfer costs as proxies for market prices in order to derive demand functions. The direct question approach, as the title indicates, directly asks users what they are willing to pay for specified opportunities. Since the direct question approach can be used to evaluate opportunities not actually experienced whereas the travel/transfer cost approach cannot, the direct question approach was chosen as the measurement technique.

The major disadvantage of this procedure is that it rests upon the validity of the responses to the hypothetical questions of willingness to pay. At least two types of response bias can be identified. A respondent may understate his willingness to pay in the hope that he can avoid paying as much as he really values the activity and still participate. The second type of bias is overstating willingness to pay to indicate that the opportunity should be maintained and improved.

Several sources reviewed (Knetsch 1974, Knetsch and Davis 1966, Idaho Cooperative Fishery Unit 1973, and Randall, Ives, and Eastman 1974) give suggestions for designing questions to reduce the possibility of bias. These suggestions are:

1. The less hypothetical the question, the more stable and reliable the response.
2. Ask the questions while the respondent is engaged in the activity to reduce the requirement of the respondent projecting himself from one situation to another.
3. Consider only one possible change in conditions at a time.
4. Formulate the questions so as to remove opinion.
5. Design the test items similar to those in the actual situation.
6. Make situations concrete rather than symbolic.
7. Design the test items so as to involve institutionalized or routinized behavior where role expectations of respondents are well defined.
8. Pretest questions through direct interviews to reduce ambiguity.

These criteria were followed as closely as possible in the design of the questionnaire.

Sample and Questionnaire Design

During the 1974 deer hunting season, holders of four separate categories of licenses (each with resident and non-resident classifications) could legally harvest deer in Colorado. These categories were: deer, sportsman[1], archery deer, and muzzle-loading rifle. Holders of deer and sportsman licenses hunted during the regular rifle season. Holders of the other license categories hunted in separate seasons. In order to fulfill computational requirements of at least 200 observations from each category, the total sample size (2508) was divided as follows: 350 sampling units each for archery deer and muzzle-loading rifle and the remaining 1808 sampling units were distributed proportionately by percentage of license holders in the resident and non-resident classifications of the deer and sportsman license categories. Appropriate geographical representation was insured by assigning quotas for the resident and non-resident classifications according to weighted historical proportions of hunter numbers by county and national census region, respectively. Each quota was then filled via random sampling.

Data was collected by a two stage process. First, each sampling unit was sent a questionnaire, cover letter, and postage-paid return envelope. Two follow-up mailings were made to non-respondents when necessary. This procedure resulted in a 77 percent response rate. Information obtained from this questionnaire in-

[1]After the 1975 season, the sportsman license category was eliminated.

cluded game management unit hunted, number of days hunted, and socio-economic data. The game management unit hunted was used to formulate the second stage questionnaire. Additionally, hunters were presented 73 Likert-type items and asked the degree to which each adds or detracts from their satisfaction while deer hunting. The responses were analyzed via the BC-TRY (Tryon and Bailey 1970) cluster analysis system. This analysis defined four dimensions of the hunting experience (Easy hunt, Harvest, Out-group contact, and Nature) which were used to identify hunter types based upon similar ranking with respect to the four dimensions. The above analysis is presented in a paper by Brown, Hautaluoma, and McPhail (1977).

The second stage process involved resampling the respondents to the first questionnaire. Again two follow-ups were used when necessary. A 55 percent response rate was achieved.

After hunters were asked their variable expenditures for the 1974 season, they were given the success ratio and average hunter density for a game management unit in which they reported having hunted. The success ratio and hunter density were obtained from the *1974 Colorado Big Game Harvest* (Colorado Division of Wildlife 1975). These numbers served as a base from which the alternative success ratio and hunter density scenarios deviated. The hunters were then asked the highest price that they would be willing to pay for the trip they actually experienced. Then, they were asked their willingness to pay for eight alternatives that differed only with respect to success ratio and density of hunters.

Analytical Results

The mean response to the nine willingness to pay questions are provided in Table 1. The means are given by residence classification and license category. The columns (labeled SR) correspond to different levels of success ratio: low, actual, and high. The relationship between the low, actual, and high success ratio alternatives is consistent within each license category but varies among categories. Although subtracting or adding 15 percentage points to the actual success ratio of a game management area was deemed both reasonable and noticable for deer and sportsman license categories, it was not appropriate for archery deer and muzzle-loading rifle categories since the average success ratio for these categories was relatively low, 11 percent and 22 percent respectively. Therefore, halving and doubling the actual success ratio was utilized for these categories.

The rows of each sub-table denote the different levels of hunter density: high, actual, and low. Again, and for similar reasons, a consistent relationship is maintained within license categories but not among license categories. Due to a range of values in hunter density per square mile for deer and sportsman license categories (from a low of less than one to a high of greater than 23) a simple relationship such as halving and doubling could not be found which was deemed both reasonable and noticable. A quadratic function of the actual value was added and subtracted from the actual value to generate the high and low density levels, i.e. Actual $\pm$ (0.55 – 0.45Actual + 0.005Actual^2).

[2]Although space does not permit the provision of the mean responses for other license categories or the alternative scenarios, this information can be obtained from the authors upon request.

Table 1. Mean willingness to pay ($ per person) partitioned by license category (L = low; A = actual; H = high).

License category	Resident				Non-resident			
		Success ratio				Success ratio		
	Hunter density	L	A	H	Hunter density	L	A	H
	H	33	50	60	H	171	236	276
Deer	A	46	67	73	A	209	315	339
	L	43	64	74	L	200	285	341
	H	32	48	64	H	145	368	388
Sportsman	A	40	74	80	A	179	397	450
	L	42	72	82	L	173	386	436
Muzzle-loading rifle	H	39	51	67	H	155	203	230
	A	68	96	109	A	250	377	317
	L	55	75	97	L	182	225	259
Archery deer	H	46	65	73	H	306	309	369
	A	53	68	76	A	333	385	416
	L	50	65	75	L	322	335	413

The existence of different deer hunting opportunities (regular rifle, muzzle-loading rifle, and archery deer seasons) gives the prospective deer hunter a degree of flexibility. Probability of success, degree of congestion, range of weapon, and type of hunting skill required all vary widely among the various seasons. The hunter can choose an experience most closely reflecting his desires. The mean responses of deer and sportsman license holders who participate in the regular rifle season and the "specialty" license holders who participate in the archery deer and muzzle-loading rifle seasons are expected to reflect these differences in experience as well as differences in hunter preferences.

As expected, non-residents are willing to pay significantly more than residents. Also, willingness to pay increases as the success ratio increases and decreases as hunter density increases. However, hunters are not willing to pay for decreases in congestion. In fact for the muzzle-loading rifle category, willingness to pay would decrease significantly if there were fewer hunters. Since differences in willingness to pay exist between the residence classifications, they will be discussed separately beginning with Colorado residents.

Within the resident classification, the responses of regular deer and sportsman license holders were similar. A significant difference at the 10 percent level does not exist for the means of either the actual experience or any of the alternative scenarios. The effects of changes in success ratio and hunter density were also similar for these categories. For the regular deer license category, a 15 percentage point decrease in the success ratio will cause an average decrease of 33 percent in willingness to pay; a 15 percentage point increase in the success ratio would lead to an average 15 percent increase in value. For the sportsman license category, similar decreases and increases lead to changes in willingness to pay averaging a

40 percent decrease and an 18 percent increase respectively. Within each category, increases in congestion lead to an average 25 percent decrease in willingness to pay while a decrease in congestion has no significant effect on willingness to pay.

The muzzle-loading rifle license holder is willing to pay significantly more (at the .001 level) than the other license categories. He is also significantly more sensitive (at the .001 level) to congestion levels than the other license holders. The mean responses indicate that any change in present hunter numbers will cause a decrease in willingness to pay. Doubling hunter density leads to an average 43 percent decrease in willingness to pay and halving hunter density yields an average 18 percent decrease. This latter result may be related to the fact that only a limited number of permits are presently issued for this category. Doubling or halving the success ratio implies a 25 percent increase and 27 percent decrease in willingness to pay, respectively.

Unlike hunters of other categories, archery deer license holders exhibit little reaction to changes in hunter density. They do however react to changes in the success ratio. A 50 percent decrease in the success ratio would lead to an average 25 percent decrease in willingness to pay while doubling the success ratio yields a response averaging 13 percent higher.

The mean responses of non-resident deer license holders are essentially the same as those for resident deer license holders except that they average approximately 4.7 times greater. The percent changes in mean willingness to pay caused by varying success ratio and hunter density are almost identical.

Non-resident sportsman license holders are more sensitive to decreases and less sensitive to increases in the success ratio than resident sportsman license holders. The average percent changes are 57 percent and 10 percent respectively. The hypothesized increase in congestion implies a 13 percent decrease in hunter benefits. Again, decreasing hunter density has no significant effect on willingness to pay.

Mean responses of non-resident muzzle-loading rifle hunters exhibit a pattern similar to that of their resident counterparts with one unexpected exception. Mean willingness to pay drops for the alternative of doubling the success ratio while holding hunter density constant. A reasonable explanation of this phenomenon has not been discovered by the authors.

Non-resident archery deer license holders indicate that a 50 percent decrease in success would lower the value of their experience an average of 6 percent and a doubling of the success ratio would increase benefits by an average of 17 percent. A doubling of hunter density leads to an average 13 percent decrease in mean willingness to pay.

Although the above results do support the hypothesis that hunters are willing to pay different amounts for different experiences, the effects of user preferences upon willingness to pay are more dramatically shown by using the hunter preference types identified by Brown, Hautaluoma, and McPhail (1977).

Mean willingness to pay for the actual experience is presented for the hunter preference types identified within the resident deer category[2]. The mean responses ($ per person) for the eight hunter types beginning with type 1 and ending with type 8 are 104, 29, 62, 54, 52, 60, 108, and 69 respectively.

The inclusion of hunter types into an analysis of covariance model was significant at the .01 level and removed 15 percent of the variation in willingness to pay for the actual experience. Similar reductions in variance of 10 to 15 percent were observed for the eight alternative success ratio and hunter density scenarios. Additionally, the intensity of preferences are also reflected in willingness to pay as shown below.

The type 2 hunter was identified by Brown et al. (1977), as being a "minimum gratification" type and was cited as being a potential dropout from the deer hunting experience. The mean response of this group was the lowest of all types, $29 per hunter. Type 7 hunters, identified as being "gung-ho" hunters, scored the highest in every attribute of the experience. The mean response of this group was the highest, $108 per hunter.

Similar analyses were undertaken for the muzzle-loading rifle and archery deer categories. For each category, hunter preference types, as identified by Brown et al. (1977), were included as the main effect in an analysis of covariance model. The results indicated that inclusion of hunter preference types did not significantly reduce the variation in willingness to pay for the actual experience or any of the alternative scenarios. It appears that provision of "special" hunting experiences attracts individuals with preferences similar enough that the remaining differences do not significantly affect the value of the experience.

Conclusions

The principle finding of methodological interest is that the value of deer hunting varies among hunting opportunities that have different attributes and among hunter preference types. By explicitly incorporating the differences in hunting opportunities and preference types into the analysis, the degree of variation in willingness to pay can be reduced. This increases the precision of hunter demand estimates.

Further, general conclusions can be stated concerning the effects of congestion and success upon the value of the hunting experience. Willingness to pay is found to be directly related to chances for success although for some preference types this factor has a relatively small impact. Additionally, increases in congestion levels will generally decrease the value of the experience. The archery deer license category and certain preference types are exceptions to the rule. However, even though many respondents indicated that there are presently too many hunters in the field, they were not willing to incur additional costs to reduce hunter density.

Other findings of policy import are also noted. The esimated mean value of the experience for muzzle-loading rifle hunters is greater than that of any other license category. Also, since the success ratios realized during archery deer and muzzle-loading rifle seasons are smaller than the success ratio during the regular rifle season, the estimated value per harvested animal is greater for the "speciality" weapons categories.

Each of the above conclusions indicate that further diversity of hunting experiences, such as more emphasis on special weapons or the use of split seasons, can increase the total satisfactions of the hunting public for any given level of deer herds.

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Predator Control: The Public Viewpoint

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Introduction

The problem of choosing among available methods of predator control has reached the national forum. The president, congress, federal agencies, and national interest groups have all become involved in reviewing the economic and political costs and benefits of control policy alternatives. Reliable and objective information concerning general public attitudes regarding predator control, however, has been lacking.

As part of a comprehensive analysis of the predator control problem, the U.S. Department of Agriculture, Economic Research Service and U.S. Fish and Wildlife Service, in cooperation with the University of Arizona, conducted a nationwide survey of public attitudes toward predator control.[1] Telephone interviews were conducted in May and June 1976 using a representative probability sample of telephone households in the 48 contiguous states and the District of Columbia. To avoid systematic sampling bias, telephone numbers were randomly generated, calls were made in the evenings and on weekends, and the potential respondent in each household was randomly selected by sex and age (18 and older). Respondents in 78 percent of the households completed interviews, providing 2041 cases.[2]

The telephone survey was designed to screen respondents on the basis of their knowledge of and interest in the conflict between environmentalists and livestock ranchers concerning the killing of coyotes. Approximately one-third of the respondents were uninformed and uninterested in the controversy and therefore were not required to answer specific questions regarding predator control. The questions they did answer, however, provide some interesting information on the constituency of these disinterested and uninformed respondents, as well as general wildlife attitudes of the entire population. Because the coyote control controversy has much in common with other wildlife issues, these general attitudes toward wildlife are expected to indicate the potential for attitudinal shifts as predator control becomes a more publicized and generally salient issue.

General Attitudes Toward Wildlife

Some of the general wildlife issues addressed by the survey concern the relative importance of various uses and roles of wildlife. Most wildlife uses can be clas-

[1] For other aspects of the analysis of predator control see Gee et al. (1977a and b) and Gum and Arthur (1977a and b).

[2] Additional details concerning the survey and copies of the questionnaire may be obtained by writing to Environmental Economic Studies, Economic Research Service, Room 420 GHI Building, U. S. Dept. of Agriculture, Washington D.C. 20250.

sified as consumptive or nonconsumptive. Consumptive uses are those which impact wildlife populations, i.e., require killing of animals. These uses include sport hunting, killing for food, and killing for furs. Nonconsumptive uses, on the other hand, have no direct impacts on wildlife populations. They include the ecological or existence values, as well as the aesthetic or viewing value of animals. Respondents were asked to indicate the importance of each of these values by rating each on an 11-point importance scale (0 = not important at all . . . 10 = extremely important).

Nonconsumptive uses were rated as most important; mean ratings for viewing, existence, and ecological values averaged 8-9 points, while mean ratings of food, fur, and hunting ranged from 2-5 points each. When respondents were asked to indicate the values of consumptive and nonconsumptive uses by distributing 100 points among existence, viewing, and hunting values, the effects were even more dramatic. Of 100 points, only 12 points were allocated to hunting (6 percent of the sample rated hunting highest). This effect is partially explained by data indicating that respondents who value consumptive uses also value nonconsumptive uses, though the reverse is not often true. Seventy-two percent of respondents who rated hunting as "extremely important" on the 11-point scales also rated viewing 10, and 68 percent of those who rated hunting 10 rated existence 10. Although Kellert (1976) submits that substantially fewer hunters have dominant ecologistic, aesthetic, or naturalistic concerns than have dominant concerns for nonconsumptive values of wildlife, these data suggest that the latter concerns do not preclude simultaneous enjoyment of the aesthetic and ecological values of wildlife (see Potter, Hendee, and Clark 1973).

Another explanation of the low values placed on hunting relative to nonconsumptive wildlife uses is that values of zero on the 10 point importance scales were used much more for hunting (36 percent of all respondents) than for any nonconsumptive uses (1-2 percent). A question directly addressing opposition to hunting revealed that 45 percent of the sample disapproved of hunting.

Because predator control is clearly a consumptive use of predator populations, the relative values people ascribe to consumptive and nonconsumptive uses are expected to relate to their attitudes toward predator control. The data for informed or interested respondents indicate that those who most highly value nonconsumptive uses or oppose consumptive uses also are more likely to find predator control methods unacceptable and express more concern for the humaneness of control methods and less concern for the economic impacts of control than other respondents. In addition they tend to like coyotes more than those who value consumptive uses, although coyotes were generally one of the least liked of 16 wild and domestic species. Only the skunk was liked less. Uninformed-disinterested respondents, on the other hand, tended to ascribe less importance to both nonconsumptive uses and economic impacts, and liked wild animals less and domestic animals more than other respondents.

Attitudes Related to Predator Control

All respondents were asked several questions which dealt more directly with control issues. These questions treated farmers' rights to kill predators, relative humaneness of some common control methods, and knowledge of coyotes. Only 23 percent of the sample indicated a farmer should not be allowed to kill an animal that killed some of his livestock, but of those who approved of such killing, only 43 percent approved of the killing of other animals of the same species for prevention of further predation, a common approach to predator control. Of the methods used to kill predators, trapping and slow poisons were judged least humane; killing instantly with guns, on the other hand, was perceived to cause even less animal suffering than high quality zoos and packing plants.

Knowledge of coyote habits and population trends was generally limited, with less than 60 percent of the population answering most knowledge questions correctly. An exception was the 92 percent correct affirmative response to the question "Do coyotes sometimes kill sheep?" (Table 1, column 1). Despite this indication of the widespread knowledge of coyote predation of sheep, 56 percent of respondents reported they had not heard of the controversy between livestock ranchers and environmentalists concerning coyote control.

Athough knowledge of the general control issue was not related to knowledge of coyotes in particular, there was a relationship between knowledge of coyotes and concern for some of the issues involving predator control. Respondents scoring high on knowledge about coyotes rated their concern for the rancher-environmentalist controversy lower, their concern for economic impacts of control higher, and found current killing control methods more acceptable. These respondents also were older, had less formal education, and liked coyotes less and sheep more than other respondents.

Although little general knowledge of or affinity for the coyote was evidenced, when respondents were asked to trade off their concern for the killing of sheep and killing of coyotes, they expressed slightly more concern that coyotes are killed. People who expressed the most concern for coyotes tended to express less concern for the economic impacts of control and the effects of coyote populations on other wildlife; and rated the acceptability of current control methods lower. Degree of concern for coyotes was also related to place of residence (nine census divisions). Residents of the Pacific Coast Region and Middle Atlantic States indicated the most concern for coyotes, while those of the West-South-Central Region—largely comprised of a major sheep producing state, Texas—expressed the most concern for killing of sheep. Rural residents were less concerned about the killing of coyotes than nonrural residents.

Using Public Attitudes in Predator Control Policy Analysis

How then can this attitudinal information be included in control policy decision processes? Certainly, policy decisions should not be based solely on public attitudes, but these attitudes can provide a valuable addition to technical and economic information and pressures of special interest groups that presently dominate policy decisions. General public attitudes have largely been ignored because data were unavailable or not amenable to current economic planning models. Quantification of public attitudes would facilitate the inclusion of these social values in the planning process.

The present survey provides quantitative measures of the social values surrounding the control issues. The values can be hierarchically arranged as in Figure 1. Values such as acceptability of the control methods can be disaggregated into the perceived humaneness, species specificity (related to the accidental killing of other animals), and cost effectiveness of the methods. Control method specificity

Table 1. Mean characteristics and attitudes of the total sample and subsamples with homogeneous attitudes toward predator control.

Variable	Total sample	Subsample 1	Subsample 2	Subsample 3
Percent female	58	31***	50	52
Age	43.4	32.6***	43.7***	47.9***
Income [a]	2.9	3.3	3.3*	3.0*
Education [b]	3.5	4.8***	3.7***	3.6***
Percent that ever lived on farm	43	48	49	36***
Like of coyotes [c]	32	49.0***	27.9***	25.2***
Like of sheep [c]	48	43.2***	51.1**	51.9**
Percent correct on knowledge questions				
Coyote populations increasing?	50	40***	65**	64**
Coyotes west of Mississippi?	53	42	44	49
Coyotes control rodents?	89	95**	87**	88
Coyotes adapt easily?	25	35	31	32
Coyotes kill sheep?	92	85***	95*	96*
Coyotes kill pets?	58	49**	70***	64*
10 point rating scales of importance				
Rancher-environmentalist controversy	4.9	6.2***	4.0**	3.9**
Ranchers going out of business	6.3	4.9***	6.9***	7.4***
Increasing prices	5.9	4.6***	6.7***	6.9***
Less food produced	6.5	5.2***	7.1***	7.3***
Less jobs	6.1	4.8***	6.6***	7.2***
10 point scales of method acceptability				
Fast poisons	4.3	3.2***	5.2***	5.1***
Slow poisons	1.3	.9***	1.4	1.3
Aerial gunning	2.5	1.9***	4.3***	3.1*
Denning	2.3	1.4***	2.9***	3.4***
Ground shotting	4.3	4.0*	5.2***	5.6***
Leg traps	1.6	1.2***	1.8	2.0**
Number of respondents	2,041	139	209	147

[a] *Value*: 1. < $5000. 2. 5 – 10,000. 3. 10 – 15,000. 4. 15 – 25,000. 5. >25,000.
[b] *Value*: 1. < 8 years. 2. Some high school. 3. High school diploma. 4. Technical school. 5. Some college. 6. Bachelors degree. 7. Graduate school.
[c] Of possible 100 points. Deer = 50.
Significance levels: *p<.05; **p<.01; ***p<.001

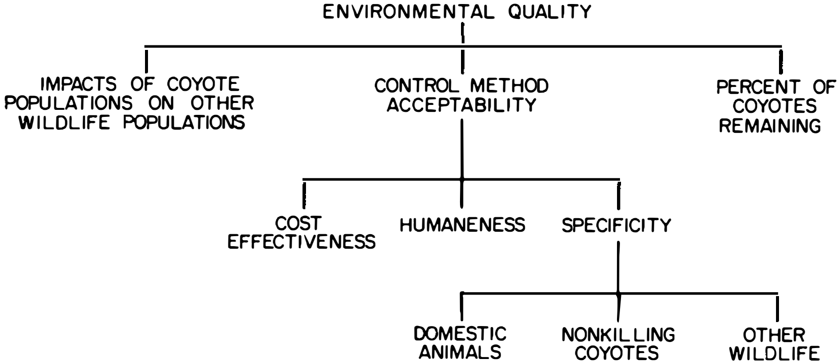

Figure 1. Hierarchy of social values for predator control.

is then further disaggregated into the specificity regarding domestic animals, wild animals, and coyotes that are not currently causing losses.

Respondents were asked to judge the relative importance of the social values within each level of the hierarchy, e.g., whether they are more concerned about the humaneness, species specificity, or cost effectiveness of control methods. A ratio scaling method was used (see Gum, Roefs, and Kimball 1976), so that values in various levels of the hierarchy could be compared. For each hierarchical level in Figure 1, respondents first ranked the three value categories for importance, then were asked to distribute 100 points among the categories to reflect more precisely the relative importance of each. The results for the whole sample are listed in the first column of Table 2. The other columns represent the point allocation of some subsamples with homogeneous attitudes. The first column of Table 2 reveals that, in general, humaneness is considered the most important subcategory of method acceptability, but subsample 1 is comprised of respondents who allocated proportionally more points to specificity. Subsample 1 also values wild animals much more than domestic animals, while subsample 2 shows the opposite trend.

Other characteristics of these subsamples are provided in Table 1. The subsamples most concerned with humaneness of control methods and least concerned with their species specificity (subsamples 2 and 3) surprisingly tend to rate the acceptability of control methods higher. High acceptance of control methods is also related to general dislike of coyotes, lack of concern for the number of coyotes killed, and greater knowledge of coyote habits and population trends.

This information on the attitudes of various audiences toward control issues can then be translated into attitudes concerning specific policy alternatives. Even the two-thirds of the survey sample that had heard of the control issue or were interested in it might not be familiar enough with the specific control alternatives to judge the social impacts of particular policies. Further, they could not be expected to evaluate a nearly infinite array of alternative policies in order to anticipate all the information that might be desired by policy makers. Thus, the impacts of alternative policies on measurable (usually physical) aspects of the environment are determined, and these measurable environmental parameters are linked to the social values expressed by the public.

Table 2. Mean points allocated to environmental values by total sample and subsamples with homogeneous allocations.

Environmental value category [a]	Total sample	Subsample 1	Subsample 2	Subsample 3
Primary values				
Impacts of coyote populations on other wildlife	46	41	49	56
Acceptability of methods	30	16	36	38
Coyotes remaining	24	43	15	6
Total points	100	100	100	100
Acceptability subcategories				
Cost-effectiveness	16	14	17	21
Specificity of methods	32	45	19	22
Humaneness of methods	52	41	64	57
Total points	100	100	100	100
Specificity subcategories				
Impact on coyotes that are not killing sheep	20	24	6	15
Impact on domestic animals	42	25	67	53
Impact on other wildlife	38	51	27	32
Total points	100	100	100	100

[a] See Figure 1 for value structure.

The measurable aspects of the physical or social environment which are related to the lowest level values of the hierarchy in Figure 1 (i.e. cost effectiveness, humaneness, coyotes remaining, impacts of coyote populations on other wildlife, and the three types of specificity values) are identified and their relationship to social values quantified. For instance, the cost effectiveness value is measured in terms of the cost of the control alternative relative to the most inexpensive method. Descriptions of the relationship of these social values to their respective physical measures are crucial to measuring the impact of alternative policies on social values. Thus, these relationships should be verified with empirical data when possible. Impacts of policy alternatives on environmental variables are then measured, and these measures synthesized with public preference weights (allocated points) assigned to the values to provide information concerning public preferences for particular policy alternatives. (For the mathematical function see Gum, Roefs, and Kimball 1976.)

Preferences can be determined for any audience of interest to the policy maker: for example, regional samples, only the intensely interested public, the informed public, or environmentalists. Policy makers can use these subsample preferences to anticipate the general vocal or nonvocal public response to a potential policy decision or possible outcry of select interest groups, and use this information to heighten achievement of social, environmental, and political, as well as economic goals.

Information on public preferences for particular control alternatives can also become part of a more comprehensive information system, such as the computerized system for predator control described by Gum and Arthur (1976). A computerized information system permits a policy maker to review the economic, social, and environmental impacts of a wide variety of policy alternatives in a very short time. The information system does not tell the policy maker how much importance to ascribe to public preferences, but it does provide information regarding the trade-offs among public preferences and economic or environmental impacts.

Using such an information system, a decision maker can compare the aggregate environmental quality values (highest level value, Fig. 1) of feasible alternatives or look at the trade-offs among lower level values. He can accomplish this by comparing the mean environmental quality values of several alternatives or by viewing the different distributions of individual environmental quality values for those alternatives. The solid line in Figure 2 illustrates the distribution of individual environmental quality values calculated for the current mix of control methods. (Federal, state, and private expenditures in 1974 included: $3.5 million trapping, $600,000 denning, $1.5 million aerial gunning, $1.1 million ground shooting, $51,000 toxicants, $290,000 snares, $31,000 M-44 cyanide ejector.) Note that a mean value for environmental quality for the entire sample would not reflect the disparity of public attitudes. Approximately 40 percent of the respondents judged the overall environmental value of present control methods to be relatively high. The other half of the sample seems to have a conflicting point of view; between the 40 and 45 percent points (horizontal axis Fig. 2) the environmental quality rating drops dramtically.

The dashed line in Figure 2 gives the environmental quality distribution for an alternative mix of control methods and expenditures. (For more examples see Gum and Arthur 1977b). Expenditures for trapping and 1080 poison were reduced to zero, denning and ground shooting expenditures held constant, and aerial gunning and M-44 expenditures increased $.5 million and $5.7 million, respectively. Overall expenditures increased from $7 million to $10 million. Despite the increase in expenditures, especially for the M-44, Figure 2 reveals a trend toward higher environmental values for the higher control level with increased use of the M-44. This finding is somewhat paradoxical in view of the recent outcry against use of the M-44. This conflict illustrates the hazards of assuming that the vocalized desires of select interest groups represent the desires of the general public.

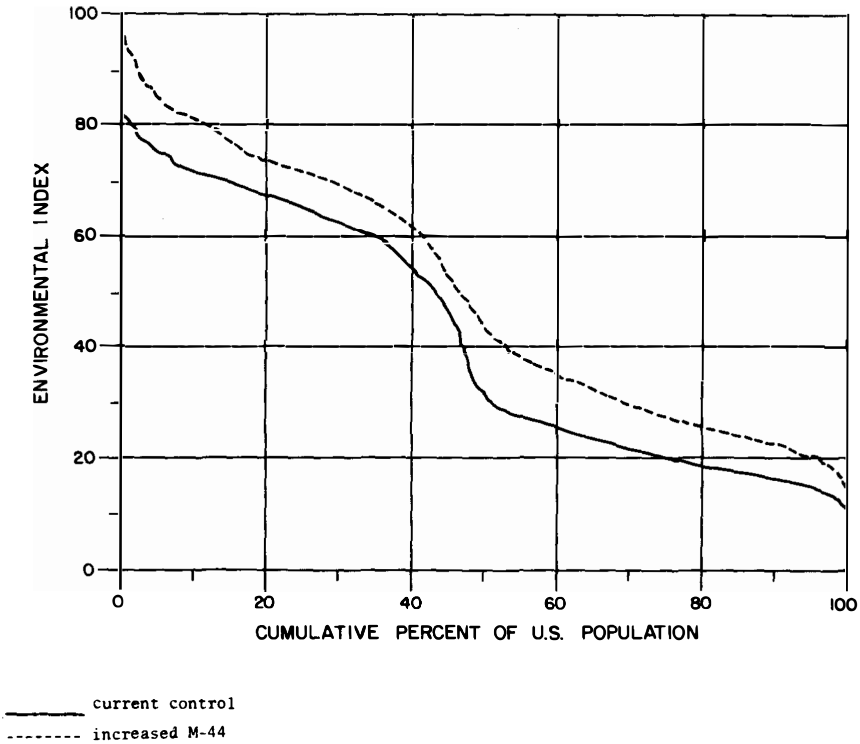

Figure 2. Distribution of individual environmental quality values for the current mix of control methods and increased use of the M-44.

Other Public Concerns With Control

Other survey questions probed these value questions from slightly different points of view. For instance, although respondents were asked whether control humaneness, cost effectiveness, or impacts on other species concern them most, they were also asked whether their concerns for the species specificity of control vary with the circumstances, i.e. with different levels of predation losses. The results indicate that as lamb and sheep losses increase from 0 to 20 percent there is a corresponding increase in the number of respondents who are willing to risk losses of wildlife other than coyotes in order to prevent further livestock losses. Nevertheless, they prefer the use of more humane methods of control, such as shooting from the ground and fast-acting poisons, and strongly advocate the development of nonkilling methods such as repellent chemicals, guard dogs, and birth control.

Although they expressed relatively little concern for the costs of control—at least when compared to such concerns as method humaneness and impacts on nontarget species—most people did not advocate such nonkilling control methods as insurance programs or rancher subsidies. When asked whether control expenditures should be increased, most people responded that expenditures should be held at current levels.

Conclusions

The results of the national attitude survey indicate an already widespread interest in issues surrounding predator control. Primary concerns focus not on the effects of control on the coyote, but rather on the impacts of control on nontarget species and the humaneness of the methods employed. There are small subsets of the national sample which express concern for coyotes in particular, but the predominant trend is toward greater concerns for other wildlife and domestic animals.

Respondents were also more concerned about humaneness and species specificity than about cost effectiveness. Thus, when preference values of different methods and levels of expenditures are compared, increases in expenditures result in little or no loss in environmental value ratings for the higher control level. If the mix of methods is altered, increased humaneness and specificity provided by the substitute and additional control methods, as well as higher cost effectiveness levels, result in increases in perceived environmental values. In response to the question addressing control expenditures, most people indicated that increased expenditures are not desirable, though the actual environmental results of those increased expenditures would likely be increased social benefits for this same public. It is precisely this type of information that will be a valuable addition to the present set of data used to implement control policy decision making.

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Influence of Knowledge of Wildlife Management Principles on Behavior and Attitudes Toward Resource Issues

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Introduction

"Biologists once dreamed of solving wildlife problems while the galleries cheered. Wiser now, they see the need for human engineering as well as better research" (King 1948). Wildlife managers have been aware of the need to better understand the human dimension of their management programs for some time. Wildlife researchers have widely surveyed the hunter population (see Schole 1973 for a review), but less effort has been directed toward the general public (Hendee 1969; Moss et al. 1969; Klessig 1970; Sofrenko and Nolan 1972; Applegate 1973, 1975; Fowler and Bury 1973; Shaw 1973; Hansen et al. 1974; Kitts and Low 1974; Linder et al. 1974; Martin et al. 1974; Rosonke et al. 1974; Shaw and Gilbert 1974; Shaw 1974, 1975), and even fewer studies have dealt with issues related to knowledge of wildlife management principles (Wievil 1947, George 1966).

With the growing environmental awareness, new concepts such as land-use planning as well as established practices such as hunting and trapping have become issues of concern to the American public. Wildlife managers should have less difficulty working with a public knowledgeable of the principles behind management policies. Consequently, managers have developed educational programs designed to increase public understanding. The main objective of this paper is to look at relationships between the level of understanding of wildlife principles and other variables in Iowa's general public.

Methods

Sampling Technique

This study is based on a random sample of 1500 Iowa residents 18 years of age or older; 1060 usable returns were received. A mailed 14-page questionnaire was used, with a single follow-up 3 weeks after the first mailing. A representative sample was assured by randomly selecting a sample of phone books, pages within phone books, and telephone numbers on pages. A short telephone interview was used to determine the number of potential respondents over 18 years of age living in a household. One of those persons was then selected at random, and the cooperation of that person was requested.

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Measurements

Wildlife knowledge was measured with nine statements reflecting principles of wildlife management and biology. Each item was scored on a Likert-type, 7-point, agree-disagree scale. For this study, correct knowledge was inferred if an item was given a response value of one or two (affirmative). Correctly answered questions were given a value of one, and incorrect responses were valued as zero. The knowledge-scale score was the sum of values over all nine items. Items used were: The most serious problem facing Iowa wildlife is lack of food and shelter; long hunting seasons are the chief cause of declines in pheasant populations; the size of waterfowl populations can be regulated by adjusting hunting seasons; lack of a safe place to nest is a serious problem for pheasants in Iowa; wildlife is more plentiful where field sizes are smaller and more types of crops are grown; one cock pheasant can mate with many hens in the spring; if animals become too numerous and crowded, females will produce less young; the fox's main diet consists of pheasants, quail, and any other birds they can capture; and if man does not harvest surplus animals, nature will.

Respondents were queried as to whether they had read literature or had memberships in the following: Sierra Club, Izaak Walton League, Ducks Unlimited, The Wilderness Society, Audubon Society, Friends of Animals, National Rifle Association, National Wildlife Federation, Defenders of Wildlife, and Humane Society of United States. Whether respondents had read literature of the U.S. Department of Interior, Iowa Conservation Commission, National Park Service, and Fish and Wildlife Service also was determined. Memberships and reading of literature each were counted as 1 and summed.

Involvements on behalf of issues of hunting, trapping, land-use and gun control were measured by an eight-item inventory of politically oriented activities as follows: made contacts with a government agency, a federal legislator, a state legislator, or a newspaper; or carried a petition, signed a petition, joined a special-interest group; or contributed to a fund. All involvements were summed for each respondent. Positions on these issues were recorded as for, against, or no opinion.

Results and Discussion

Determining the amount of knowledge relative to a specific area possessed by a group of people as diverse as the general public is difficult. Barriers in communication arise from a lack of familiarity with terminology used in phrasing questions. Many times experts disagree on exact facts. In constructing the questions on knowledge, much effort was made to avoid these problems by using general vocabulary words to convey basic concepts on which a group of wildlife biologists agreed. An example is the question, "The most serious problem facing Iowa wildlife is lack of food and shelter." Iowa game biologists agreed that the statement is a fact without equivocation. "Habitat" would have been the term to use in preference to food and shelter because some respondents felt that shelter was more of a problem than food, and vice versa, which was not the main point of the question. Yet habitat is a term not commonly used by the general public. As a result, some respondents may have answered incorrectly. An additional problem occurs in measuring knowledge without the influence of emotions. People strongly opposed to hunting might sincerely feel that the most serious problem facing Iowa wildlife was hunting, per se, and disagree even though they realized that lack of habitat was a problem. Nevertheless, our objective was to determine the degree to which Iowans approached agreement with game biologists in their perceptions of facts about wildlife and principles upon which game harvests are justified.

Wildlife Knowledge

Socioeconomic factors had an important bearing on wildlife knowledge (Table 1). Males had higher average scores (3.6) than did females (2.9) on the nine questions concerning knowledge of wildlife management. This difference is undoubtedly linked to differential socialization, based on sex, in our society. Individuals with hunting experience had higher scores (3.7) than did those who never hunted (2.5). Current hunters had the highest scores of any group (4.3), and their score exceeded that of former hunters (3.2). Single persons had a lower average score (2.6) than those who were married (3.3) or were widowed (3.4). Iowans scored higher (3.3) than easterners (2.5) and the score of other westerners (2.8) was indistinguishable from these groups; the difference is probably due to regional relevance of some of the questions.

As age increased, people scored higher on wildlife knowledge. The scores of persons 50-69 years old (3.7) were similar to scores of those over 69 (3.8), but both groups scored higher than those under 30 (2.7) and the age group 30-49 (3.0). Among occupation classes, farmers scored highest (4.0) and full-time students lowest (2.4). Four groups statistically distinguishable were: farmers; two blue-collar groups (3.9 and 3.7) and managerial (3.5); white-collar skilled (3.3); and housewives (2.9), professional (2.8), white-collar semiskilled (2.8), and students.

Childhood residence also influenced wildlife knowledge. Individuals reared on a farm, on a rural nonfarm area, or in a small town scored higher (3.4-3.5) than those reared in a large city of more than 50,000 (2.4). Respondents reared in a medium-sized city were intermediate in score (2.9) and could not be distinguished statistically from those reared in communities either larger or smaller.

Respondents with a grade-school education did best on the test of wildlife knowledge (3.6) and had scores similar to those with 2 years of college (3.4) and with a high school diploma (3.3). These groups did better than those with a college diploma (2.5). Individuals with postgraduate work were intermediate (2.9) and not statistically distinguishable from those scoring highest and lowest. The trend for people with lower incomes to score higher on wildlife knowledge than those with higher incomes was not significant ($P = 0.20$).

Table 1. Relationships between socioeconomic factors and (1) knowledge of wildlife management, (2) readership of publications bearing on natural resource issues, and (3) attitudes toward hunting. Probabilities for the F tests are * where $P \leq 0.05$, ** where $P \leq 0.01$, and ***where $P \leq 0.01$. F and P values are in parentheses. N is the same for wildlife knowledge and readership.

Factors	Wildlife knowledge		Readership	Attitude toward hunting	
	n	$\bar{x} \pm$ SD	$\bar{x} \pm$ SD	n	$\bar{x} \pm$ SD
Sex	(24.0***)		(19.7***)	(66.7***)	
M	519	3.57±2.38	2.09±2.15	494	3.13±1.82
F	528	2.89±2.10	1.53±1.88	490	4.09±1.84

Table 1 (cont.)

Factors	Wildlife knowledge		Readership	Attitude toward hunting	
	n	$\bar{x} \pm$ SD	$\bar{x} \pm$ SD	n	$\bar{x} \pm$ SD
Ever hunted	(74.0***)		(40.5***)	(225.3***)	
Yes	622	3.72±2.29	2.13±2.14	592	2.95±1.69
No	415	2.53±2.01	1.32±1.75	387	4.62±1.71
Currently hunt	(38.3***)		(36.3***)	272.3***	
Yes	296	4.26±2.31	2.61±2.29	285	2.02±1.21
No	399	3.20±2.15	1.65±1.91	375	3.98±1.70
Marital status	(8.3***)		(4.08*)	(10.3***)	
Single	164	2.57±2.02	1.99±2.32	152	3.82±1.84
Married	728	3.34±2.31	1.85±1.97	695	3.44±1.88
Widowed	156	3.40±2.18	1.40±1.96	137	4.19±1.87
Home state	(3.5*)		(2.4)	(0.8)	
Iowa	949	3.28±2.27	1.80±2.01	891	3.58±1.88
Westerner	48	2.77±2.20	1.50±1.82	45	3.84±2.04
Easterner	49	2.53±2.17	2.37±2.55	44	3.84±1.99
Age	(13.5***)		(2.59*)	(2.2)	
<30	255	2.69±2.04	1.72±1.98	242	3.51±1.86
30-49	334	2.98±2.25	1.97±2.08	321	3.47±1.87
50-69	324	3.69±2.28	1.87±1.98	300	3.70±1.91
>69	135	3.76±2.38	1.42±2.11	119	3.94±1.95
Occupation	(5.6***)		(4.8***)	(8.2***)	
Professional	125	2.82±2.17	2.36±2.37	118	4.42±1.86
Managerial	95	3.48±2.17	2.36±2.25	91	3.61±1.85
White collar-skilled	122	3.25±2.38	1.99±1.97	114	3.49±1.70
White collar-semiskilled	146	2.75±2.17	1.50±1.73	138	3.95±1.78
Blue collar-skilled	85	3.87±2.50	2.32±2.18	82	2.61±1.72
Blue collar-semiskilled	114	3.69±2.38	1.79±2.26	108	3.21±2.06
Farmer	92	4.03±2.06	1.51±1.96	87	3.17±1.67
Housewife	175	2.89±2.08	1.32±1.67	158	3.81±1.82
Student-full time	34	2.41±1.96	1.82±1.87	33	3.82±2.08
Childhood residence	(7.6***)		(0.8)	(3.3**)	
Farm	465	3.51±2.16	1.80±2.09	435	3.49±1.81
Rural, non farm	39	3.54±2.23	1.82±2.26	37	3.92±2.11
<5,000	204	3.39±2.26	1.63±1.89	188	3.38±1.91
5-50,000	214	2.87±2.39	1.99±2.05	203	3.71±1.94
> 50,000	125	2.42±2.22	1.78±1.92	120	4.08±1.93
Education	(4.9***)		(10.9***)	(4.0*)	
Grade school	160	3.61±2.36	1.05±1.33	145	3.69±2.04
High school	535	3.25±2.23	1.76±2.03	506	3.45±1.81
2-yr college	82	3.40±2.40	2.07±2.14	77	3.40±1.89
4-yr college	116	2.47±2.01	2.41±2.18	112	4.17±1.78
Post graduate	37	2.86±2.08	2.70±2.58	34	3.94±1.84
Income	(1.5)		(6.7***)	(2.0)	
< $5,000	134	3.49±2.19	1.04±1.43	120	4.04±2.01
5-10,000	250	3.31±2.29	1.81±2.00	232	3.53±1.81
10-15,000	277	3.29±2.32	1.92±2.18	265	3.55±1.90
15-25,000	234	3.09±2.21	2.13±2.14	224	3.49±1.88
> 25,000	108	2.86±2.31	1.95±2.03	105	3.58±1.86

Readership

The only socioeconomic factors that did not significantly affect readership but did affect wildlife knowledge were home state of the respondent ($P=0.09$) and place of childhood residence ($P=0.50$). In readership of publications related to natural resources, as with wildlife knowledge, scores of males (2.1) exceeded those of females (1.5). Scores of individuals with hunting experience (2.1) exceeded those of persons who never hunted (1.3), and scores of current hunters (2.6) exceeded those of former hunters (1.7).

Single persons (2.0) and married persons (1.9) had higher readership than widowed persons (1.4). Persons 30-49 years of age (2.0) and those 50-69 (1.9) had higher scores than those over 69 (1.4). Among occupational groups, professionals (2.4), managers (2.4), and blue-collar skilled (2.3) had higher scores than housewives (1.3). Other groups were intermediate. Readership increased with education. Postgraduates and those with 4-year degrees scored higher (2.7, 2.4) than those with a high school diploma (1.8), and they, in turn, had a higher degree of readership than those with a grade-school education (1.0). Income was related to readership, but only those with annual family incomes under $5,000 had a score (1.0) significantly lower than other income categories (1.8-2.1).

Attitude Toward Hunting

Attitudes toward hunting (based on a 7-point scale with 1 = very agreeable and 7 = very disagreeable) were related to both wildlife knowledge and readership of literature related to natural resources. Males had a more favorable attitude (denoted by a smaller mean score, 3.1) toward hunting than did females (4.1). Individuals with hunting experience were more favorable toward hunting (3.0) than did those who never hunted (4.6), and this latter group was more unfavorable toward hunting than any other class in Table 1. Current hunters were more favorable to hunting (2.0) than were former hunters (4.0). Current hunters favored hunting to a greater degree than any other class of persons in Table 1. Married people were more favorable toward hunting (3.4) than either single (3.8) or widowed persons (4.2). The highly unfavorable score for widowed persons probably was due to a preponderance of females in this category. Those who considered Iowa their home state were no more favorable toward hunting (3.6) than other westerners (3.8) or easterners (3.8).

People 50 or more years old were less favorable toward hunting (3.7-3.9) than those under 50 (3.5, 3.5), but the difference was not significant ($P=0.08$). This may be a reflection of the increased proportion of females in older age classes. Blue-collar, skilled people were more favorable toward hunting (2.6) than any other class. Farmers and blue-collar, semiskilled (3.2) were statistically separable from students (3.8), white-collar, semiskilled (3.9), and the least favorable group, professionals (4.4). Individuals reared on a farm (3.5) and in a small town (3.4) were more favorable toward hunting those reared in a large city (4.1).

Education also was related to attitudes toward hunting; those with a 4-year degree were less favorable (4.2) than those with 2 years of college or a high school diploma (3.5). Income was not significantly related to hunting attitude ($P=0.10$), but those with the least income were less favorable toward hunting (4.0) than those with incomes over $5,000 (3.5, 3.5, 3.6, 3.6).

Knowledge, Readership, and Attitude

These items were interrelated, and for all respondents, the product-moment correlation (*r*) was 0.19 for readership and wildlife knowledge, 0.19 for readership and attitude toward hunting, and 0.27 for knowledge and attitude. For a composite group defined so as to maximize wildlife knowledge (males; ever hunted; married; Iowans or other westerners; age >49; occupation as managers, white-collar skilled, blue collar, or farmer; childhood residence <50,000; education <4-year college) and another group lowest in wildlife knowledge (all others), *r* values were 0.16 for readership and knowledge, 0.32 for readership and attitude, and 0.20 for knowledge and attitude for the first group and 0.19, 0.18, and 0.25, respectively, for the second. Selecting for a group highest in readership (males; ever hunted; single or married; age <70; education high school and up; income >$5,000) and lowest (all others), *r* values for the same relationships were 0.29, 0.27, 0.37, respectively, for the first group and 0.11, 0.10, and 0.19 for the second.

Wildlife Knowledge as a Predictor of Attitude Toward Hunting

The utility of knowledge about wildlife management as a predictor of attitude toward hunting may be examined in several ways. Five groups were defined on the basis of answers to nine wildlife-knowledge questions. These groups, from the lowest knowledge level (Group I) to the highest (Group V), were created by counting correct answers as follows: fewer than 2, 2 or 3, 4 or 5, 6 or 7, and 8 or 9. Mean attitude scores (based on the 7-point scale) in each group were (*n* in parentheses): I (259)-4.1, II (302)-3.9, III (248)-3.4, IV (143)-2.8, and V (40)-2.2. Thus, individuals who answered none or only one question correctly averaged "no opinion" or "neutral," while those who correctly answered all the questions, or missed only one, found hunting to be moderately agreeable.

The five respondent groups, on the basis of wildlife knowledge, also can be compared with a polar-adjective check list. All respondents checked a 7-point scale representing their feelings about hunting between the following adjective-pairs: valuable-worthless, kind-cruel, pleasant-unpleasant, good-bad, gentle-rough, clean-dirty, fair-unfair, wise-foolish, honest-dishonest, unselfish-selfish, mature-immature, exciting-boring, relaxed-tense, active-passive, rational-irrational and challenging-dull. After summing responses for those pairs, mean scores were computed for the 5 groups (*n* in parentheses): I (245)-62.0, II (282)-59.0, III (219)-53.6, IV (123)-48.4, and V (32)-40.1. Thus, those respondents with the greatest number of correct answers concerning wildlife knowledge (Group V) had the most favorable scores on attitude toward hunting by this measure of attitude as well.

Relationships Between Issues

Of 413 respondents who stated positions on all four issues, 145 were *for* hunting, trapping, land-use regulations, and gun control (F-H, F-T, F-LU, and F-GC); 93 were *for* three of the issues and *against* gun control (A-GC); 43 were A-H, A-T, F-LU, and F-GC; 42 were F-H, A-T, F-LU, and F-GC; 37 were F-H, F-T, A-LU, and A-GC; 20 were F-H, A-T, F-LU, and A-GC; and the rest were arranged in nine other combinations with from 1 to 8 in each group. Of these 413 respondents, only 15 percent were *against* hunting, 20 percent were *against* trapping, and 14 percent were *against* land-use regulations. A distinctly higher percentage (42 percent) was *against* gun control.

Certain socioeconomic factors were related to positions on issues. We synthesized two polarized groups: Group I, those F-H, F-T, A-LU, and A-GC, and Group II, those A-H, A-T, F-LU, and F-GC. These groups were compared with chi-square analysis. Males (24) outnumbered females (12) in Group I and were fewer (16-27) in Group II (P=0.02). Singles were few (5) in Group I as compared with Group II (16), but married and widowed were similar (28-24 and 3-3, P=0.06). Composition of the groups varied with childhood residence (P=0.07) (in the same order as in Table 1: 15–14, 4–1, 7–4, 7–11, and 3–12). Group II persons tended to be from larger cities. Persons in occupational groups also varied (P=0.01) (in the same order as in Table 1: 3–12, 2–5, 3–2, 2–5, 6–1, 4–2, 5–2, 6–6, and 0–8); disparity was greatest among professionals, blue-collar workers, farmers, and full-time students. Other socioeconomic classes did not vary significantly between Groups I and II.

Degree of Involvement and Issues

Groups I and II were different in their involvement with issues. Group I persons (37) were politically involved an average of 0.30 times with hunting, while those in Group II (43) were involved only 0.02 times (P=0.05). For trapping, Group I persons were politically involved 0.22 times, and Group II persons were never involved (P=0.07). Amount of involvement was more intense with land-use regulations for Group I (0.49) and for Group II persons (0.16), also (P=0.04). The greatest involvement was for Group I people with gun control (0.70); Group II people were involved much less (0.07, P=0.01). Again, sex, marital status, childhood residence, and occupation probably were determining factors for Groups I and II in their involvements with issues.

Occupations and Issues

Of 629 respondents who took a position on hunting, full-time students were most opposed to hunting (36 percent). The white-collar skilled group (8 percent) and the blue-collar group (10 percent) had the lowest percentages against. Of the people who took a position on trapping (n=545), groups with the highest percentages against trapping were students (54 percent), white-collar semiskilled (42 percent), and professionals (35 percent). Blue-collar groups (23 and 20 percent) and farmers (23 percent) had the lowest percentages of their groups against trapping.

Opponents of land-use regulations (n=581) were chiefly blue-collar skilled (20 percent) and farmers (25 percent). Groups most favorable to land-use regulations were students (only 4 percent against), white-collar groups (7 and 8 percent), and professionals (10 percent against). Gun control (n=668) was opposed chiefly by blue-collar groups (65 and 68 percent), managers (57 percent), and farmers (62 percent). Gun control was favored chiefly by professionals (21 percent against), white-collar semiskilled, and students (both 23 percent).

Students were more likely to be against hunting and trapping and for land-use regulations and gun control. Professionals and students were closely allied. Blue-collar groups and farmers took similar positions, generally for hunting and trapping and against land-use regulations and gun control.

Table 2. Relationships between wildlife knowledge, knowledge of resource organizations, organizational memberships, and political involvements based upon respondent's position (for=F, against=A, no opinion=N) on hunting, trapping, land-use regulation, and gun control. N is shown in parenthesis by position groups (F,A,N). The F value and probability (*≤0.05, **≤0.01, and ***≤0.001) are shown in parentheses.

Position	Wildlife knowledge $\bar{x}\pm SD$	Organizations recognized $\bar{x}\pm SD$	Organization membership $\bar{x}\pm SD$	Political involvement $\bar{x}\pm SD$
Hunting	(15.1***)	(29.0***)	(1.4)	(7.3***)
F (570)	3.52±2.30	4.85±2.48	0.18±0.60	0.21±0.70
A (98)	2.86±1.84	5.05±2.41	0.17±0.45	0.14±0.75
N (212)	2.58±2.18	3.43±2.30	0.11±0.31	0.02±0.14
Trapping	(13.8***)	(12.6***)	(6.5**)	(4.6***)
F (406)	3.60±2.36	4.84±2.46	0.18±0.47	0.10±0.58
A (173)	2.87±1.99	5.32±2.47	0.11±0.31	0.01±0.11
N (220)	2.71±2.12	4.13±2.23	0.07±0.26	0.01±0.15
Land Use	(5.4**)	(13.1***)	(0.1)	(9.0***)
F (532)	3.26±2.26	4.93±2.38	0.14±0.41	0.19±0.72
A (83)	3.78±2.30	5.19±2.60	0.14±0.35	0.43±0.90
N (198)	2.85±2.11	3.98±2.37	0.13±0.35	0.06±0.36
Gun Control	(30.5***)	(17.1***)	(3.4*)	(15.0***)
F (430)	2.73±2.09	4.68±2.38	0.12±0.35	0.16±0.65
A (277)	4.02±2.31	5.16±2.46	0.19±0.47	0.50±1.35
N (134)	2.96±2.15	3.68±2.42	0.10±0.31	0.07±0.49

Issues, Wildlife Knowledge, Organizations, and Involvements

Wildlife knowledge was uniformly high among those for hunting and trapping (Table 2). Wildlife knowledge declined among those for land-use regulations and especially among those for gun control. Wildlife knowledge was high for those against land-use regulations and especially so for those against gun control. As might be expected, wildlife knowledge was relatively low among those with no opinion on land-use regulations and gun control.

Individuals for or against issues recognized more organizations related to natural resources than did those with no opinion. Typically, those against the issues recognized more organizations than those for issues. Membership in organizations generally was highest among those for hunting and trapping and against gun control.

Individuals who were for hunting and for trapping took more political action (0.21, 0.10) than those against (0.14, 0.01) (Table 2). The opposite was true for land-use regulations and gun control; those against the issues were more involved (0.43, 0.50) than those for (0.19, 0.16). Opponents of the latter two issues were the most active politically. Little political activity was found with the trapping issue.

Recommendations and Conclusions

Knowledge of wildlife management facts and principles was associated with socioeconomic factors and other variables. Typically, people who scored highest on wildlife knowledge were married males more than 49 years of age who currently hunted and were farmers, blue-collar workers, or managers who had grown up in a rural or small town setting and had an education including up to 2 years of college. Farmers scored higher than all the rest, and this likely resulted from experiential learning. Thus, any education program to increase knowledge of wildlife should include contacts with wildlife in a natural setting.

We have shown that socioeconomic background, wildlife knowledge, and readership are all interrelated and that each has an influence on a person's attitude toward hunting. Wildlife knowledge can be considered a predictor of attitude toward hunting. Socioeconomic factors are beyond easy control, but whether a person has ever hunted is amenable to control through a "take a child hunting" approach. Readership also is subject to a degree of control by wildlife interests through increasing or decreasing information and education (I&E) programs, or by changing the emphasis of content or the potential audience of that program. Both experiential and I&E programs may be effective in improving attitudes toward hunting.

Numerically, few are against hunting (11 percent) and against land-use regulation (10 percent) among the Iowa public. More are against trapping (22 percent), and the greatest number (33 percent) are against gun control. Percentages for hunting, trapping, and land-use are 65, 51, and 66. Fewer people are neutral toward gun control (16 percent), and a majority (51 percent) favor it. Little political involvement is associated with these issues at this time. Greater political involvements by those for hunting might have resulted from increased publicity on hunting such as the television show *Guns of Autumn,* which was shown a few months before our questionnaire was mailed. Responses of the public in Iowa may be typical of other midwestern states with relatively low populations and agriculturally oriented economies.

Those with high wildlife knowledge and high readership are generally for hunting and trapping and against gun control. In general, these people have more organizational and political involvements. The unfavorable attitude of Iowa students, however, probably indicates a trend that will eventually become more widespread and develop further with continuing urbanization. Wildlife agencies should improve the quality of sport hunting and increase emphasis on nonhunting aspects of wildlife management to accommodate this trend.

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Changes in Responses From Identical Ohio Hunters Interviewed in 1960–61 and 1973–74.

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Introduction—Review

Hunters and hunting have been legitimate subjects for research and debate for a long time. Hunting played an important role in the evolutionary development of man and may have been responsible for selection of a larger brain size (Krantz 1968). Oswalt (1973:170) has suggested "that hominids did not learn to hunt effectively until after the rise of incipient culture." There are many extant tribes, societies or cultures that are still largely dependent on hunting for their existence, including those in Australia, Greenland, Mexico, South America and Alaska (Oswalt 1973); Baffin Island (Kemp 1971); and Peru (Carneiro 1970).

White (1967) emphasized that some of our wildlife and conservation philosophies may be related to our religious heritage. In the Japanese culture, nature is an object of appreciation and companionship rather than an object of study, exploitation or mastery (Watanabe 1974). Tocher and Milne (1974) made some cross cultural comparisons concerning wildlife attitudes and suggested that man relates to wildlife through fear, competition for food, as a source of products, and as a model for behavior in the satisfaction of esthetic or psychic needs. Edward of Norwich (1406–13), in the first book written in English about hunters and hunting, suggested (p. 4) . . . "that hunting causeth a man to eschew the seven deadly sins. Secondly men are better when riding, more just and more understanding, and more alert and more at ease and more undertaking. . . . .; in short and long all good customs and manners cometh thereof, and the health of man and of his soul." Perhaps one of the most eloquent definitions or discussions concerning hunting was written by Ortega y Gasset (1972:52), who suggested that killing is not the exclusive purpose of hunting.

There has been a great increase in interest and research dealing with hunters, hunting and anti-hunting in recent years. Schole (1973) and Potter, Sharpe, and Hendee (1973) summarized some of the literature. Hope (1974:78) succinctly stated that "The object of hunting is to kill something." Mannix (1967) recommended that hunters return to the more primitive methods of hunting such as coursing with cheetah, blowguns and bolos. Pine (1973:177) attempted to counter the notion that hunting has some basis for continuance because it is atavistic; he said, "Hunting must be recognized for what it is, a relic of a remote past." Rikhoff (1973:203) disagreed and felt that "Since man is a hunter by nature, the act of hunting can hardly be an 'unnatural' act, let alone immoral, unethical or unholy."

The human values of wildlife and hunting are moral and ethical judgments of the human mind, so hunting should be viewed as one use of wildlife just as there are other uses (Klein 1973). Stanojevic (1967) discussed the right of animals to exist and the right of man to take animals and suggested that consideration should be given to future generations of man in the preservation of wild animal species. Stankey et al. (1973) felt that success in terms of taking an animal was an important aspect of the hunting experience. Earlier papers about hunters and hunting were those of Clarke (1958), who felt that hunters must be guided by a respect for nature, Anthony (1957) and Coon (1954) who emphasized the historical and biological experience of man as a predator, Krutch (1957), who felt that hunting was a "damnable pleasure," and Leonard (1965:423), who suggested "that for our present state of development, at least, hunting and fishing are socially acceptable pursuits. . . ." Amory (1974), a strong opponent of hunting, suggested that public agencies should no longer manage for game species. Further controversy about hunters and hunting was increased by the 1975 CBS telecasts "Guns of Autumn" and "Echoes of the Guns of Autumn." Applegate (1973) found that about 54 percent of the New Jersey residents he surveyed approved of deer hunting. About one-half of a sample of male college students hunted (Shaw and Gilbert 1974).

Concerns about non-consumptive uses of wildlife and criticism of consumptive users are increasing (Shaw 1974). Hunters probably will be faced with increasingly restrictive regulations (Waterman 1973). By the year 2000 there will be permit systems for hunting and revocation of licenses for violators (Shafer and Moeller 1974). Violators of the deer hunting laws in New York seem to be more successful in bagging game than those who abide by the law (Schafer, Amidon, and Severinghaus 1972). Urban and rural dwellers responded differently to questions about bird hunting in Saskatchewan; those living in rural areas were more tolerant of hunting (Schweitzer et al. 1973). Dove hunting in South Dakota is quite controversial, and those opposed are more willing to state their views (Linder et al. 1974). Both income as well as place of residence seem to influence the way landowners in New York feel about hunting (Brown 1974).

Participation in hunting by the general population is related to place of residence (Kennedy 1973), and as the population density increases the percentage of residents purchasing hunting licenses decreased (Peterle 1967). High hunter density in the field is tolerated by New Jersey deer hunters; 15 hunters per 100 acres was considered too low for good deer hunting success (Kennedy 1973). In an evaluation of satisfactions gained from outdoor recreation, including hunting, More (1973:234) concluded that ". . . . the pleasure of hunting comes more from the *process* than from the *product*." Hunters apparently "harvest" various dimensions of satisfaction including nature, escapism, skill and shooting (Potter, Hendee, and Clark 1973). Talhelm (1973) attempted to place monetary values on these recreational benefits. Attitudes, philosophies and behavior of Colorado hunters were described by Schole et al. (1973). Responses of Wisconsin duck hunters to the point system was reported by Klessig and Hunt (1973). How Wisconsin hunters perceived the state wildlife agency seemed to be related to their participation and success in hunting, but the state agency apparently had a better knowledge of hunters than the opposite (Eisele 1973). Other hunter surveys have dealt with the accuracy of the reported kill for deer (Kranz 1974) as well as the number of waterfowl taken or crippled (Sen 1973).

The future of hunting and hunters in the USA will depend on a large number of variables influenced by social, political and economic considerations. The ORRRC report of 1962 (p. 4) stated that "One cannot justify the continuance of hunting in modern society nor offer grounds for its social encouragement by saying it is atavistic. . . .Could it be, then, that hunting is neutral and it makes no important difference to society whether man can hunt, or is the activity socially beneficial or, perhaps, harmful?" Certainly, federal and state agencies responsible for regulating hunting are changing in response to political, social and economic pressure (Clement 1974).

The welfare of wildlife should be given the first priority by agencies legally responsible. Hunters and hunting do confer some benefits to society, however ill defined and controversial they might be. The generation of economic benefits has been well described and documented (U.S. Fish and Wildlife Service 1966, 1972). We are only beginning to define and describe other social, physical, ethical, moral, mental and religious aspects of hunters and hunting. In our present state of ignorance, it is probably only safe to say there will be change.

Methods

Original Ohio Hunter Survey 1960–61

Methods, data and results of our original survey in 1960–61 were documented in earlier publications (Peterle 1961, 1967). We surveyed 6,810 (about 1 percent of the total) 1959 Ohio hunting license buyers in 1960, utilizing a 24-page mailed questionnaire containing 200 questions. Individuals were randomly selected from license stubs. We received a response of 4,144 questionnaires after five follow-up letters to non-respondents. An additional personal interview sample of 8 percent of the non-respondents was conducted (Yuhas 1962). Nonrespondents differed from those returning questionnaires in several socioeconomic characteristics as well as in their participation in hunting. Mailed survey data represented a segment of the Ohio hunting license buyers who chose to respond to a mailed questionnaire. These responses reflected what hunting license buyers chose to tell us, and may not represent their true feelings or facts about themselves (see Hayne *in* Peterle 1961: 265). Data were coded, punched on IBM cards and analysed with simple regression, *t*-tests and multiple regression.

Resurvey of Hunters Sampled in 1960–61

Our project in 1973–74 was combined to include a new sample of individuals purchasing a hunting license in 1972, a cohort of those hunting license buyers who responded in 1960–61 and a sample of nonhunting license buyers obtained from the drivers' license registrations. We attempted to obtain a sample size of 1,000 in each of these cohorts. This report deals mainly with those hunters that were sampled both in 1960–61 and 1973–74. The questionnaire was essentially the same style and format as that used in 1960–61—the small booklet fit into a business-sized envelope, contained 186 questions on 16 pages and was entitled "For Hunters Only." Most of the opinion questions were identical to those in the earlier survey, but we added a fourth category for a checked response. In the first survey the respondent was given a choice of agree, partially agree or disagree when responding to an opinion question; in the recent survey this was altered to strongly disagree, disagree, agree and strongly agree. In the second survey, we combined the first two categories for analytical purposes when we compared them to the earlier data. We added some questions to the 1973–74 questionnaire that were related to our other surveys, *viz,* about prisons, prison reform, drugs, moral issues and religious preferences and beliefs. We deleted some questions that produced what we thought were spurious correlations in the original survey, or those that appeared unacceptable to some of our respondents. We began by addressing every third person from the list of respondents to our initial questionnaire to obtain a sample of about 1,000. Our cover and follow-up letters referred to their earlier cooperation but, despite five follow-up letters, we were not able to meet our original goal of 1,000 respondents. As a result of moves, deaths, responses from other members of the family or friends and refusal to respond, we completed the resurvey with 591 respondents who completed both the original questionnaire in 1960–61 and also the second questionnaire in 1973–74.

Results

These results are based on a sample of 591 individuals who we feel confident completed both questionnaires. We eliminated paired responses if they did not give their age as 13–14 years older or if they indicated a different sex, name or residence location. Some of the basic socioeconomic characteristics changed between the first and second sample, aside from the respondents' change in age of about 14 years. Our respondents, who were predominantly white males (Table 1), had more than doubled their income, fewer of them were single and concurrently more were married, widowed, and divorced. They had increased their family size by nearly one child per family and had nearly an additional year of schooling. Our initial survey did not request information regarding religious preference, but our respondents were predominately Protestant. Compared to our non-hunters there were fewer Catholics, Jews, and those who indicated no religious preference among our hunters sampled in 1960 and in 1974. As one might anticipate, 14 years also resulted in a change in occupations. We had about the same number of higher executives, more business managers and lesser professionals, a greater number in clerical and sales positions, skilled manual employees and machine operators. We had fewer unskilled workers and farmers, and there were no students in the second survey.

Our hunters' relationship with hunting also changed (Table 2). They hunt significantly fewer days and kill less game. They prefer to hunt different species of game; the number of pheasant hunters decreased, a response to declining pheasant populations in Ohio and nearly three times more of them preferred to hunt deer, a response to increasing deer numbers in Ohio. The deer kill in Ohio increased from 2,584 in 1960 to 9,390 in 1974. There was a slight increase in rabbit hunting, and a decrease in squirrel hunting. More of our hunters preferred to hunt ruffed grouse, although less than 4.0 percent of the total. The number of raccoon, fox, quail and duck hunters remained about the same, Distance traveled to hunt may be an indication of interest. More of our hunters traveled shorter distances, but the number of those that traveled more than 100 miles to hunt also increased. This may partially reflect greater accessibility to freeways and also a higher participation in deer hunting. Fewer of our respondents would take advantage of a more liberal hunting season than said they would 14 years ago. Most who changed their opinion indicated they would hunt the same amount of time if the season were extended. This also implied a lower interest in hunting as reflected in fewer days hunted and less game killed. Gun ownership has also changed; slightly fewer hunters owned shotguns, and more of them owned rifles and pistols. Ownership of rifles might reflect increased participation in deer hunting, primarily out-of-state, because only shotguns and bow and arrow are legal for deer hunting in Ohio.

Table 1. Socio-economic characteristics of Ohio hunters surveyed in 1960–61 and in 1973–74.

	1960–61	1973–74
Age, years	35.91	48.91
Sex - Male %	98.1	98.1
White	97.3	97.3
Black	0.8	0.8
Female %	1.9	1.9
White	1.9	1.9
Black	0.0	0.0
Marital Status %		
Single	19.2	3.6
Married	79.2	91.4
Widowed	0.3	1.7
Divorced	1.4	3.1
Income	\$5,289	\$13,682
Religious Preference %		
Protestant	No data	71.6
Catholic		20.8
Jewish		0.2
None		4.3
Education, years	11.02	11.68
Family size		
Mean number children	1.92	2.87

There is a limited deer season for muzzle-loading rifles. Hunting has certain social implications in terms of companionship. There is a slight tendency for our hunters to hunt alone or with fewer people than they did earlier. More hunted alone and with one other person than hunted with two or three or more people. This may reflect a decreased interest on the part of former hunting companions, changes of residence by friends and deaths. Slightly fewer of our hunters also fished after 14 years, 68 vs. 72 percent in the earlier survey. Our hunters have increased their readership of outdoor magazines and they are more prone to make home repairs than they were earlier. This is related to the higher proportion that are married and own their own homes.

We tested about 168 variables in a multiple regression and reviewed the effect of these variables on days hunted and game killed. The general trend was to have fewer significant regressions in the new data. Occupation significantly influenced the number of days hunted ($P < 0.01$) and the game killed ($P < 0.05$) in the original survey but neither of these regression coefficients was significant in the most recent responses. This was also true for education and hunting success and for those who would pay a higher fee and hunting success; the correlations were significant with the old data but not with the new information. Hunting success and game killed were correlated with the type of game most preferred to hunt, e.g. pheasant, deer, and duck. Partial regression coefficients with the old data indicated that 79 correlations were significant ($P < 0.05$) when related to days hunted and hunting success. Analysis of the new data and the same set of partial regression coefficients, showed only 28 significant correlations. As an example, when

Table 2. Characteristics of Ohio hunters interviewed in 1960–61 and in 1973–74.

		1960–61	1973–74
Days Hunted, day ($\bar{x}$ ± SD) $p < 0.01$		5.14 ± 2.6	2.91 ± 3.2
Game Killed (points) $p < 0.01$		35.9 ± 30.9	29.1 ± 31.9
Game Preferred (%) $p < 0.01$			
Pheasant		37.0	26.6
Rabbit		29.7	32.1
Squirrel		17.6	13.1
Grouse		1.0	3.9
Quail		2.0	2.9
Raccoon-Fox		6.1	6.7
Deer		4.5	11.5
Duck		2.2	3.1
Distance traveled to hunt (%) NS $p > 0.5$	0–50	57.9	60.7
	51–100	19.5	13.8
	101 +	22.6	25.6
Would hunt longer if season extended (%) $p < 0.01$		46.1	27.5
Gun ownership (%) $p < 0.02$			
Rifle		75.5	80.5
Shotgun		95.8	93.0
Pistol		37.7	52.0
Number of companions (%) $p < 0.01$			
Alone		11.0	13.4
1		42.4	45.8
2		26.0	24.5
3+		20.5	16.4
Also fished (%) $p < 0.06$		72.0	68.1

we tested education with days hunted and hunting success we found partial coefficients that were significant with days hunted included: fishing, operative, service and labor occupations, preference for pheasant and rabbit hunting, age, income, and age at initial hunt. In the new data, education and days hunted, showed only partial regression coefficients with the occupations of craftsmen, operative and service workers. In the original data set, education and hunting success showed nine significant coefficients: fishing, occupations of farmer, operative, service worker and laborer, pheasant and rabbit hunting, willingness to pay a higher fee and age at initial hunt. In the new data these same correlations showed only fishing and pheasant hunting were significant.

Most agencies responsible for wildlife are concerned about two important aspects of their responsibility, funding and the use of scientific methods and findings in decision making. We asked two questions related to these areas; the first inquired whether our respondents agreed that scientific studies should form the basis of a management program and the second was related to whether they would be willing to pay a higher license fee if the funds were used for research and management. Utilizing simple correlation coefficients that were consistent in both sets of data, we can provide some insight into the kinds of hunters who agreed or disagreed with these two questions. First the question of scientific studies: those who agreed to this view were more willing to pay a higher fee, were older, had a higher income, probably served in the armed forces, held occupations as craftsmen or operatives and service workers, and were also fishermen and probably rabbit hunters. Those who disagreed with the view that scientific studies should be the basis for wildlife management killed more game, were better educated, were farmers, laborers or professional workers and were more likely to be squirrel hunters. Increased financial resources are important, and those hunting more days and killing more game are willing to pay an increased license fee. They were more likely to be clerks and sales people, and had higher incomes and armed forces experience. Marital status and the age at which they began to hunt also were related to whether they would be willing to pay a higher fee. They felt scientific studies should be the basis of management programs, and they were most likely deer hunters and fishermen. Those opposed to paying a higher fee were in the crafts and labor occupations, had higher education and might have been rabbit hunters. These simple correlations were evident in both the original data and in the resurvey.

We asked 48 opinion questions in the second survey booklet. In most instances, the wording was exactly as it was in the original questionnaire. We did clarify some questions in the most recent survey, but the intent and meaning appeared to be identical. Most of these responses from the two surveys are shown in Table 3. They are grouped by subject matter—those dealing with hunting methods, hunting philosophy or attitudes about wildlife; some questions about general conservation and a group of rather unrelated questions. The table presents the percent agreeing with the statement in 1960–61 and 1973–74, the proportion of the respondents that altered their opinion in some way, and finally the significance of these changes: whether respondents tended to agree or disagree more in the second response. The general trend was toward greater disagreement in 1973–74. Perhaps this reflects greater conservatism associated with increasing age, but the trend also must be influenced by the changing social, ethical and moral values of society. Only two changes were significant towards greater agreement: a stronger objection toward any restrictions of the right to own firearms and a greater appreciation for the non-consumptive aspects of hunting. The latter may be a factor of age, less time spent afield and less game killed by the older hunter. A high proportion (42 percent) of our respondents changed their mind about stocking game, and this was toward greater disagreement. On some questions, opinions varied very little. Less than 5 percent of our respondents altered their opinions about such matters as following a wounded animal, principal goal is a clean kill, that animals feel no pain (few agree with this view), polluters and litterers should be fined, breaking your match is a good idea, and respecting the rights of the landowner if asked to leave his land. The federal regulation for a three-shell limit when hunting waterfowl seems well accepted. Even though about 12 percent changed their mind, 92 percent still agreed with this regulation. About one-third fewer of our respondents felt that poison was a good way to control pest animals. There was also a decrease of about two-thirds in those who indicated they would kill all they could if there were no legal limits. Fewer also thought they would like to hunt until they killed at least one piece of game. Despite this lesser emphasis on killing game, fewer indicated a deep satisfaction from hunting and less felt satisfied if they killed

Table 3. Attitudes about hunting, conservation and wildlife of Ohio hunters interviewed in 1960–61 and in 1973–74.

Abbreviated question	Percent 'agreement[a] 1960–61	Percent 'agreement[a] 1973–74	Percent altered opinion	Significance[b] Disagree $p<$	Significance[b] Agree $p<$
Hunting Methods					
Should only load 3 shells for duck	91.7	91.7	11.8	1.0 (No change)	
Unload shotgun before climbing fence	81.1	77.8	23.3	0.11	
Sunday hunting should be legalized	37.0	37.4	25.5		0.87
When lost in woods keep moving	90.1	78.0	23.4	0.01	
Run down wounded deer immediately	66.6	58.2	27.4	0.01	
Stocking game is the only answer	75.9	45.1	42.3	0.01	
Firearms training should be required	92.8	83.1	18.0	0.01	
Reciprocity for Ohio-Kentucky hunters	64.3	66.9	32.1		0.29
Hunting Philosophy					
Deep satisfaction to hunt	99.1	88.5	12.5	0.01	
Enjoy nature's beauty while hunting	92.5	97.0	8.1		0.01
Hunting promotes understanding	94.8	86.9	13.8	0.01	
Hunting avoids monotony of work	92.5	90.7	15.4	0.28	
Man is a predator	84.2	80.9	25.3	0.16	
Only man has conception of death	43.9	34.5	34.7	0.01	
Animals feel no pain	1.7	2.8	4.3		0.22
Only man considers death of animals sport	41.2	30.6	39.9	0.01	
True hunter inflicts pain	3.9	4.0	6.8		0.87
Satisfaction if no game killed	83.8	79.1	21.2	0.02	
Principal goal is clean kill	98.4	97.0	3.8	0.09	
True hunter follows wounded animal	99.0	97.0	3.7	0.02	

Table 3 (cont.)

Abbreviated question	Percent agreement[a] 1960–61	Percent agreement[a] 1973–74	Percent altered opinion	Significance[b] Disagree $p<$	Significance[b] Agree $p<$
Like to hunt until game killed	77.4	46.1	40.9	0.01	
If no limit would kill all possible	16.9	5.0	17.2	0.01	
Game laws are often violated	93.9	85.0	16.5	0.01	
Would report game law violators	71.5	65.5	28.1	0.01	
Would leave private land if asked without argument	99.3	98.1	2.5	0.07	
Would pay fee equal to movie cost to hunt one day	75.1	53.6	37.2	0.01	
Farmer has a right to charge fee to hunt	72.2	72.8	24.3		0.80
All should be able to hunt farmers' land	8.5	2.6	10.8	0.01	
Game belongs to all people	67.9	51.3	32.9	0.01	
Would pay higher fee for wildlife research and management	88.2	73.8	24.1	0.01	
Scientific studies should be basis for game management	94.2	87.6	14.6	0.01	
Conservation					
Govt. should set aside more wilderness	92.8	90.5	13.4	0.16	
Should not pick wild flowers	55.7	48.9	38.9	0.01	
Litterers should be fined	98.4	98.1	3.6	0.65	
Polluters should be prosecuted	97.9	97.1	3.9	0.40	
Should always break match	97.2	96.4	4.9	0.45	
Poison is good way to control animal damage	17.6	6.7	21.4	0.01	
Other					
Objects to firearm restrictions	72.4	79.6	34.6		0.01
Objects to payment of highway tolls	44.8	41.3	37.9	0.19	

Table 3 (cont.)

Abbreviated question	Percent agreement[a] 1960–61	Percent agreement[a] 1973–74	Percent altered opinion	Significance[b] Disagree $p<$	Significance[b] Agree $p<$
Stopping autos for insect inspection is annoying	24.9	22.2	29.8	0.23	
Spit on fish bait for good luck	8.4	7.1	9.6	0.33	
Would not attend bullfight	42.5	45.0	35.2	0.32	
Animals would die of old age	89.4	77.4	26.9	0.01	
Wild dogs and cats should be shot	79.2	66.3	29.7	0.01	
Only toadstools are poisonous	13.8	9.5	19.0	0.02	

[a] 1960–61 sum of agree and partially agree; 1973–74 sum of strongly agree and agree.

[b] p value, assuming equal probability of change to or from agreement or disagreement, chi square test.

no game. Fewer of the hunters thought that game laws were frequently violated, but fewer would report violators to the local conservation officer. There was some contradiction in philosophies about hunting; fewer agreed that they gained a deep satisfaction from hunting, but more of them indicated they enjoyed the beauties of nature while hunting. Fewer also felt that hunting was a way to promote better understanding among participants. Our older hunters felt less inhibited in terms of picking wildflowers, but nearly two-thirds fewer of them felt that poison was a good way to control pest animals. There is apparently not a strong trend for the promotion of Sunday hunting in Ohio by our group of hunters; those agreeing that Sunday hunting should be permitted remained almost identical, but about one-fourth of them did change their mind.

Discussion and Summary

Our Ohio hunters, besides being 14 years older since the initial survey, hunted less and killed less game than they did 14 years ago. This may partially reflect decreased game populations, smaller numbers of areas on which to hunt, and decreased interest. They earned nearly three times more salary, were slightly better educated and more of them were married, widowed and divorced. More of the older respondents preferred deer hunting; fewer indicated that pheasant hunting was their most preferred sport. About 5 percent more owned rifles, 3 percent fewer owned shotguns and 14 percent more owned pistols. Four percent of the respondents no longer fished. More of them preferred to hunt alone or with one other person as opposed to groups. Fewer were interested in hunting, fewer would kill all the game they could if the law allowed, and fewer liked to hunt until they killed at least one piece of game. Less gained deep satisfaction from hunting, but more of them enjoyed the beauties of nature while hunting. Fewer were sympathetic toward scientific management of game and fewer would be willing to pay a higher fee for wildlife research and management. Fewer of them would be willing to pay a daily fee comparable to the price of a movie for hunting privileges. Fewer felt that poison was a good animal control method.

It is difficult to characterize the changes in our hunters over the 14-year period, other than to indicate they have less interest and are less successful at killing game. In some ways they seem less sympathetic toward responsible game management and sportsmanlike conduct. Greater age, and presumably experience, does not promote, at least for this group of hunters, a greater appreciation and sympathy for professional wildlife management nor for hunting as a sport as defined by our series of questions. Our respondents are influenced by greater urbanization, lower game populations, fewer places to hunt and changing social and economic values. We also do not know if these hunters are representative of all hunters in Ohio or hunters in other states. Responses from this small sample of hunters, questioned after 14 years, suggested that state and federal agencies responsible for game management cannot depend on greater experience and maturity as factors for the enhancement of greater understanding and support for scientific game management, nor for improved hunting ethics.

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Human Concerns in Natural Resources Planning

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Mitigating the Impacts to Wildlife from Socioeconomic Developments

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Introduction

Development of water, mineral, and other natural resources for socioeconomic purposes encroaches severely on fish and wildlife habitats. Resultant concern for the conservation of fish and wildlife resources has prompted environmental legislation requiring identification of alternative and mitigative measures for proposed federal projects (National Environmental Policy Act, P.L. 91–190).

Project plans must incorporate mitigative measures if we are to ensure that fish and wildlife values will not be diminished by continuing socioeconomic developments. A multitude of plans to alleviate the wildlife losses caused by such projects have been developed and wholly or partially implemented. However, there still is no substantiated basis for the selection of mitigation measures and it was not until the latter half of 1976 that a standardized evaluation technique was accepted (U.S. Fish and Wildlife Service 1976b). In order to advance assurance that desired mitigations can be accomplished, attention must be directed toward the policies and results of past efforts.

While compensation for fish losses has been possible on past water projects,* the successful mitigation of wildlife losses has been extremely limited. In view of this limited success and repeated requirements for wildlife mitigation, the U.S. Fish and Wildlife Service (USFWS) is funding an evaluation of previous and current mitigation attempts. The study's objective is to develop recommendations

*Donald Dexter, Wyoming Game and Fish Dept. 1977: personal communication.

that can be used to increase the effectiveness and efficiency of the mitigative phases of future resource developments.

This paper is a review of the progress and preliminary results of this evaluation. For background, legal aspects of the mitigation process will be described first. Then, three problem areas demonstrated during previous attempts to mitigate wildlife losses will be covered: (1) problems originating in the identification of project impacts and the determination of appropriate mitigative measures; (2) impediments to the inclusion of mitigation measures in project plans and to their actual implementation; and (3) factors preventing implemented measures from achieving planned goals. Finally, the status of wildlife mitigation in natural resource planning today and the manner in which it may proceed in the future will be discussed.

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Legal Aspects of Mitigation

Mitigation may be defined as an increase in the carrying capacity of wildlife habitats to a level such that the increment of improvement will offset the wildlife and habitat losses induced by natural resource developments. It has been required for water projects since the 1946 amendment (P.L. 79–732) to the 1934 act (P.L. 73–121) that first promoted fish and wildlife conservation. Amended again in 1958 (P.L. 85–624), the act became known as the Fish and Wildlife Coordination Act. This study has focused on Bureau of Reclamation projects regulated by this law. Emphasis has been on mitigation in the western states for losses of terrestrial wildlife, primarily big game.

Review of pertinent legislation reveals the basic character of measures that govern the manner in which water resource developments relate to wildlife. The Fish and Wildlife Coordination Act requires that construction agencies only "give full consideration" to the ways in which wildlife may be affected by water projects (P.L. 85–624, Sec. 2(b)); the National Environmental Policy Act (NEPA) of 1969 calls for public input and the estimation of detrimental impacts to wildlife prior to project approval (P.L. 91–190); and the 1973 "Principles and Standards for Planning Water and Related Land Resources" recognizes national economic development and preservation of environmental quality as equal objectives (U.S. Water Resources Council 1973).

Unfortunately, the above measures have been unable to ensure the maintenance of wildlife values. The Fish and Wildlife Coordination Act fails to define mitigation or the extent to which predicted wildlife losses must be alleviated. NEPA and the Principles and Standards are only procedural acts; identification of a project's negative impacts does not prohibit project approval or assure the choice of alternatives which wisely balance development and environmental considerations. None of the measures contain procedures to mandate the implementation and completion of wildlife mitigation.

Indentification of Impacts/Determination of Mitigation

The first of three areas in which effective mitigation has been stalled is the identification and quantification of a development's effects on wildlife. This also involves determination and appraisal of measures that can alleviate these effects. The impacts of water projects can be primary or secondary and of long- or short-term duration.

Primary Impacts to Wildlife

Project construction, operation, and maintenance produce several primary impacts to wildlife.

Wildlife habitat losses. Reservoir filling accounts for the vast majority of habitat losses. Examples of acreages inundated include the 9,300 acres (3,764 ha) of mule deer winter range covered by Flaming Gorge Reservoir in northeastern Utah and southwestern Wyoming (Utah Dept. of Fish and Game 1962); the 6,140 acres (2,485 ha) of mule deer winter range inundated by Blue Mesa Reservoir in western Colorado (U.S. Congress, House 1959); and the nearly 6,000 acres (2428 ha) of elk and deer winter range that became part of Heron Reservoir in north central New Mexico (U.S. Bureau of Sport Fisheries and Wildlife 1964). Although deer are the important game species in these examples, inundation also means habitat losses for most other wildlife species in the project area.

Construction activities (short-term) and recreational, access and other facilities (long-term) related to the project result in additional, though smaller, habitat losses. Other losses or modifications of wildlife habitat come from increases in cultivated lands when irrigation is a part of a water project. The negative implications of all habitat losses are magnified during critical periods such as unusually severe winters.

Blockage/disruption of wildlife migration routes. Dams, reservoirs, and irrigation canals are common features of water projects. Placement of these structures in and across traditional wildlife migration routes disrupts or blocks wildlife migrations. The presence of Flaming Gorge Reservoir produced such a blockage. However the severity of direct mortality from this disruption was less than that predicted on the basis of observations at shallower reservoirs. Because of the depth of Flaming Gorge Reservoir, extensive ice formation usually occurs after fall deer migration and complete ice breakup usually preceeds spring migration (Warren 1973). Observations and shoreline track counts provide evidence that some deer complete their migrations by swimming across the reservoir.

Direct losses of wildlife. The primary impact to wildlife from the Navajo Indian Irrigation Project in northwest New Mexico has been losses of wildlife in the main irrigation canal. From 1969–1975 an estimated 150 deer and antelope were rescued from the dry canal while 38 deer and 3 antelope were known to have been lost in it (U.S. Fish and Wildlife Service 1976a). With recent filling of the canal, inflation of these losses is anticipated.

Alterations in wildlife behavior patterns. Daily or seasonal behavior patterns of wildlife may be influenced by the development of water resources. For example, construction of Flaming Gorge Reservoir has apparently contributed to some shifts in migratory routes of the region's mule deer herd.* However this and similar impacts are virtually impossible to quantify or even qualify without extensive pre- and post-impoundment studies.

* Rudy Drobnick, Utah Division of Wildlife Resources 1977: personal communication.

Secondary Impacts to Wildlife

Secondary impacts are indirectly attributable to the project. These chain effects result from developments tied to recreation, access, or human population growth that has been stimulated by the project and its construction.

Wildlife habitat losses. Today at Flaming Gorge much of the remaining winter range is threatened by subdivisions, roads (including plans for a highway that will bisect critical winter range), and a proposed ski resort. Ultimate effects of these chain developments may be of greater detriment to the area's wildlife than the migration blockage and habitat loss identified at project onset.** A new problem has now evolved: what course should be followed to compensate for secondary impacts not anticipated in preliminary project and mitigation plans? One of the ramifications of this question pertains to the time span over which a project's impacts should be mitigated.

Highway mortality increases. Addition of access roads for project or secondary developments, in conjunction with widening and/or upgrading the main highway in the project area, are usual consequences of reservoir construction. Because of the project, these roads now support greater levels of use. As a consequence, motor vehicles may become a principle source of mortality to wildlife. This has been the situation at Flaming Gorge where mortality from motor vehicles, particularly in fawning areas and at intersections with migration trails, accounts for 80 percent of all nonhunting mortality of deer in the project vicinity (Warren 1973). Prior to development of Flaming Gorge Reservoir, there were virtually no paved highways in the area and deer mortality from motor vehicles was minimal.* With commencement of construction, at least 39 deer were killed by project gravel trucks from 1960–62 and an additional 212 deer were killed on highways from 1962–69 (Warren 1973).

Wildlife/human conflicts. Another secondary impact of water projects is the greater probability for conflicts between wildlife and human activities. This results from the increased acreages of cultivated lands, greater edges of human activities abutting wildlife habitats, and reductions in available habitats that typically result from such developments. More frequent incidences of wildlife-caused crop damage similar to those experienced at Navajo Reservoir are a consequence of increased wildlife/public interactions (Shepherd 1965).

Alternatively, wildlife may be adversely affected by the human population growth—both temporary and permanent—which a project brings. Disturbances to fawning and calving grounds could be critical to reproductive success.

Other consequences of population growth include the removal of critical range from production as well as concommitant disturbances which prevent full utilization of the remaining range. These factors both contribute to greater concentrations of wildlife on the part of the range that is used, with subsequent deterioration of that increasingly critical habitat.

Impacts to the Public

An important and contradictory consequence of water developments is simultaneous diminution and enhancement of public opportunities for consumptive and

**Rudy Drobnick and Clair Huff, Utah Division of Wildlife Resources 1977: personal communication.

*Rudy Drobnick, Utah Division of Wildlife Resources 1977: personal communication.

nonconsumptive wildlife utilization. It is here in particular that human dimensions enter into the need for mitigating wildlife losses.

Comparisons of both harvests and nonconsumptive wildlife use, from pre- through post-project development, may indicate the realized impact of a project on an area's wildlife resources. However, limited periods of data collection and variability in weather and management practices may complicate and invalidate such comparisons.

It is more difficult to obtain the value of nonconsumptive wildlife utilization lost because of the project. Increased interest in outdoor recreation means increases in human pressures on natural areas. Numbers of users only indicate the realized demand for outdoor recreation and esthetic enjoyment of wildlife. Visitor days do not signify the degree to which the demand is, or could be, satisfied or the value of the area's wildlife. Furthermore, natural resource valuation must take into account the tremendous complexities in satisfying a public of widely divergent views and desires. Thus water projects may frustrate some outdoor enthusiasts by destroying undeveloped areas; at the same time, they may further the interests of others by providing greater access and recreational opportunity for those who pursue intensive use recreation such as boating, swimming, picnicking, etc.

Determination of Mitigation Measures

Once impacts associated with a specific project have been identified, the process of mitigating probable wildlife losses can begin. Quantification of impacts is a prerequisite for any decisions regarding the means and extent of recommended mitigation measures. As discussed above, natural resources such as fish and wildlife populations involve many intangible and incommensurable values. As a result, assessment of wildlife values is a subjective, transitory, and controversial activity. Recent work is attempting to decrease the subjectiveness of such valuations (Daniel and Lamaire 1974, U.S. Fish and Wildlife Service 1974 and 1976b, Flood et al. 1976). Standardized, quantifiable methods of impact prediction and habitat evaluation must be developed before sufficient allowances for wildlife values will become an integral part of water resource projects.

Coordination of Mitigation and Project Plans

Coordination and inclusion of mitigation measures with project plans is the second area where the attainment of wildlife mitigation has been limited. At this stage in planning, the construction agency accepts or rejects proposed measures and may or may not modify projects accordingly.

Mitigation measures decrease the benefit/cost ratio of a given project. Since that ratio is of major importance to project approval, there is little incentive for the construction agency to modify project plans once the input of the fish and wildlife agencies has been "considered." On projects authorized and developed in the decade after passage of the Fish and Wildlife Coordination Act of 1958, project construction started and was often completed before agreement had been reached on appropriate mitigation measures. Consequently project modifications that could have lessened wildlife losses were not instituted.

Project-caused wildlife losses may be essentially irreversible because of these delays in implementation of mitigation measures. For example, at Blue Mesa Reservoir in western Colorado, impediments to initial phases of mitigation were never overcome. Rather than present mitigation proposals, the U.S. Fish and Wildlife Service opposed the project. The Service's opposition was based on the unmitigability of fish and wildlife losses. Political factors entered the process when support for the project by Colorado's governor helped overrule USFWS opposition (U.S. Congress, House 1959). The project was then constructed without incorporation of a plan for mitigating wildlife losses.

Recommendations to acquire land for mitigation have since evolved in letters between the Colorado Division of Wildlife and the U.S. Fish and Wildlife Service.* Lack of suitable lands, difficulty in finding a willing seller in a county where public lands predominate, and eroded purchasing power of allocated funds have prevented such acquisition. Twelve years after project completion, mitigation for big game losses remains nonexistent. With no anticipated changes in these factors, prospects are slight for ever effecting significant mitigation.

In contrast to Blue Mesa, a comprehensive plan for mitigation of wildlife damages was drawn up with commencement of the Trinity project in northern California. In this case, initial interagency cooperation was poor. At first the Bureau of Reclamation did not accept the premise of a need for mitigation of an overutilized deer range (U.S. Bureau of Relamation 1960). (W.I. Palmer, Acting Commissioner, Bureau of Reclamation, Oct. 7, 1960. Memo to: Regional Director, Sacramento, California. Subject: Funding of improvement of deer range, Trinity Reservoir area. Central Valley Project.)

Once the Bureau of Reclamation accepted the mitigation measures proposed for Trinity, the problem became one of implementation. As with Blue Mesa, a large portion of the area is in public ownership; finding willing sellers and coordinating the availability of purchase funds with a willing seller have made the acquisition of land for mitigation impossible. A final obstacle to accomplishment of mitigation at Trinity arose when detailed analysis of soils, slope, and visual effects, in addition to reluctance of the responsible agencies to use prescribed burning, made the habitat manipulations originally recommended unfeasible (Trinity River Basin Fish and Wildlife Task Force 1975).

The experience of Trinity has been of benefit to plans for subsequent California water projects. Opposition by the U.S. Forest Service, Bureau of Land Management, and California Department of Fish and Game was instrumental in preventing construction of the Helena Dam immediately downstream from Trinity. That opposition was based on the impossibility of mitigating fish and wildlife losses which were predicted to be analogous to those sustained at Trinity.

Both Blue Mesa and Trinity exemplify some of the weaknesses in the Fish and Wildlife Coordination Act. There, as in all water developments, the position of the U.S. Fish and Wildlife Service has been one of advocacy rather than of control. Unfortunately, the Act provides little stimulus for construction agencies to coordinate and effect mitigation in conjunction with project development.

Biological Ineffectiveness of Mitigation

On a few of the projects already mentioned, some mitigative measures have proceeded beyond the prediction, planning, and approval stages. Yet reduction of wildlife losses has still been less than desired.

*Enos Stone, U.S. Bureau of Reclamation 1977: personal communication.

Too often habitats have been manipulated with minimal assurance of success; pre-manipulation evaluations are insufficient (as was seen at Trinity) and post-manipulation evaluations (to verify whether programs do accomplish their objectives) are sporadic at best.

Habitat manipulations that were conducted at Trinity generally produced the desired vegetative response* (increases in production and control of plant species less beneficial to wildlife) but failed to consistently produce the desired wildlife response (increased use of treated areas), Trinity River Basin Fish and Wildlife Task Force 1975).

In this instance harvest regulations have undoubtedly influenced the situation California's "bucks only" harvest adds to the difficulty of deer mitigation and management. With a bucks only harvest, wildlife agencies are unable to decrease a herd to complement vegetative conditions (Trinity River Basin Fish and Wildlife Task Force 1975; Thompson et al. 1971). Trinity thus illustrates why management policies must be designed to allow implementation of effective mitigation. The problem of accurately measuring changes in wildlife populations and correlating them to project impacts or mitigation results is also readily apparent.

Current Projects

The current situation and outlook for wildlife illustrate the role of recent legislation in mitigation. Passage of NEPA affords the general public, special interest groups, and other government agencies the opportunity to offer suggestions, support, or opposition to federal projects while development is still in the planning stage. Now that fish, wildlife, and esthetic values are recognized in preliminary planning stages, construction agencies find it more difficult to justify their projects.

In recent years construction of many projects has been delayed when the environmental impact statement process has brough fish and wildlife concerns to the center of attention. For example, initial wildlife agency opposition to development, combined with construction/wildlife agency disagreement on adequate mitigation measures, have delayed the Savery-Pot Hook project in north-central Colorado.

A public hearing on the mitigation measures proposed for Savery-Pot Hook showed how projected damages and recommended mitigation must be substantiated with detailed and reliable data on wildlife conditions (U.S. Congress, Senate 1975). At that hearing, wildlife agencies did not have quantitative data to defend their recommendations to either the construction agency or local landowners.

Interagency bargaining and public intervention have resulted in a site change for one of the two reservoirs proposed in the 1972 draft environmental impact statement (EIS) for Savery-Pot Hook. An updated draft EIS was released last year; it incorporates a new reservoir site that is more agreeable to fish and wildlife interests (U.S. Bureau of Reclamation 1976). It also includes a mitigation plan less disruptive to local landowners and less costly for the construction agency than the one initially proposed by wildlife interests.

In this case project development will not be initiated without agreement on a wildlife mitigation plan. However Savery-Pot Hook and similar projects are

*Marv Hoffer, U.S. Bureau of Land Management 1977; personal communication.

examples of the increasing polarization between construction agencies and wildlife agencies who have become more demanding in their mitigation goals. The complex and heated bargaining which ensues over project features and mitigation plans has become a too common part of most water and other natural resource developments of the 1970s. This polarization and bargaining make agreements harder to attain and are unproductive to wildlife interests, development goals, or interagency relations.

Conclusions and Future Outlook

Some hope for easing the complicated and often unproductive mitigation process lies in amendment of the Fish and Wildlife Coordination Act. A bill to do this has again been introduced to Congress (U.S. Conress, House 1977). By providing a stronger, more definitive framework for the mitigation process, the amendment is designed to help solve wildlife problems in the earliest stages of water project planning and place more emphasis on completion of project evaluations (Wildlife Management Institute 1976a and b).

Fifteen to 20 years of repeated attempts, scattered habitat manipulations, innumerable memos, reports, and studies have done little to alleviate the wildlife losses caused by dams and reservoirs such as Blue Mesa and Trinity. It is doubtful whether another 15 or 20 years of effort can compensate for the resources long lost. With the limited materials available for wildlife preservation, mitigation for projects partially completed, in the planning stages, and barely under consideration should be favored over patchwork attempts to mitigate older projects. These older projects do, however, serve as lessons on situations to avoid and on why mitigative practices may fall short of preferred ends. Causes of impact may differ, but similar effects to wildlife allow extrapolation from past water projects to the mitigation that must be an essential part of future coal, oil shale, or other developments of our natural resources.

Amendment of the Fish and Wildlife Coordination Act would improve the chances of achieving significant wildlife mitigation on water projects. Meanwhile, it is most important to strive for full compliance with existing policies and laws. Agency dedication to carry out the "Principles and Standards for Planning Water and Related Land Resources" can aid in this end. There is also a need, as would be satisfied by amendment of the Fish and Wildlife Coordination Act, for commitment by the construction agency to condemn land for wildlife in conjunction with the condemnation of land for project construction, and for provision of funds to operate and maintain mitigative practices throughout the life of a project. Extensive evaluations of pre-project conditions, followed by thorough post-development monitoring, must also be obligatory features of any resource developments. Allowances must be made for plan revisions and institution of further mitigatory practices when implemented measures prove unsuccessful.

A major factor in the ineffectiveness of past mitigation attempts has been the unreliability of ecosystem evaluations and lack of creativity in the application of management practices. Further support for the current attempts to improve that reliability is needed. Since results of accepted management practices have been so inconsistent and unproductive, greater imagination and a willingness to try new techniques of habitat manipulation and systems of management could provide answers for the preservation of our wildlife resources. Of course, without an informed public supportive of wildlife management efforts, none of these measures can succeed. Open and well-publicized hearings at which wildlife agencies present quantitative data that substantiate their claims for mitigation are essential to such whole-hearted public support. Only then will corrective steps be instituted and minimization of the fish and wildlife losses from human-served developments be achieved.

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Unfulfilled Mitigation Requirements of the Fish and Wildlife Coordination Act

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Background

The fish and wildlife resources of this country are taking a severe beating at the hands of federal construction agencies involved in authorized water resource development programs.[1] Wildlife habitat is taken without compensation for federal projects which dam, dredge, drain, and channelize our most productive streams and wetlands. Fish passages are blocked, water quality is deterioriated, streamflows are depleted, and riverine ecosystems are flooded without a backward glance. Populations of important game and nongame species of wildlife continue to decline; the list of species threatened with extinction continues to grow.

It is not supposed to happen that way. Back in 1958 Congress called for an end to the thoughtless destruction of fish and wildlife resources caused by federal water projects. In ringing terms, Congress announced that wildlife conservation would receive "equal consideration" with other features of water resource developments. No longer the kid who came late for supper, wildlife values would be up front with the rest of the project purposes from planning to implementation. Damage would be prevented by consultation and study; unavoidable losses would be compensated by mitigation measures integrated into project plans. No more free rides for the developers. That was what Congress had in mind when it passed the Fish and Wildlife Coordination Act of 1958.

But the Coordination Act is not working. Information to identify and defend mitigation measures is not acquired prior to project implementation, much less prior to authorization. Specific mitigation measures are not recommended to construction agencies; or, if recommended, are flatly rejected by construction agencies as unjustifiable. Mitigation methodologies are not uniform—one agency is replacing habitat, another is replacing recreational opportunities. Mitigation plans are not submitted to Congress for funding along with project construction. In euphemistic terms, the fish and wildlife column of the federal water resources development balance sheet—which the Coordination Act was supposed to enhance—shows a minus figure.

Is the problem really so pervasive? The National Wildlife Federation believes it is. The Federation has found mitigation either nonexistent or so feeble as to invite profound sympathy and dismay in projects all across the nation. Under every rock lies a new fish and wildlife horror story. And the Federation has turned quite a few rocks—the Cache River/Bayou Deview channelization, the Atchafalaya floodway, Trotters Shoals Dam, Garrison Diversion, Orme Dam, Lukfata Dam, Obion/Forked Deer channelization, Gathright Dam . . . .

[1]These resources are also destroyed by non-federal projects carried out under federal permits and licenses. This paper, however, deals solely with federal projects authorized by Congress.

So what can be done to cure this terrible disease? Three things (not necessarily in this order): (1) amend the Coordination Act to put some teeth into it; (2) issue uniform regulations to implement the Act's requirements; and (3) retrofit old projects with adequate mitigation features.

Amendments

The Coordination Act uses too many "mays" and not enough "shalls." The intent and purposes of the Act are fairly clear from the language and legislative history, but several key provisions are needed to make policy reality. First, a bottom line should be established: No project will be constructed unless and until an adequate mitigation plan has been submitted to Congress. Second, the responsibility for who does what and when they do it should be fixed. Third, mitigation studies must be adequately funded in a timely fashion. Fourth, a citizens suit provision should be added to aid enforcement. And fifth, provision for post-construction evaluation should be made, and retroactive mitigation required as needed. A bill (HR 582) has been introduced in the 95th Congress to accomplish these changes.

As an aside, it should be noted that even a precisely drafted statute—more than a rarity among federal laws—will not ensure compliance. The thing that makes laws work better than legislative draftsmen is a procedural mechanism to translate congressional policy into administrative action. That, coupled with judicial review and public participation, can transform even the most elusive statute—like the National Environmental Policy Act (NEPA)—into an effective legal tool. NEPA did not define what type of "detailed statement" it was requiring or precisely what it should contain. Nor did it prescribe that statements must be circulated for review and comment; or that the public was to play a key role in enforcement. Those things were developed by regulations issued by the Council on Environmental Quality, which were given legal effect by the courts.

Regulations

With or without the amendments, the issuance of comprehensive regulations spelling out the procedures to be followed in formulating, reviewing, authorizing, and implementing federal water projects under the Coordination Act is long overdue. More than any other single factor, the failure of the Coordination Act can be attributed to the failure to establish, by strict regulations, the rules under which the game is to be played.

The first question is who should write such regulations. There are at least two candidates: The secretaries of interior and army. The secretary of interior controls both the agency charged with the primary responsibility for developing mitigation measures—the United States Fish and Wildlife Service (USFWS) and one of the two principal construction agencies covered by the Coordination Act—the Bureau of Reclamation (BuRec). The secretary of the army controls the other construction agency covered by the Act—the Corps of Engineers.

The logical choice for the job of writing regulations would be the secretary of interior since the statute gives him most of the administrative responsibility as well as express authority, in section 4, to promulgate regulations. However, the statute also confers considerable discretion with the Corps of Engineers to accept or reject the secretary of interior's recommendations. Therefore, the best approach would be to coordinate regulations between the Interior and Army Departments, if possible; and if not, the secretary of interior, with the input of the USFWS and BuRec, should issue regulations governing his department's performance under the Act.

The next question is what policies and procedures should be included in the regulations. At least five critical ideas must be covered.

Methodology

At least two methods of mitigation are presently employed. The first is the old recreational usage approach, under which fish and wildlife values are measured in terms of hunting and fishing man-days, and are compensated by finding or creating other recreational opportunities to replace those lost to the project. This approach totally ignores nonconsumptive uses and users. The Corps of Engineers still clings to this method because of (1) the ease in quantifying the losses and (2) the low price tag.

A second approach, recently adopted by the USFWS, includes both monetary and nonmonetary evaluation of habitat quality. The nonmonetary evaluation attempts to measure the quality of habitat on a project area to the full range of fish and wildlife present, employing a scale of 1 to 10. The monetary segment of the evaluation provides data on the supply and demand for fish and wildlife in the project area. It also furnishes the benefit and cost figures required to justify enhancement features and for allocating project costs among project purposes.

Under the USFWS methodology, mitigation is interpreted to require that lost habitat not simply be replaced—replacement does not add anything to the natural systems "inventory"—but that it be replaced *and improved.* This is a qualitative rather than quantitative (e. g., acre for acre) approach to mitigation. From a purely fish and wildlife standpoint, it is clearly preferable to the recreational usage approach.

The USFWS methodology finds support in the Coordination Act and its legislative history, which flatly rejects the benefit/cost analysis approach to mitigation. It finds further support in the Water Resource Council's *Principles and Standards for Planning Water and Related Land Resources* (1973), which specifically recognize the non-monetary, intrinsic value of natural systems. Finally, the USFWS interpretation of the mitigation concept can be supported by NEPA's command that federal laws, including the Coordination Act, be interpreted and administered to further the policies of NEPA, one of which is to "enhance the quality of renewable resources."

In short, the USFWS methodology is both a logical and legal application of the mitigation requirement. It should be adopted by regulation.

Framework

The procedure for planning, reviewing and incorporating mitigation measures into projects has been haphazard. The regulations should lay out the steps to be followed in preparing and submitting mitigation plans to Congress which track the statute:

1. Consultation between USFWS, state fish and game agencies and construction agencies before and after project authorization.

2. Investigation of mitigation measures by USFWS/state agencies.
3. Preparation of a mitigation report containing the secretary of interior's specific recommendations.
4. Determination, in writing, by the construction agency as to which recommendations are justified and which are not, with supporting reasons.
5. Incorporation of accepted recommendations into the construction agency's project report to Congress.
6. Submission of the project report, containing the mitigation plan, to Congress by the construction agency.

Timing

Mitigation plans are submitted, if ever, at random times over the life of a project. Two courts have held that mitigation plans must be submitted to Congress prior to the start of construction (*Akers* v. *Resor* and *Environmental Defense Fund* v. *Froehlke*). These cases recognized that delay in submitting mitigation plans increases their cost, forecloses alternatives, and results in uncompensated losses.

In keeping with the Coordination Act's policy that wildlife resources receive "equal consideration" and be developed and improved "concurrently" with other project features, the regulations should require that mitigation features be implemented alongside other project features. For example, land acquisition for replacement habitat should proceed concurrently with land acquisition for reservoir purposes.

Public Review

The public is not getting a shot at proposed mitigation plans. It should for two reasons: (1) the resources at stake are public resources, and the public deserves a say in how they are treated; and (2) public support for mitigation plans helps win administrative and congressional approval.

There is already a handy mechanism for public review of mitigation plans. It is called the draft environmental impact statement. Instead of considering mitigation plans as irrelevant to a project impact statement as BuRec does, or maintaining that mitigation plans require separate congressional authorization before public discussion as the Corps does, these agencies should be required to include proposed mitigation measures in draft impact statements. One of the primary purposes of the draft statement is to inform the public of key policy decisions so affected members can provide their input. Without information regarding the fish and wildlife impacts of a project, and the measures proposed to mitigate those impacts, the public is denied any meaningful role in the review process.

Retrofit

In addition to equipping new water projects with adequate wildlife conservation features, steps must be taken to retrofit the old projects—those which are fully or partially completed as well as those which are authorized but not under construction. Many projects have been built without regard for mitigation; many others are about to be built with inadequate mitigation plans.

The Coordination Act authorizes mitigation for all projects which were less than 60 percent complete in 1958. It also authorizes mitigation for modifications of completed projects. The Act further requires that mitigation features be incorporated into *any* report submitted to Congress, not just the original project report. Where a mitigation plan is not submitted at the time of project authorization—which has generally been the case—it must be incorporated into subsequent reports submitted with appropriations requests. In other words, the mitigation plan requirement does not simply disappear just because someone missed the first deadline.

As a first step toward rectifying past errors, the Department of Interior should conduct a review of Corps and BuRec authorized projects to determine which are in need of mitigation features. The Carter Administration has recently announced a comprehensive economic/environmental review of all authorized water resource projects, some of which may be targeted for deauthorization. Evaluation of the status of mitigation plans for all of these projects should be incorporated into the Carter review.

Upon completion of this review, a list of projects requiring mitigation features should be compiled and a timetable for retrofitting should be established—so many projects each year, for example. It will then be up to the Department of Interior, with funds provided by the construction agencies, to develop appropriate mitigation techniques for each one. A plan for each project should be prepared, published, circulated for public review and comment like an environmental impact statement, and submitted to Congress for funding.

Funding

The most fundamental problem in administering any statutory program is getting the funds to run it. The same is true of the Coordination Act. Lack of money and manpower has been the principal reason for the poor performance by the USFWS in putting mitigation plans together prior to project implementation. The Service's traditionally timid approach to securing the necessary funds from construction agencies has not helped.

The Coordination Act itself offers the solution to this problem. The Act provides that the cost of planning and implementing mitigation plans should be an "integral part" of project costs. It also provides for the transfer of funds from the construction agencies to the USFWS to conduct necessary studies. The funding and transfer mechanisms of the Act have not been used effectively by the USFWS.

The cost of investigating new mitigation features and implementing authorized features, including personnel costs, should be computed annually for every water project by the USFWS. These cost figures should then be included as line items in the annual budget submitted to Congress by the construction agencies. Once appropriated, the money for these costs should be transferred to the USFWS.

To relieve the manpower problem, the USFWS should make greater use of independent contractors to do baseline studies. The service should also consider transferring funds to state fish and game agencies to conduct necessary studies. In practice, the state agencies very often perform these studies at their own expense.

Conclusion

The failure of the Federal Government to take better care of our important fish and wildlife resources is a national disgrace. In some cases, as in the Pacific Northwest, the unmitigated loss of these resources caused by federal water projects has been catastrophic. The indifference of construction agencies and the timidity of wildlife management agencies have combined to render the Fish and Wildlife Coordination Act virtually meaningless. To add to the insult, courts have held that citizens lack standing to enforce the Act's provisions.

The basic congressional policy underlying the Coordination Act is that the Federal Government should pay for what it takes; it should replace all the divots. Nice legal arguments can be contrived to circumvent this policy because the Act, unfortunately, talks too softly. But in the real world the results of the bureaucratic evasion of responsibility are all too evident, and it is in the real world that solutions are demanded.

It is time for the Federal Government to face up to its responsibilities under the Coordination Act, to internalize the costs of destroying fish and wildlife resources, to salvage a little of our natural heritage for the benefit of future generations. New legislation can make the job easier. But even without new legislation, there is enough on the books to start to do the job right, and to start tomorrow.

A Method of Evaluating Impacts of Timber Harvests on Nontimber Forest Resources

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Introduction

National forest timber harvest policies are of primary concern to a growing segment of the population living in the Douglas fir and ponderosa pine regions of the Pacific Northwest. Demands on national forests for a variety of forest products have never been greater. Pressure for larger timber harvests on national forests increases as the worldwide demand for timber products increases and the supply of timber from other sources decreases. At the same time, demands for the nontimber products and uses of national forests, including fish and wildlife, continue to increase as our society becomes more leisure oriented. The situation is further complicated because all demands for goods and services provided by national forests are constrained by increasing concern for esthetics and environmental safeguards. One consequence of these often conflicting demands is that timber harvest scheduling policies receive an unprecedented level of attention from special interest groups and the public.

In 1975, the chief of the U. S. Forest Service requested a study of timber harvest scheduling alternatives for national forests. Thirteen physical, economic, and social consequences of implementing eight alternative scheduling systems on national forests were studied by a designated team of Forest Service scientists and administrators. As members of this team, we were responsible for evaluating the two consequences involving nontimber forest resources: effects on the ecosystem and effects on the nontimber benefits.

To evaluate the consequences resulting from alternative harvesting policies, we had to recognize some important characteristics of forest resources. As social scientists, we recognized that quality of life and social well-being depend on consumer goods, services, and environmental amenities. The forest provides all of these. Forest products such as timber, forage, and water are marketed for monetary returns. Other products such as recreation, fish, and wildlife are not marketed in traditional ways. Certain amenities such as scenery are not marketed at all. Without markets, outputs cannot be evaluated by traditional monetary means. The next best thing is an examination of the physical consequences of actions. Even this is not easy, for the data on physical and biological consequences of forest management activities on nontimber resources are often weak or nonexistent.

Faced with the responsibility of evaluating alternatives in such a context, we needed to establish relationships between management activities and the outputs of nontimber forest resources, including fish and wildlife. Without time to establish long-term studies and without a sound base of established studies, we had to rely on the experience of specialists in the various resource disciplines. We used this experience to obtain estimates of the nature and magnitude of impacts and to evaluate their importance.

Methods

Our study used five essential steps: (1) selection of criteria, (2) identification of threshold of concern levels, (3) estimation of impacts, (4) comparison of estimated impacts with threshold of concern levels, and (5) classification of impacts in terms of direction and magnitude.

Step one, the selection of criteria, identified the impacts we wished to measure. We attempted to define criteria in terms of social objectives. Two classes of criteria were used, those relating to use levels and those relating to environmental standards. We had to avoid developing too many criteria. Activities such as logging, roadbuilding, slash disposal, and chemical control of brush may create an almost infinite number of identifiable impacts. Failure to limit the number of criteria may cause difficulty in interpretation of impact data.

Our discussions with nontimber resource specialists indicated that forest managers would be better equipped to judge potential impacts if they could relate to a benchmark level of social concern, rather than if impacts were stated strictly in physical terms. From this idea we formulated a method based on what we call the "threshold of concern" (TOC) concept.

In step two, a TOC was specified for each criterion. To understand TOC, visualize the potential range of an impact as being from essentially none to enormous. For example, if our criterion is the amount of sediment in water, we could have values ranging from minute to very muddy. Threshold of concern is that point along the range of impacts where a manager needs to be concerned because the situation will (1) draw the attention and concern of interest groups or the general public, (2) cause a noticeable change in use pattern, or (3) require additional costs to maintain the ecosystem. With this concept, the manager's attention is focused on how the expected impact compares with a defined level of concern rather than on the magnitude of the impact alone.

Estimating impacts, the third step in our process, was accomplished by panels of specialists assembled for this purpose. Impacts were estimated from the criteria developed in step one, timber harvesting data, and related forest management data such as roading plans, investment levels, and utilization standards. Impacts were usually expressed in physical terms and represented changes from the impact level associated with the current timber harvest policy. As such, impacts needed to be interpreted in terms of social impacts expressed as criteria. For example, one of our criteria was "maintenance or enhancement of cold water fish populations." A change in harvesting policy would generate physical data representing changes in water quality. This data would have to be interpreted in terms of impact on maintaining or enhancing cold water fish populations.

The question most relevant to the decision maker is whether the estimated impact exceeds the TOC. This question is addressed in step 4, which compares the estimated impact with the TOC.

The fifth step involves classifying and recording the results by comparing the impacts with the TOC levels. If the impact exceeds the TOC, a "2" is recorded; if not, the impact is classified as a "1," which designates that the impact is noticeable but not considered significant.

If the estimated impact represents no change from the impact associated with the present timber harvest policy, it would be a negligible impact and classified

"N. C." All "1" and "2" level impacts are recorded with either a plus or a minus sign, depending on whether the impact is considered beneficial or adverse.

This brief outline of our method for evaluating impacts is in some ways similar to the "Delphi method" (Dalkey 1969). The Delphi technique was developed to elicit and evaluate informed intuitive group judgment as a means of arriving at a consensus. Three distinctive features of the technique are: anonymous response, iteration and controlled feedback, and statistical response. The approach we used was much more informal, but our aim was to tap the intuitive (based on experience) judgment of informed specialists in the absence of any data linking management activities to resource impacts.

Application

The remainder of this paper describes an application of our method to the fish and wildlife resources in the Pacific Northwest. Because of the large number of species represented and their varying requirements, it is difficult to prescribe forest management objectives for wildlife. Interest groups with special objectives for some classes of wildlife are numerous. Unfortunately, their objectives often conflict. Defining broad social objectives and criteria that satisfactorily cover the many diversified interests is also difficult.

Three criteria for evaluating fish and wildlife values were selected on the basis of three broad use categories. The first criterion, anadromous and resident cold water fish populations, represents a primary concern of both fishermen and environmentalists. The second criterion, deer and elk populations, represents a major concern of sportsmen who participate in big game hunting. The third criterion, wildlife populations for viewing by casual, general, and discriminating observers, represents a concern of a broad category of forest recreationists and users who enjoy seeing wildlife.

A TOC was estimated for each of three criteria by the judgment of the panel of fish and wildlife specialists from state and federal agencies in Oregon and Washington. The TOC level for anadromous and resident cold water fish populations was estimated at 10 percent. This means that the specialists felt a change in fish population amounting to a minimum of 10 percent of the present levels in the Pacific Northwest would be significant as indicated in our definition of "TOC." For deer and elk populations, the TOC was set at 10 to 15 percent (or whenever the antlered male component drops below 15 percent of the herd). And for wildlife populations for viewing, the TOC was estimated at 10–20 percent for the casual viewer, 25–50 percent for the general viewer, and 10–20 percent for the discriminating viewer.

Impacts on fish and wildlife values were estimated for the Douglas-fir and the ponderosa pine-mixed conifer subregions of the Pacific Northwest. Timber inventory for the Mt. Hood National Forest was used as a proxy for the Douglas-fir subregion. Timber inventory for the Ochoco National Forest was used as a proxy for the ponderosa pine-mixed conifer subregion. Timber harvest estimates were generated by various computer scheduling models, including Timber RAM (Navon 1971).

Impacts were estimated by the panels of specialists. These estimates were based on the physical effects of timber harvest scheduling on the land as indicated by the acres harvested, types of silvicultural treatments applied, and the miles of road built for each of the eight timber harvest scheduling alternatives.

Panelists were told to assume that the present forest resource management policy would not change and that the *proportion* of the total resource management budget allocated to fish and wildlife resource management would not increase even if the rates of investment and funding were to increase. Panelists were asked to assume that expenditures to mitigate timber harvesting impacts would continue in *proportion* to increased timber management activities. Therefore, increased investment in timber management would not reflect increased emphasis on protection of nontimber resources.

A feature limiting the usefulness of our results was the lack of a direct link between timber stands scheduled for harvest in the computer programs and their location on the ground. This weakness made estimation of the impacts on fish and wildlife benefits more speculative than was desirable.

Results

Although our intent was to focus on our method of evaluating impacts, a brief summary of findings relating to our example of three fish and wildlife criteria will be useful.

Fish populations. Anadromous and resident cold water fish populations are directly related to fish habitat conditions which are affected by changes in water quality. Sediment, a common indicator of water quality, is directly related to the amount of soil disturbance associated with timber harvest and roadbuilding practices. Fish and watershed management specialists indicated that often an inadequate emphasis (staffing and funding) on road maintenance and on the enforcement of regulations governing logging practices is more responsible for deteriorating water quality than the logging practices themselves. They also indicated that any large-scale increase in timber harvesting or roadbuilding would result in major adverse impacts on fish habitats.

Deer and elk populations. Like most wildlife, deer and elk populations are directly related to the condition of their habitat. Adequate summer and winter range, with sufficient conifers to provide cover, are needed to maintain herd size. The ever-expanding road system, which accompanies most timber harvests, reduces cover and increases human access. The result is often increased harvest of antlered males and increased opportunities for harassment of animals during the rest of the year. Both factors can contribute to an immediate and long-term reduction in populations.

Wildlife populations for viewing. Management practices which are detrimental to certain species may be beneficial to others. We cannot generalize for all wildlife when we speak of specific forest management practices. To provide a wide range of species for viewing without closing options, we must preserve a wide range of habitat types and successional stages. This means that monoculture cannot become pervasive on all lands.

Summary

We have described a subjective method for evaluating potential impacts on nontimber forest resources, including fish and wildlife values. This approach uses the collective professional judgment of specialists together with a concept we call "threshold of concern." Panels of specialists selected criteria for identifying impacts in terms of social objectives, estimated the TOC for each criterion, estimated impacts from management activities and compared them with the TOC for each criterion, and classified impacts according to their magnitude and direction (i. e., adverse or beneficial).

We recognize that this approach is crude. We feel, however, that it can be helpful to forest managers due to the present state-of-the-art of evaluating impacts on nonmarketed benefits of forest resources. The approach provides forest managers with a procedure to evaluate potential impacts in terms of social objectives, and it relates the impact to a defined level of social concern, the TOC, within a social objective.

Decision makers are still faced with the problem of making trade-offs among social objectives. We suggest that, through the use of the TOC concept, they are better equipped to make decisions that affect the public welfare than they are if potential impacts are stated strictly in terms of physical quantities.

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Balancing Economic and Environmental Objectives

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National legislation such as the National Environmental Act (PL 91–190), executive decisions such as implementation of the *Principles and Standards for Planning Water and Related Land Resources* (WRC 36FR 24778) and judicial decisions such as that of the Eighth Circuit, U.S. District Court respecting the Cross Florida Barge Canal Project (*FDE* v. *Secretary of the Army,* January 31, 1974; Department of the Army 1975: 2) consistently direct that federal investments affecting the nation's natural resources must be subject to an evaluation of environmental and economic impacts on an equal basis. Since equality is difficult to define in the absence of a common measurement criterion, there has been very little progress in achieving the "so ordered" balanced impact evaluations. All of the legislative, executive and judicial powers of a great nation may hasten development of such technological systems as manned lunar exploration, nuclear energy generation and measurement of noncommensurate values, but the mere ordering of such feats does not assure either technical success, social acceptability or adoption. Our subject is that of defining, by description and demonstration, the current state of the art in reconciling some of the noncommensurable values necessary to consider environmental and economic impacts on an essentially equivalent, if not equal, basis.

Traditionally, we are faced with a simple, single-valued objective to accomplish. This single objective normally takes the form of maximizing some expected benefit from investment of available resources. Examples in economics include decisions to maximize profit from business, rate of return on investment, or gross sales in marketing. Such maximizing behavior can be found in other fields of endeavor, such as wildlife management which seeks to maximize game birds produced per acre, or recreation management which seeks to maximize the number of visitors to particular facilities. Such maximizing behavior represents a certain naiveté about the complexity of choices people face in making decisions about allocation of increasingly scarce natural resources. Such alleged maximizing behavior is a partial analysis from which we make normative judgments about correct choices and it does not lead to either good management decisions or good political decisions.

Management decisions are not based solely on a single-valued maximizing criterion. Each of us, as consumer or producer or public sector decision maker, must deal with conflict situations in which several objectives must be attained under given internal or external constraints. In the investment decision we are likely to accept some lower rate of return in exchange for reduced risk or liquidity. The essence of good management decisions rests in the manager's ability to identify, evaluate and execute a series of tradeoffs among competing goals—the sum of which provides a total level of satisfaction which, for most people, cannot be obtained from maximizing any single objective.

We are now enriching our decision making and performance evaluation models by adding multiple objective criteria from which we can develop "satisficing" behavior patterns. These models are maturing rapidly so that we can specify a separate objective function for each of several goals. The coefficients, or measurement criteria, need not necessarily be commensurate or even explicity converted to a common denominator. We need only to develop matrices of tradeoff functions and these may be stated in quite primitive barter terms. We need not fear the possible unhappy theoretical consequences of trading apples for oranges when we consider the possibility that our preferred position might be some combination of apples and oranges. In fact, the neoclassical theory of utility maximization embraced this concept of satisfaction through diversity which somehow became obscured in modern decision theory.

Economic-Environmental Balancing Models

The importance of multiple objective analyses may be glimpsed by observing the many variations of multiple objective programming models being developed or applied in such fields as engineering, finance, management, economics, water resources and public policy. Samples of these optimization models include the environmental evaluation system (EES) proposed for conducting environmental impact analyses (Dee et al. 1973); the iterative programming of a series of paired, sequential choices (Dyer 1972); the interactive, sequential exploration of solutions proposed in the STEM method (Benayoun et al. 1971); and a major contribution by Kornbluth (1974) which redefines traditional duality theory of vector maximization for multiple objectives.

The environmental evaluation system (EES) was a forced reaction to the National Environmental Policy Act of 1969. This legislation recognized the inherent public desire for a confrontation between economic and environmental evaluation systems. The environmental evaluation system sought to maintain the separate identity of environmental quality indicators in physical units. With this constraint the only optimization possibility was to transfer physical units into commensurate units called environmental impact units (EIU) on the basis of expected changes in environmental quality on a "with" versus "without" project basis. The difficulty with this approach is that the environmental impact units are not integrated with the economic units and thus there is no feel for a tradeoff function between economic and environmental values (Taylor, North, and Davis 1975).

A very significant application of vector maximization using duality theory to assess tradeoffs among goals has been made by Haimes and Hall (1974). This application has been applied largely to decision making for large water resources systems and is referred to as the surrogate worth tradeoff method (SWT). The surrogate worth tradeoff is used to estimate marginal preference of one objective over another. However, the method is cumbersome and complex since it requires the decision maker to transfer noncommensurable units into commensurable units on the basis of a series of indices from -10 to $+10$ with 0 indicating an even-valued tradeoff in which the subjective preference for objective $f_i\,(X)$ is just equal to the subjective preference for a marginal unit of objective $f_j\,(X)$.

An optimum solution in this model has significant theoretical support in economics since it would be equivalent to the condition of Pareto optimality in which no other feasible solution could improve the value of objective i without simultaneously degrading the value of objective j. The tradeoff function between Objectives i and j is given as:

$$T_{ij} = -\frac{\partial f_i\,(X)}{\partial f_j\,(X)}$$

The surrogate worth tradeoff method of multiple objective decision making requires the decision maker to interact with the model by assigning subjective values to tradeoff functions in terms of the index of surrogates. The determination of indexed surrogates for tradeoffs is most difficult to implement.

A method which may be more operational and yet retains the feature of integrating noncommensurable values is goal programming in which subjective decision making requires only the specification of a general policy level for an objective. By specifying the general policy level as an objective, we avoid specifying a personal preference or relative desirability of a series of objectives as required with the surrogate worth tradeoff method.

Goal programming (GP) requires establishment of desirable and attainable goal levels. These goals may be specified in terms of demand functions for various economic and/or environmental outputs or they may be generally conceived "policies" with respect to goal levels. In any case, the goal programming algorithm does not require that any or all of these goals be attained. The levels of attainment for any set or sets of goals will always be limited by the sum of the resources available. In a simple investment decision, resource limitations would be those of the investment budget. In a more complex situation available resources might be total land and associated natural resources parameters in some given zone such as a river basin or a political subdivision.

The significance of the goal programming technique as a decision making tool for multiple objective goals is given by the objective function, *viz:*

$$\text{minimize} \quad Z = \sum_{i=1}^{n} (W_i^+ Y_i^+ = W_i^- Y_i^-)$$

$$\text{subject to:} \quad \sum_{i=1}^{n} \sum_{j=1}^{m} GC_{ij} X_j - W_i^+ {}_i^+ + W_i^- Y_i^- \leqslant GL_i$$

$$\text{when} \quad 0 \leqslant X_j \leqslant 1$$

where:
- GC_{ij} = the amount of any goal i contributed by any alternative j,
- X_j = a decision variable corresponding to any alternative j,
- W_i^+ = penalty weight for over attainment of GL_i,
- W_i^- = penalty weight for under attainment of GL_i,
- Y_i^+ = positive deviation from a goal, GL_i,
- Y_i^- = negative deviation from a goal, GL_i,
- GL_i = a goal level specified which may be under-achieved, over-achieved or exactly achieved.

The goal programming objective function is minimization of weighted deviations from specified goal levels. The resulting solutions can be obtained through a conventional simplex LP algorithm or the X_j may be constrained by an integer programming (IP) variant to eliminate acceptance of partial alternatives (A_i) which might occur under certain LP formulations.

The contribution of goal programming to decision making is in the presentation of the tradeoff matrix. Goal programming requires only an effort to attain a specified goal. The resulting solutions are "satisficing" and generally do not constrain the solution to exact achievement of specified goals. Thus the goal programming algorithm is an optimizing system which accommodates a complex range of decision variables, i.e., a matrix of competing and complementary goals to be sought with limited resources.

The use of goal programming does not absolve the decision maker of identifying and quantifying environmental parameters. The most difficult problems in structuring a goal programming system to deal with multiple objectives are selection and quantification of reliable data which are relevant to the goal objectives or the resource limitations. However, any comprehensive operational decision making matrix must include careful and reasonably accurate organization of data.

Critics of early goal programming models were particularly harsh respecting the need to establish a series of goal weights and a range of goal deviations in order to establish priorities for the various goals specified. Recently developed systems of goal programming tend to use weight adjustors to achieve equivalency among noncommensurable units of measure rather than to assign priorities. The use of weights to assign relative priorities to goals have been illustrated by Neely, North, and Fortson (1976a, 1976b) and Neely (1977). An example of the use of weight adjustors to achieve equivalency among noncommensurate parameters has been demonstrated by North, Neely, and Carlton (1976).

Goal Programming for Alternatives

Recent applications of goal programming have tended to recognize the potential of the system by focusing on the true objective function of the goal programming formulation, viz., minimization of the sum of the weighted deviations for all goals in a specified matrix without giving implicit priority to a component objective such as net present value. In these formulations goal weights are used to achieve equivalency in the *numeri* while goal deviations (under-achievement or over-achievement) are penalized in a rational direction to minimize adverse factors such as cost or quality degradation or to maximize an expectation such as user days or rare species habitat. The critical factor in arriving at this formulation of the goal programming model to "satisfice" a set of multiple goals was the discovery of the possibility of mating the economic concept of "highest and best use" with the multiple objective capabilities of the goal programming model (North, Neely, and Carlton 1976).

This application of the goal programming model requires an additional activity not usually included in the more familiar investment versions. The concept of highest and best use infers a continuum of alternative uses such that the value of marginal product from each divisable unit for each alternative use is equal, i.e., there is a potential equilibrium position in which the sum of the values in the alternative uses for any given demand are equal (Figure 1).

In this formulation it is necessary to develop all feasible alternatives for the land resource composite. This discovery of alternatives is largely an art and requires

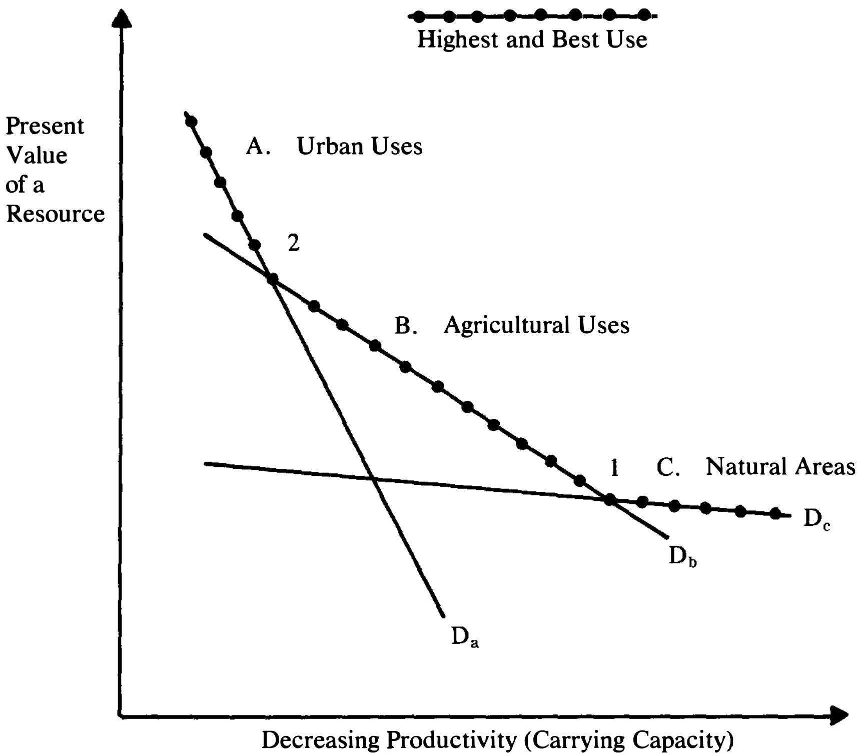

Figure 1. A generalized illustration of the concept of highest and best use, indicating the points of transfer (1,2) from a lower to a higher valued use.

substantial public input from those affected by resource development decisions. The first cut at defining alternatives is to define certain basic activities such as agriculture, wildlife, forestry, tourism, business, navigation and recreation. These general alternatives can be specifically defined in precise activities such as a wild and scenic river or a national forest or a theme park. Such specific uses are described as "operational alternatives."

Operational Alternatives for the Cross Florida Barge Canal

This application of goal programming was made in response to a restudy of the cross Florida Barge Canal by the Corps of Engineers. The plan of study called for a "highest and best use study" of the Oklawaha River Valley to include the discovery and description of all feasible alternatives.

These operational alternatives included a given set of six Corps of Engineers' scenarios which served as a framework for the Cross Florida Barge Canal (CFBC) restudy. An additional set of seven alternatives were developed for the goal programming model. These seven additional alternatives were congruent with two of the Corps of Engineers' scenarios and provided a set of positive futures for the Oklawaha River Valley other than those which would be provided in the construct or abandon scenarios. The set of operational alternatives with the applicable reaches were defined as follows:

1.	Authorized project (CFBC)	All reaches
2.	Eureka upland R20 alignment	All reaches
3.	Eureka upland R18 alignment	All reaches
4.	Abandon without development	All reaches
5.	Restore to original condition	All reaches
6.	Restore to original conditions with:	
	a. Wild and scenic river	Each reach
	b. National forest	Each reach
	c. National recreation area	Each reach
	d. Wildlife area	Each reach
	e. Scenic river park	Each reach
	f. Tourist development	Each reach
	g. Agriculture and forestry	Each reach
7.	Preserve and maintain	All reaches
8.	Preserve and maintain with:	
	a. National recreation area	Each reach

These operational alternatives define a set of "highest and best uses," some of which are mutually exclusive and some of which are complementary. Each alternative will produce some mix of economic and environmental outputs (goal achievements). The preferred solution can now be described in terms of the highest and best use alternatives for a set of goal levels rather than on the basis of using a set of weights to establish priorities. In this formulation the weights were established on the basis of technical parameters rather than on the basis of judgments respecting possible priorities. The decision maker is given the opportunity to consider the resource allocation problem in terms of technically defined alternatives. In this process each successive alternative would be less efficient in meeting the specified goal levels with the available resources.

The prime solution, i.e., the combination of alternatives which minimize the sum of the weighted deviations, would be the dotted line *a, b, c,* in Figure 1. The goal programming algorithm based on these sets of operational alternatives can be modified to delete the "highest and best use solution" and produce a "second best" solution which optimizes the specified goals "ex" the highest and best use solution. This means there would be a series of vectors for the second best solution at some level lower than the line *a, b, c* in Figure 1. For the goal levels specified in the Cross Florida Barge Canal Restudy, the successively less desirable alternatives are outlined with a general indication of the sensitivity of various goal levels (Figure 2). Eight additional alternatives of successively lower efficiencies were not produced although the program could be replicated to display the full matrix of alternative solutions.

In earlier goal programming formulations the "second best" solutions would have been obtained by varying either goal levels or goal weights to indicate the consequences of different sets of priorities. However, the set of goal weights (Table 1) are developed in this formulation to achieve a given level of equivalency among noncommensurable measurement units specified in the 12 economic and 11 environmental goals. The division between economic and environmental goals has no significance other than to illustrate the conventional confrontation between these sets of objectives as specified in NEPA and in the "Principles and Standards" and as adopted by various interests. However, specification into categories

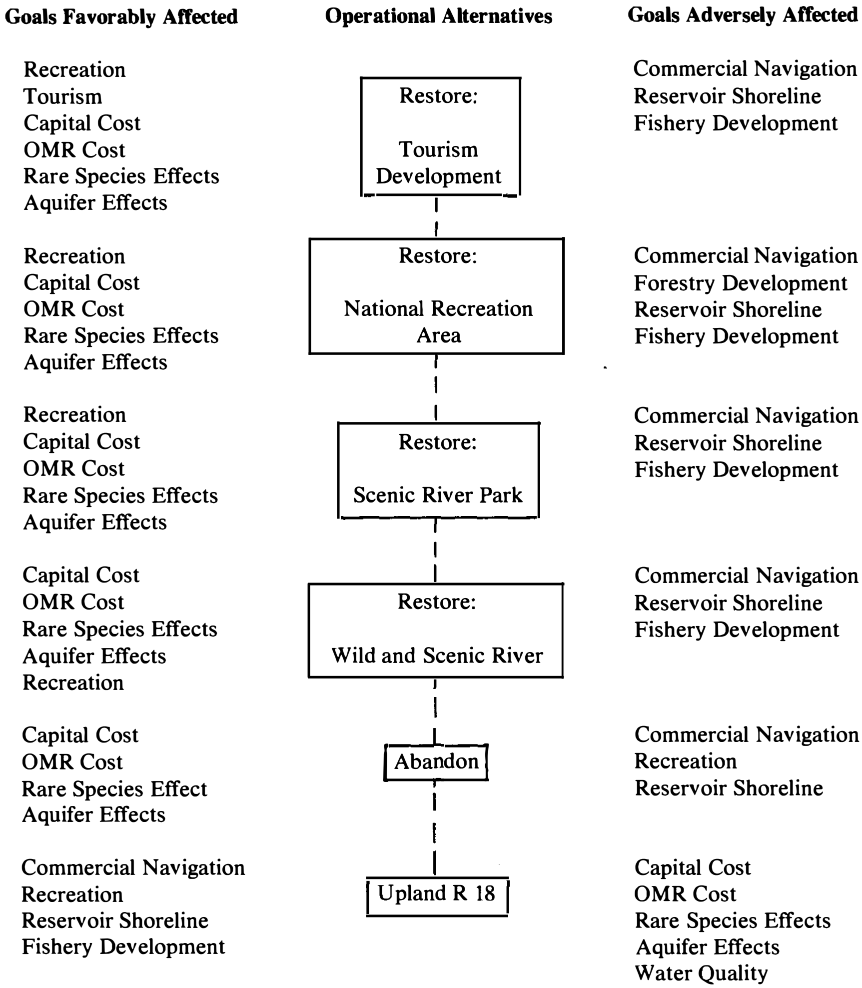

Figure 2. The "highest and best" operational alternatives for the Oklawaha River Valley and Lake Rousseau. Note: Goals are listed as favorably or adversely affected as determined by the goal programming model using sequential deletion of the previous best solution. Alternatives for specific reaches may vary from the dominant alternative (Table 2).

provides a system of organization with respect to particular economic or environmental parameters which may be identified for any given problem or study area.

The discovery and definition of alternatives have been described earlier as an art with respect to a given decision-making problem. Subsequent to development of alternatives one must also develop a set of specific goals to be achieved for each set of alternatives. In the Cross Florida Barge Canal Restudy the list of 23 economic and environmental goals were not necessarily exclusive of all possible goals. However, these goals should represent a reasonable mixture of desirable private and public outputs needed or desired from the resources available in the Oklawaha River Valley (Table 1). The classification of the resources available and

Table 1. Summary of economic and environmental goals with approximate dollar equivalents for each goal weight for the cross Florida Barge Canal Study Area.

Objective/goal	Weights	Equivalents	
		Units	Dollars
Economic			
Commercial navigation (million $, PV)	1.0	$1	$1
General recreation (million days, AA)	47.43[a]	1 day	$1.80
Flood control (million $, AA)	26.35[a]	$1	$1
Developed land (000 ac.)	6.0	1 acre	$6,000
Agricultural development (million $, PV)	1.0	$1	$1
Wildlife development (000 days)	0.126[a]	1 day	$3
Forestry development (million $, PV)	1.610[a]	$1	$1
Fishery development (000 days)	0.076[a]	1 day	$1.80
Tourist development (million days, AA)	79.0	1 day	$3
Facilities area (000 ac.)	3.0	1 acre	$3,000
Capital cost (million $, PV)	1.0	$1	$1
OMR cost (million $, AA)	26.35[a]	$1	$1
Environmental			
Reservoir area (000 ac.)	0.460	1 acre	$460
River miles (miles)	0.020	1 mile	$20,000
Wetlands area (000 ac.)	0.460	1 acre	$460
Reservoir shoreline (miles)	0.010	1 mile	$10,000
Aquatic habitat, others (000 ac.)	0.460	1 acre	$460
Water quality (yes/no)	10.0	1 reach	$10 million
Game habitat (000 ac.)	0.70	1 acre	$700
Rare species habitat (no. species)	5.0	1 species	$5 million
Cultural features (no. sites)	5.0	1 site	$5 million
Natural features (no sites)	5.0	1 site	$5 million
Aquifer effects (yes/no)	120.0	if affected	$120 million

[a]Includes capitalization of average annual values at 2⅞ percent.

the enumeration of various demands for both economic and environmental outputs is critical in formulating an operational goal programming system.

The initial quantification of desired goal levels for each objective may be made in a laboratory setting by formulators of the model or they may be gained from empirical evidence through interviews or various group decision-making systems such as the popular "Delphi Technique." Once goal levels are established, the model can then be used for manipulation to determine the extent of achievement (over, under, exact) for each of the goals specified.

When a goal level is set by the weight adjustors to be achieved exactly, a policy position has been established respecting a particular objective as a highly valued one such as creating high employment or perhaps a very costly mistake such as destruction of a rare species habitat. Generally, weight adjustors would be used to penalize under-achievement of desirable goals such as production or output in excess of certain well defined needs. Also, over-achievement of goals for which lower values are preferrable would be penalized. For example, under-achievement of cost is preferred to over-achievement.

Once initial conditions have been satisfied and initial feasible solutions are obtained which minimize the sum of the weighted deviations from the specified goals (Table 2, column 1 - "Goal levels"), some satisfacory result has been

Table 2. Summary of the goal achievements for the preferred and selected alternative solutions, Cross Florida Barge Canal study area: A = Restore: tourism in Rodman, Eureka, West End; scenic river park in Upper River[a]; B = Restore: national recreation area in Rodman, Eureka, Upper River; wild and scenic river in West End[b]; C = Restore: scenic river park in Rodman, Eureka, Upper River; wild and scenic river in West End[c]; and D = Restore: wild and scenic river in Eureka, Upper River, West End; national forest in Rodman[d].

Objectives/goals (units)	Goal levels	A	B	C	D	Abandon[e]	Upland R18[f]
Economic							
Commercial navigation (million $, PV)*	390.537	0.000	0.000	0.000	0.000	0.000	390.537
General recreation (million days, AA)*	6.800	6.765	4.637	2.900	1.440	0.332	2.112
Flood damage reduction (million $, AA)*	0.002	0.000	0.000	0.000	0.000	0.000	0.002
Developed land (000 acres)	15.710	13.191	13.125	13.062	13.028	12.146	12.143
Agricultural development (million $, PV)	6.873	6.873	6.110	6.110	6.110	6.873	6.417
Wildlife development (000 days)*	254.091	249.370	252.715	253.297	251.402	249.623	210.128
Forestry development (million $, PV)	75.344	57.285	4.942	56.494	55.773	56.225	50.883
Fishery development (000 days)*	424.172	98.393	98.393	98.393	98.384	115.772	211.927
Tourism development (million Days, AA)	7.340	7.340	0.480	0.300	0.100	0.000	0.050
Facilities area (000 acres)	1.290	0.614	0.548	0.505	0.451	0.000	1.290
Capital cost (million $, PV)#	16.700	61.811	60.567	58.777	57.777	16.700	306.133
OMR cost (million $, AA)#	0.140	1.191	0.758	0.554	0.439	0.273	3.062
Environmental							
Reservoir area (000 acres)	3.501	3.501	3.501	3.501	3.501	4.392	14.366
River length (miles)	78.000	78.000	78.000	78.000	78.000	78.000	55.400
Wetlands area (000 acres)	3.254	3.254	3.254	3.254	3.254	3.200	2.812
Reservoir shoreline (miles)	213.800	26.300	26.300	26.300	26.300	31.300	118.300
Aquatic habitat, Others (000 acres)	4.068	4.068	4.068	4.068	4.068	4.163	3.209
Water quality (yes/no)	4.000	4.000	4.000	4.000	4.000	4.000	2.000
Game habitat (000 acres)	110.414	109.800	109.868	109.911	109.965	108.807	94.624
Rare species effects (no. species)	+7.000	+7.000	+7.000	+7.000	+7.000	+4.000	−24.000
Cultural features (no. sites)	5.000	5.000	5.000	5.000	5.000	5.000	5.000
Natural features (no. sites)	13.000	13.000	13.000	13.000	13.000	13.000	10.000
Aquifer effects (yes/no)	4.000	4.000	4.000	4.000	4.000	4.000	3.000
Benefit-cost ratio $(\frac{*}{\#})$[g]	--	3.860	3.218	2.410	1.550	2.344	1.380

[a]This alternative is the preferred solution.
[b]The tourism development and scenic river park operational alternatives were deleted from consideration.
[c]The tourism development and national recreation area (restore and preserve) operational alternatives were deleted from consideration.
[d]The tourism development, national recreation area (restore and preserve), and scenic river park operational alternatives were deleted from consideration.
[e]The tourism development operational alternative was deleted from consideration.
[f]The tourism development, national recreation area (restore and preserve), scenic river park, wild and scenic river, abandon and preserve and maintain operational alternatives were deleted from consideration.
[g]The benefit cost ratio can be obtained by converting the solutions for each goal (each row) into dollar equivalents shown as weights in Table 1. For example, in order to convert general recreation average annual (AA) user days into millions of dollars in present value (PV) terms, the weight shown in the first column of Table 1 (47.43) must be multiplied by the goal achieved (6.765 million) to obtain the dollar value of $320.864 million.

achieved. This mixture of both economic and environmental outputs is a real solution in the sense that investment and economic decisions are rarely ever maximized when considered in the context of complex multiple objective situations.

The Goal Programming Solutions

The preferred solution for the goal levels and weights (Table 1) established by the study team is the "restore to original condition with tourism development alternative" for the Rodman, Eureka and West End reaches with a scenic river park alternative in the Upper River reach (Table 2). For this tourism development solution there are no navigation benefits. There are an estimated 6.765 million visitor days of general recreation benefits and 7.34 million visitor days of tourist activities. Goal levels set for general recreation and tourism werc exactly achieved. However, one should note the under- and over-achievement for other goal levels.

Although the main purpose in using goal programming is to avoid the inadequacies and criticisms of the benefit-cost ratio as a decision-making tool, many responses to the preliminary results of this study indicated a desire to know the resulting benefit-cost ratio. Since people are accustomed to the benefit-cost ratio, it is shown as it might be calculated and presented by the Corps of Engineers in a traditional benefit cost and analysis. For the tourism development alternative the ratio is 3.86 (Table 2).

The goal programming technique of selecting project alternatives allows one to look at the "next best" solutions or to "force" a particular solution in order to observe the goal levels achieved. Because the tourism development alternative tends to dominate alternatives in the Cross Florida Barge Canal area, a second best solution was obtained by deleting tourism development from consideration. The next best solution was "restore to original conditions and develop a national recreation area" in Rodman, Eureka and Upper River reaches with a "wild and scenic river alternative" in the West End reach.

The results of the "second best solution" can be compared directly with the preferred solution by the different goal levels achieved (Table 2). For example, in this solution general recreation benefits are under-achieved at $4.637 million. Wildlife development benefits are larger than for the tourism development alternative but still under-achieved relative to the specified goal. Forestry development benefits are only a fraction of the goal level possibility and considerably less than in the preferred solution because of constraints on timber harvest in a national recreation area and in a wild and scenic river. Tourism development benefits were minimal at only 480,000 tourist days compared with the achieved goal of 7.34 million tourist days in the preferred solution. Environmental goals achieved are not significantly different in the national recreation area from the preferred tourism development solution. The reader can study the tradeoffs for the successively less desirable alternatives (Table 2).

Interpretation and Applications

The decision maker should study carefully the results of the preferred solution, and each alternative solution, to understand the goal achievements possible with each alternative. The outputs achieved, using the goal programming technique, are determined by the operation alternatives described in the text and documented by data (North et al. 1976). If the results are not satisfactory in terms of alternative priorities which may be established by local or state interest, by national interest or by arbitration to develop an acceptable consensus on appropriate priorities, then adjustments in the priorities (changes in goals, goal levels or weights) or in the specification of alternatives can be made to observe the achievable benefits or conditions and costs of doing so in terms of each economic or environmental parameter.

Even though the scientific and lay interests in conservation of natural resources have a longstanding historical record, the concepts of environmental preservation, i.e., the reservation of natural habitats and related ecosystems from disturbance, are quite recent. This expanding concept of a broad "public trust" for natural and environmental resources, whether privately or publicly held, became politically viable in the late 1960s as a national objective. Environmental quality is now recognized in national water resources planning as an objective at least equal to the accepted national objective of economic development (U.S. Water Resources Council 1973).

If one seeks to find a source of the changing attitudes toward the environment and natural resources, it can be found in both metaphysical and economic concepts of values. In the metaphysical concept of value there is an intuitive recognition that certain natural states of being are valuable merely for their existence, i.e., without any direct economic justification. In the traditional economic concept of value there exists a cause, that is, increasing demands and/or decreasing supplies of the resources. It is usually difficult to deal with these concepts of value without engaging in circular reasoning because the ultimate goal or the objective cannot be clearly specified with respect to the use of resources.

The Oklawaha River Valley is an excellent case to demonstrate the process of decision making for multiple objectives with respect to the competing uses of natural resources wherein one must specify certain expectations or goals in both physical and monetary terms. The Oklawaha River Valley has all of the attributes and characteristics necessary to be included in a specialized public use reservation such as a wild river, scenic river or a national recreation area or to be dedicated to the national transportation system or left to the private sector. Any of these possibilities could be developed for the Oklawaha River Valley with sufficient local and national interest in a particular future.

The highest and best use of the Oklawaha River Valley would be that combination of uses which will provide for this area of Florida an optimum mix of economic and environmental values. These values have been described in dollar and physical terms so that the cost of each alternative can be reckoned in terms of miles of scenic river lost or, conversely, miles of scenic river gained can be reckoned in terms of dollars of reservoir fishing benefits foregone. Multiple objective analyses do not provide answers but decision makers are provided with organized, relevant data (possible solutions) from which both expected outcomes and expected costs of alternatives foregone can be fully considered in terms of balancing economic and environmental values.

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State Comprehensive Outdoor Recreation Plans as a Vehicle for Fish and Wildlife Planning

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One of the most popular and far-reaching programs in the fields of conservation and outdoor recreation has resulted from the Land and Water Conservation Fund Act of 1965, as amended. Since its passage, $961 million have been used for the acquisition of 1.7 million acres as additions to national parks, national forests, fish and wildlife areas and other federal recreation lands. During the same period, over $1.3 billion has been appropriated and apportioned for matching grants to states and local governments. This has resulted in 5881 projects to acquire 1,563,428 acres (625,371 ha) and 11,102 projects committing $775,865,135 for outdoor recreation facilities. This is the federal share which is matched by state or local funds. Recent legislation doubled the Fund to $600 million in fiscal year (FY) 1978, $750 million in FY 1979, and $900 million each year thereafter through 1989.

Of special concern to us today is the requirement in the Land and Water Conservation Fund Act (LWCF) that each state must prepare a statewide, comprehensive outdoor recreation plan (SCORP) that is acceptable to the secretary of interior before that state can receive acquisition and development grants. These should meet priority outdoor recreation needs identified in the plan. I will not dwell on the evolution of state planning. Suffice it to say it is still evolving. Today, all states have been through several generations of SCORPs, and the present versions are considered improvements over earlier efforts.

I am sure that no one at this conference would question the assertion that fish and wildlife are important recreation resources. The user survey that the Bureau of Outdoor Recreation will be conducting this year lists 28 outdoor recreation activities—some as specific as "snowmobiling," some as general as "visiting zoos, outdoor aquariums, fairs, carnivals, and amusement parks." Of the 28, ten are directly or indirectly concerned with fish and wildlife. There can be little doubt that people are interested in and concerned with fish and wildlife. Man's impact upon fish, wildlife and the habitats that support them is equally well accepted. However, it appears that many whose responsibility it is to manage, perpetuate, and/or protect fish and wildlife think largely of that impact and very little of the fact that people are the reason wildlife and fish are important. One way to tie the biological or ecological management of these resources to the needs of people who use them is through the statewide comprehensive outdoor recreation plans.

Through cooperative agreements between the Bureau of Outdoor Recreation and the Fish and Wildlife Service, both agencies have attempted to see that SCORPs and fish and wildlife management plans are coordinated and integrated. Essentially, these agreements encourage the state outdoor recreation and fish and wildlife planners to develop overall assessments of hunting and fishing as an integral part of the SCORP; to effect close planning coordination, thus avoiding duplication in collection of data; to use like methodologies for inventorying recreation resources; and to use the same basic estimates and projections of population and other supply and demand variables in their state planning efforts. The agreement calls for review by both agencies of the SCORPs and the fish and wildlife plans. This is being done.

The Bureau of Outdoor Recreation offers a state two planning options in the development of its SCORP. Option I, the original planning program, allows a state to develop its SCORP and submit it for a fixed period eligibility. The quality and comprehensiveness of the SCORP determines the length of eligibility, but not more than 5 years.

Option II is a continuing planning program. The state must submit a plan that can guide its acquisition and development program, but its eligibility continues as long as it has an adequate planning staff, a planning budget and continually supplements and updates the basic plan. Again, at 5-year intervals, a completely updated planning document is required.

At the present time, 24 states are on Option I and 31 states are on Option II. Thirteen Option I states and 23 Option II states currently have planning projects through the Land and Water Conservation Fund program. One Option II state uses the Department of Housing and Urban Development 701 Program and 18 states support their own outdoor recreation planning programs without Federal financial assistance.

It is important to recognize that in many states the SCORP is the only document concerned with land and water use planning. Coordination and interaction by the various levels of government and the private sector is vitally important for determining the future of land use planning within a state. At present all states are receiving 701 Planning Grants from the Department of Housing and Urban Development. The Housing Act of 1954, as amended by the Housing and Community Development Act of 1974, requires each state to have a land use element in their overall state plan by August 1977 if they are to continue to receive 701 money. The Bureau of Outdoor Recreation also has an interagency agreement with HUD to see that SCORPs and 701 Plans are integrated so the coordination of SCORPs, fish and wildlife plans and 701 Plans becomes increasingly important.

At the present time, only two states—Montana and Pennsylvania—have completely integrated their fish and wildlife and SCORP planning. Montana is one of 13 states currently developing a fish and wildlife management plan but the only one of the thirteen is using Land and Water Conservation Fund planning money. Montana's plan encompasses an inventory of fish and wildlife resource areas, a fishing pressure survey and a survey of hunting and fishing licenses. Pennsylvania is not one of the 13 states developing a fish and wildlife management plan with federal aid. However, both the Pennsylvania Game Commission and the Pennsylvania Fish Commission are conducting surveys, with Land and Water Conservation Fund SCORP grants. The game commission is measuring nonconsumptive use of several state game lands. The fish commission has carried out fish population studies that have resulted in greater stocking effort in waters near urban populations. This has increased the catch per unit effort and has provided more fish for the fishermen.

A telephone survey to the Bureau of Outdoor Recreation regional offices responsible for working with the states on SCORP development indicated that at least 23 state fish and wildlife agencies were interacting and coordinating with the state outdoor recreation planning agencies. This is certainly a step in the right direction. Unfortunately, in the other states coordination is pretty fragmentary and improvement in interaction could be of great benefit to the fish and wildlife programs of those states.

Interaction and coordination efforts vary among the states. In Maine, for example, the Departments of Inland Fish and Game and Sea and Shore Fisheries began developing a long-range plan in 1968. The goals of this effort are: (1) to insure that all species of wildlife and aquatic resources are perpetuated for use and enjoyment by the people of Maine, and (2) to see that all species are maintained for their intrinsic and ecological values as well as their diverse benefits to man. Because of the development of this plan, the Maine State Park and Recreation Department is not studying needs in detail for hunting and fishing in their SCORP. Nevertheless, coordination and interaction takes place between these agencies to insure that the interests of each party are considered in comprehensive outdoor recreation planning.

In North Dakota, a major effort is underway to coordinate the planning of the state's Park Service, Forest Service, Historical Society, Game and Fish Department, Water Commission, and State Land Department. They are working together to update each agency's long-range plans and to combine them into a consolidated, coordinated plan for the future. North Dakota recognizes a critical need for more public lands for outdoor recreation. This proposed study will be coordinated by the state outdoor recreation agency. The important factor to all of us here is that, in this case, the Game and Fish Department recognizes their dire need for additional lands for hunting and fishing, and realizes that in order to accomplish their goal, a combined effort with their sister agencies can be most effective.

A review of all current SCORPs shows that 16, or about 30 percent, include excellent discussions of the fish and wildlife resources of the state and indicate that fish and wildlife planning is an important part of the state recreation program. Our review further indicates that almost all states considered hunting and fishing needs and resources, including some kind of an estimate of future needs. Most SCORPs describe the function and role of the fish and wildlife agency, but stop short of any discussion of specific agency plans or what actions should be taken to increase hunting, fishing, or other wildlife use activities.

There is another result of fish and wildlife planning within the framework of the SCORP that can have a positive effect on administration and management of a state's programs. For example, Montana and Pennsylvania, the two states where planning within the SCORP is taking place, were recipients of $3.1 and $3.2 million in Land and Water Conservation Fund projects. Montana has had 44 of its 343 projects sponsored by fish and wildlife. Pennsylvania has had 34 of its 432 projects fish and wildlife-sponsored. Three other states were recipients of even more Land and Water Conservation Fund grant money for fish and wildlife-sponsored projects: California, $6.9 million; South Carolina, $3.7 million; and Washington, $3.5 million. In each of these cases, hunting and fishing needs were incorporated into the SCORPs although overall planning was not as well integrated as in the case of Montana and Pennsylvania. Of a total of 17,226 projects funded through December 1976, 459 were sponsored by state fish and wildlife agencies.

Thirteen states to date have not had funding for fish and wildlife-sponsored projects. But, let us hasten to point out that there may well be reasons for this other than lack of plan coordination. It should be recognized that many projects sponsored by other agencies have hunting, fishing or wildlife enjoyment as one of the project purposes. Of the 17,226 projects, 1699 list fish or wildlife use as a purpose. Leaders in this respect are California with $21.9 million; Illinois with $16.3 million; New York with $13.9 million; Pennsylvania with $13.7 million; and Maryland with $11.1 million in projects where hunting and fishing are listed as project purposes. A number of the 13 states that did not sponsor fish and wildlife projects or that had only limited funding in this category did receive substantial amounts of money through projects that listed hunting and fishing as the project purposes. We cannot help but feel, however, that most fish and game agencies could use 50 percent matching money to augment current spending—especially for such things as stream access, hunting lands, or access to land-locked public lands.

Frankly, when we started research for this paper, we expected to find much less recognition of fish and wildlife as recreation resources in SCORPs. In the early days of the Land and Water Conservation Fund, that was the case. It is gratifying to find that both those who develop state outdoor recreation plans and state fish and game administrators have broadened their outlooks. There is still considerable room for improvement, however. While fish and wildlife are mentioned in most plans, less than half of the fish and wildlife managing agencies participate in SCORP development and less than a third of the SCORPs have adequate coverage of fish and wildlife as recreation resources. With the tremendously expanded Land and Water Conservation Fund as a result of the passage of P.L. 94-422, we have an opportunity not only to increase the availability of fish and wildlife as recreation resources, but also to improve our management of those resources so that they take on greater meaning for all Americans.

Characteristics of Individuals Involved in Different Types of Hunting

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Introduction

"When males hunt and females gather, the results are shared and given to the young, and the habitual sharing between a male, a female, and their offspring becomes the basis for the human family," according to Washburn and Lancaster (1968). Although hunting for food and survival may have been a necessity at one time, it no longer is the primary motivation for today's American hunter. Individual hunters seem to have their own special reasons for hunting. Yet research has shown some general trends in hunting participation (see Schole 1973 for a review). In general, most hunters are initiated to the sport at an early age by close relatives. Successful hunting experiences, love of the outdoors, and interest in guns seem to promote continued interest and participation.

Fewer studies have dealt with reasons that hunters specialize in certain species or discontinue hunting entirely (Klessig 1970). The characteristics of different types of hunters have not been compared in detail, to our knowledge. Some preliminary findings in these areas will be discussed in this paper.

Methods

Two surveys were conducted during the summer of 1976. One was a survey of a random sample of the adult population of Iowa for answers to questions about hunting, trapping, land use, gun control, conservation agency practices, and other issues (see Dahlgren et al. in this volume). In the other survey, approximately 1,225 responses were obtained from 1,500 active hunters with a mailed questionnaire and a single follow-up. The sample was based upon replies to the 1975 Iowa Conservation Commission's small game survey conducted in January and February 1976. The first survey will be referred to as the "general survey," and the latter as the "hunter survey."

Information collected from the hunter survey was linked to responses obtained from the small game survey, thereby yielding information about individuals' hunting activities, values associated with hunting, and beliefs about abilities as a hunter. Responses to harvest questions on the small game survey questionnaire were the basis for placing hunters in one of six categories:

1. *Quail hunter (Q)* were hunters who reported bagging 8 or more quail and did not qualify as an avid generalist ($n = 12$).

2. *Rabbit-squirrel hunters (RS)* were hunters who reported bagging 6 or more squirrels and (or) 8 or more rabbits, but did not qualify as an avid generalist ($n = 93$).
3. *Waterfowl hunters (W)* were hunters who reported bagging 6 or more ducks and (or) 5 or more geese, but did not qualify as an avid generalist ($n = 36$).
4. *Furbearer hunters (F)* were hunters who reported bagging 3 fox, and (or) 3 coyote, and (or) 5 raccoon, but did not qualify as an avid general hunter ($n = 43$).

   The first four groups will sometimes be referred to collectively as Specialist Hunters.
5. *Avid generalist hunters (A)* were hunters who qualified for more than one of the above first four categories or who hunted 12 or more times, but did not qualify on the basis of their bag limits ($n = 451$).
6. *Casual generalist hunters (G)* were hunters who did not qualify for any of the first five categories, but who bagged at least one animal ($n = 576$).

Results

Before examining the relationships among hunter types and their motivations for hunting, some consideration should be given to background data associated with these groupings. A composite picture of the type of individual who hunts particular species is a valuable asset in determining an individual's social environment. Differences in social environments influence values, priorities, activities, and many other aspects of life experiences. Therefore, a synthesis of the sociodemographic characteristics of hunters within each group is valuable.

Quail Hunter

Most quail hunters tended to be married males between 25 and 65 years old who were reared in small towns or rural areas. They are more likely than other hunters to have completed at least 2 years of college (45 percent), and more than half currently have family incomes of more than $15,000 per year. They are more likely to be employed in a professional or managerial capacity than most other hunters, although almost half make their living in blue-collar occupations (27 percent) or as farmers (18 percent). More than half either own or are tenants on agricultural land. Most quail hunters have lived in the same community for more than 10 years and have hunted more than 15 years.

They hunted small mammals and upland game birds before they were 16 years old, and most still hunt pheasants and rabbits in addition to quail. They were less likely to hunt squirrels than were other hunters. Over 75 percent of the quail hunters hunted waterfowl at some time, but only 33 percent currently hunt ducks. Many also hunted deer and expressed an interest in hunting turkeys and grouse in the future. More than 90 percent of the quail hunters hunted with a dog and considered that aspect an important part of the hunt. They tended to rate themselves high on shooting ability, but mediocre at "reading sign."

Waterfowl Hunters

Most waterfowl hunters were married males between 25 and 65, although more than 10 percent were over 65 years old, and about 20 percent were under 25 years old. More than half were reared in rural areas, and most of the rest in small towns with populations of less than 5,000. Less than 20 percent were farmers. The remaining waterfowl hunters were evenly divided among blue-collar, white-collar, professional, and managerial occupations. Less than 30 percent completed 2 years of college. Over three-fourths lived in the same community for more than 10 years, and two-thirds had hunted more than 15 years.

Most waterfowl hunters hunted small mammals (77 percent) and upland game birds (69 percent) when they were less than 16 years old, and over half (54 percent) had hunted waterfowl before age 16. Over time, they tended toward bird hunting and away from rabbit and squirrel hunting. Almost 20 percent quit hunting quail, and 25 and 33 percent, respectively, quit hunting rabbits and squirrels. About 40 percent currently hunt quail, deer, and squirrels, 55 percent hunt rabbits, and 50 percent want to hunt turkeys someday. Waterfowl hunters tended to rate themselves relatively high on both shooting ability and "reading sign."

Rabbit-Squirrel Hunters

This group spans all ages and, in particular, includes many younger and unmarried hunters. More than 30 percent were reared in towns having more than 5,000 people. About 10 percent were farmers. Almost half were employed in blue-collar occupations. Only 25 percent completed 2 years of college, and 20 percent had a family income of more than $15,000 per year. Most (77 percent) lived in the same community for more than 10 years, but less than 60 percent had hunted for more than 15 years. Twenty-eight percent had hunted less than 10 years.

In the rabbit-squirrel group, few members (about 20 percent) hunt only one of the two species. The remaining 80 percent overlap in that they hunt both rabbits and squirrels, and this overlap is far greater than for any other hunter group. Rabbit-squirrel hunters were less likely to have hunted rabbits and squirrels before they were 16 years old than several other groups of hunters, as well as less likely to have hunted other species before the age of 16 than the rest of the avid hunters. They were less likely to have quit hunting other species and more likely than waterfowl and furbearer hunters to have hunted upland game birds. Rabbit-squirrel hunters were not as likely to have hunted waterfowl or deer, but more likely to have hunted raccoon, fox, and coyote than were quail or waterfowl hunters. Most tended to rate themselves as mediocre at shotgun shooting and "reading sign." In general, this group was more difficult to typify than any other hunter group.

Furbearer Hunters

Furbearer hunters were most easily characterized. Many were farmers (48 percent) between 25 and 65 years old (64 percent) who were reared on a farm (81 percent). Two-thirds either owned or leased farmland in Iowa. Less than 10 percent had 2 years of college, and more than 70 percent had a family income less than $15,000 per year. Almost 90 percent had lived in the same community more than 10 years, and over 70 percent had hunted more than 15 years. The high price of long-haired furs in recent years probably caused many hunters to specialize in this group.

Furbearer hunters were less likely than any other group of hunters to have hunted upland game birds (57 percent), small mammals (66 percent), or waterfowl

(30 percent) before they were 16 years old. Almost half, however, had hunted furbearers before they were 16 years old. A small proportion of furbearer hunters also hunted pheasant, quail, and rabbits. The proportions that hunted squirrels and waterfowl were close to the overall average. Sixty-six percent of all furbearer hunters hunted raccoon, 54 percent hunted fox, and 46 percent hunted coyote. Furbearer hunters rated themselves high at "reading sign."

Avid General Hunter

The avid generalist is a broad group that contained a relatively high percentage of persons less than 25 years old (33 percent). Three-fourths of the persons in this group are married, and 64 percent are between 25 and 65 years old. They were more likely to have been reared in towns or cities (53 percent) than any other group except quail hunters. Fifty-one percent were blue-collar workers with a family income of less than $15,000 per year (70 percent). Seventy-eight percent had lived in the same community for more than 10 years, but only 59 percent had hunted for more than 15 years.

A relatively high proportion of avid hunters began hunting most species before they were 16 years old. General hunters were distinctly less likely to quit hunting than other groups.

Casual General Hunter

By definition, this group is heterogeneous in that it contains all those who did not fit any of the other categories. Most are married males (78 percent) between 25 and 65 years old (75 percent) who were reared in a rural area (52 percent). Forty-six percent worked in professional or white-collar occupations, and a relatively high proportion (34 percent) had a family income of more than $15,000 per year. Thirty-five percent completed at least 2 years of college. Seventy-five percent had lived in the same community for more than 10 years, and 64 percent had hunted for more than 15 years.

Most casual general hunters began hunting small mammals and upland game birds before they were 16 years old. They reported hunting many different species, but were more likely than most other hunters to have quit hunting many species. Most still hunted pheasants (92 percent), rabbits (71 percent), and squirrels (56 percent). They rated themselves quite low at both shotgun shooting and "reading sign."

Values of Hunters

In an effort to determine differences in reasons for hunting among hunter types, respondents were presented with five different groups of questions designed to indicate what they thought was valuable about hunting. One of these groups was introduced by the phrase: "Please check which of the following would be likely to start you hunting different species." Eleven different answers were provided such as: Higher family income, more liberal season, and new friends hunt different species. A companion question asked "Which of the following conditions would be likely to make you quit hunting?" Among the 11 response alternatives were: Physical limitations, change in attitude, regulations too restrictive, and companions quit hunting. In another question, respondents rated 10 different items as being very important, moderately important, or unimportant, in response to the statement, "Using your impression of hunters and hunting, please indicate with a check how important you think the various aspects of hunting are." The fourth question asked hunters to assess the importance of different aspects of a hunt. The final series of eight questions was preceded by two sentences: "The following statements deal with various aspects of hunting. Please indicate how you feel by circling the appropriate number on the scale." This series of statements was selected from those used by More (1970).

A series of six questions included in the questionnaire gave an indication of the importance to hunters of "getting close to nature" (Table 1). The responses of waterfowl hunters and avid hunters were similar in that "back to nature" aspects of hunting were important to them. General hunters and rabbit-squirrel hunters rated this aspect as less important than most other hunters. Quail hunters rated some aspects high but others lower. That almost all quail hunters hunted with dogs may explain why they did not rate themselves high at "reading sign." Because more than half the hunters rated this set of questions high, they must consider getting closer to nature an important aspect of the hunt.

A series of questions designed to measure the importance of hunting as a social activity were included in the questionnaire (Table 2). The response patterns, however, were so varied that we conclude that there probably are at least two different social dimensions to hunting. One aspect is that of companionship in the field, and the other refers to posthunt activities such as displaying a trophy or talking about the hunt. General hunters and furbearer hunters rated the importance of companionship in the field relatively high. General hunters and rabbit-squirrel hunters rated the posthunt social activities as unimportant.

Some hunters also viewed hunting as an escape from everyday life (Table 3). Several different facets of escape appealed selectively to different groups of hunters. The preparatory and anticipatory aspects of hunting were most important to waterfowl hunters, and least important to quail hunters. Quail hunters and avid

Table 1. Percentage of hunters who indicated a high level of importance to questions designed to measure the back to nature aspects of hunting. P = probability level obtained in the chi-square test for the interaction between the type of hunter and the response. Types of hunters are: Q = quail, R-S = rabbit-squirrel, W = waterfowl, F = furbearer, A = avid generalist hunter, G = casual generalist.

Question	Q	R-S	W	F	A	G	*P*
How do you rate yourself at "reading sign" of wildlife?	41	37	62	59	35	26	0.00
How important is being in the field?	75	61	77	55	74	66	0.04
How important is stalking the game?	75	61	79	67	72	58	0.00
I enjoy stalking or tracking game.	50	70	82	73	80	50	0.00
I like to build a blind or scout out a place to hunt before the season opens.	67	54	85	46	70	42	0.00
How important is seeing other wildlife, even if it is not a game species?	75	68	71	68	78	70	0.30

Table 2. Percentage of hunters who indicated a high level of importance to questions designed to measure the importance of social aspects of hunting. P = probability level obtained in the chi-square test for the interaction between type of hunter and the response. Types of hunters are: Q = quail, R-S = rabbit-squirrel, W = waterfowl, F = furbearer, A = avid generalist and G = casual generalist.

Question	Q	R-S	W	F	A	G	*P*
Start hunting a new species because–							
You made some new friends who hunt another species.	25	37	20	21	32	33	0.23
Quit hunting because your hunting companion quit hunting.	0	11	6	14	5	11	0.02
Importance of:							
Having hunting companions.	33	34	43	42	31	47	0.01
Being in field with friends.	67	36	48	55	45	50	0.03
Displaying a trophy.	30	6	12	24	13	8	0.00
Talking about the hunt with friends.	42	27	66	42	36	29	0.00

hunters were least likely to emphasize change in routine or relaxation and relief of tensions. The value of hunting as an escape mechanism in getting away from people and finding solitude was most important to waterfowl, rabbit-squirrel, and avid hunters.

Some hunters emphasized getting a limit, eating the game, or getting some game. These aspects were least emphasized by quail and general hunters. Although only 27 percent of all hunters felt that getting a limit was important, more than 70 percent felt that getting some game was important.

Other Factors Influencing Hunters

The preceding section dealt with some of the reasons that hunters may hunt. Some environmental conditions may influence hunter participation by limiting the potential amount of satisfaction gained from hunting. One of these factors is the availability of game. Avid rabbit-squirrel and quail hunters seemed most sensitive to the availability of the game they were seeking. Economic factors such as cost of license and equipment also impinged upon hunters. Rabbit-squirrel and furbearer hunters seemed most sensitive to these. Another important factor was competition among hunters for the game available and a place to hunt. These seemed most important to quail and rabbit-squirrel hunters.

An important consideration affecting hunters, and especially nonhunters, is their spouses' feelings about hunting. Twenty-five percent of spouses of former hunters and those who have never hunted versus 11 percent of spouses of active hunters disapprove of hunting. Caution should be exercised in interpreting this, however, inasmuch as spouses may have disapproved for many reasons; we did not determine those reasons.

The respondents to the general survey checked factors that contributed to their not hunting recently (Table 4). We assumed that current hunters who answered this question were those who curtailed their hunting but have not quit. The major factors contributing to quitting hunting or a reduction in hunting were: too many

Table 3. Percentage of hunters who indicated a high level of importance to questions designed to measure importance of hunting as an escape from routine problems. P = probability level obtained in the chi-square test for the interaction between the type of hunter and the response. Types of hunters are: Q = quail, R-S = rabbit-squirrel, W = waterfowl, F = furbearer, A = avid generalist, G = casual generalist.

Question	Q	R-S	W	F	A	G	P
Importance of:							
Anticipation of the hunt.	42	54	85	67	68	57	0.00
Preparing for the hunt	36	54	68	62	64	55	0.10
Change in daily routine	33	39	36	37	33	36	0.86
Agree to:							
Hunting helps me relax and relieve tension.	58	79	80	82	63	71	0.01
I go hunting to get away from people.	27	36	40	22	39	31	0.08
I like the sense of solitude and isolation that hunting gives me.	50	72	74	68	71	65	0.85

other responsibilities, problems related to reduced availability of game, and physical disability. More than 10 percent of the former hunters indicated all these problems, but considered other responsibilities and reduced availability of game as less important than current hunters. Former hunters also considered expense and friends quitting hunting as important factors and were three times as likely to indicate that they had developed guilt feelings about killing animals.

The most common species pursued by former hunters were rabbit (71 percent), pheasant (68 percent), and squirrel (54 percent); 20 percent of the former hunters had hunted only these species. In comparison to current hunters, former hunters were more likely to indicate that rabbits and squirrels were the species most important to them during their most active years.

Discussion

About half of the responses concerning value judgments were significantly related to the type of hunter; thus, hunters are not a homogeneous group, and meaningful subgroups of hunters exist. Avid quail and waterfowl hunters were

Table 4. Responses (percent checked) to the question "If you have not hunted recently, which of the following reasons would you consider to be contributing factors?" Significant difference ($P < 0.10$) between former and current hunters are marked with an *.

Statement	Former hunter	Current hunter
Developed guilt feelings about killing animals.	18.5	5.8*
Work around home takes too much time.	29.3	43.4*
Job or business takes too much time.	25.4	49.7*
Physical disability.	24.5	15.6*
Too expensive.	11.7	5.2*
Game populations too low.	15.3	25.4*
No place to hunt.	14.9	23.7
Too many hunters.	17.3	20.2
Friends quit hunting.	13.7	9.8
Number of respondents.	249	173

similar, but yet distinctly different on several points. Waterfowl and quail hunters could be combined as bird hunters on the basis of these similarities. Moreover, furbearer hunters could perhaps be subdivided into fox-coyote and raccoon hunters. A more refined classification system will probably be developed as more studies like this are conducted. Because one of the goals in this study was to identify different reasons for hunting among hunter groups, more than behavioral data should be examined. For instance, age, occupation, or background often were closely related to the type of hunting. For example, many fox-coyote hunters in parts of Iowa were farmers who hunt during the winter when they are not as busy with farming. Subdividing types of hunters into age, background, or occupational groups may allow us to better predict their hunting values.

Specialization in hunting generally began before hunters reached age 16. The idea was supported by Yoesting and Burkhead (1973) in a study of the significance of childhood recreation and adult leisure behavior. Most young hunters sought rabbits and squirrels, but those who eventually specialized in hunting a particular species had already started hunting that species before 16 years of age. Much of the specialization may result from the tendency to quit hunting rabbits and squirrels while continuing or increasing efforts for other game that they had been hunting. Therefore, the major factors contributing to specialization may be similar to those of initiation into hunting. For many hunters, quitting hunting may be a process that spans several years. Part of the group defined as casual general hunters may be in the process of quitting. The casual general hunter and the rabbit-squirrel hunter hold similar values, and most former hunters sought mainly rabbits and squirrels.

Those people who indicated that they quit hunting because the game populations are too low probably were really saying that the diminishing rewards gained from hunting are no longer worth the effort required. Those who indicated that other responsibilities prevent hunting probably were really saying they have reevaluated priorities and decided that hunting is no longer as important to them as it is to those who continue to hunt. Klessig (1970) found that two-thirds of former hunters quit for social and psychological reasons. If wildlife managers can identify the more important rewards the hunter is seeking, they could do a better job of selecting among the possible regulations to optimize the rewards of hunting. For instance, in several midwestern states, the people who are allowed to hunt deer are selected by some type of random drawing. A common question that then arises is, "Should we allow deer hunters to apply for a permit as a group, or should we force each hunter to apply individually?" If the deer hunters in these states consider the social aspects of hunting very important, allowing hunters to apply as a group might be a better option. With this type of knowledge, wildlife managers would be more able to manage the resource while satisfying the needs of hunters.

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Colorado Deer Hunting Experiences

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Those responsible for managing environmental resources, like big game, have often posed questions regarding how best to manage and allocate the resource to "provide benefits to people." One approach to obtaining information for answering these questions is based on consumer behavior concepts and research.

Our consumer-oriented approach to deriving management information for environmental resources, particularly game and other recreational resources, rests on ideas conceptualized by Wagar (1966) and having their theoretical base in psychology's expectancy-value theory (Lawler 1973). The general theoretical orientation we follow is described in Driver and Brown (1975). We also acknowledge a debt to the multiple satisfactions approach to game management articulated by Hendee (1974).

The management orientation of this paper suggests that managers should produce opportunities for game-related recreation which recognize the multiple dimensions of the experience. It is the experience that is the important product of recreation, and quality experiences are a function of how well the consumer's desired satisfactions are fulfilled.

Within this orientation, this paper reports characteristics of the Colorado deer hunter population in terms of the kinds of satisfaction that make up deer hunting experiences. In doing so, the usefulness of cluster analytic techniques for social research in wildlife management is illustrated. The information and analytical techniques discussed in this paper have implications for resource valuation, resource allocation, user management, and related aspects of wildlife planning and management.

Some Related Research

Most writers on game-related experiences have focused on hunting activities, even though there are other uses of game. While harvest has usually been an important attribute of the hunting experience, several writers have discussed nonharvest attributes of hunting.

In a study of Arizona hunters, Davis (1967) found that the benefit to bodily health, aesthetics, associations with others, intellectual stimulation, character building, and religious factors were each important in characterizing hunting. Kennedy's (1970) study of hunters in Maryland's Pocomoke Forest indicated that hunters valued companionship, camping out, getting out of doors, "getting away from it all," and the suspense and challenge of the hunt. More (1973), in a study of Massachusetts hunters, identified the most positively scored characteristics of hunting as aesthetic benefits, affiliation with people, and the challenge of the hunt.

Nearly all investigators of the hunting experience have rated harvest as a positive attribute although not as highly as one might expect. For instance, Kennedy (1970) found it rated positively, but ranked fourth in his list of satisfactions. More (1973) found both "killing" and "display" of game neutrally rated factors with neither contributing much to the satisfaction of Massachusetts hunters.

Potter, Hendee, and Clark (1973) reported a study designed to determine many of the important hunt factors necessary for understanding the ''multiple satisfaction'' model of hunting. From a 73-item pool of Likert type items, they identified eight dimensions (of more than one item) of the hunting experience related to satisfaction of Washington State hunters. The dimensions, produced by factor analysis, are attributes of the hunting experience that are rated as either adding to or detracting from the satisfaction derived from hunting. The dimensions are named nature, escapism, shooting, skill, vicariousness, trophy display, harvest, and equipment. Three single-item dimensions reported are in-group companionship, out-group verbal contact, and out-group visual contact.

A recent re-analysis of the Potter, Hendee, and Clark (1973) data by Hautaluoma and Brown (1977) revealed some specific characteristics of the Washington State deer hunter and his hunting experiences. Using the BC-TRY Cluster Analysis programs (Tryon and Bailey 1970), the original items were re-clustered into dimensions and then the hunters were classified according to their cluster scores across the dimensions. The value of this re-analysis was in the classification activities. Five strong dimensions applicable to all groups of deer hunters—nature, harvest, equipment, out-group contract, and skill—were identified and used in the hunter typing. For all Washington State deer hunters, 10 different types were identified. These types ranged from a group that might be termed minimum satisfaction from deer hunting to a group that indicated all five dimensions added greatly to their satisfaction.

The Colorado deer hunter study reported here employed data collection methods and scales similar to those of the Washington State study and employed the analytical methods used in the reanalysis of the Washington State data. A discussion of methods and results obtained follows.

Method

The methods involved sampling from among all 1974 Colorado deer hunting license holders, mailing questionnaires which contained hunting experience items, clustering the data on returned questionnaires, performing typological analysis using selected clusters of dimensions, and relating the identified types to other hunt and hunter characteristics.

Sampling was performed in a manner to insure representation from all deer hunter license types and geographic origins of hunters. Separate samples were drawn for in-state and out-of-state rifle, primitive weapon, sportsman, and archery license holders. For in-state samples, each county of hunter origin was assigned a quota based upon historical records and random selection of the sample was made. Out-of-state samples were drawn randomly from all license stubs. The total sample drawn was 2,508.

The intial mailing consisted of a questionnaire with cover letter plus an addressed postage-paid return envelope. Two subsequent mailings were made to nonrespondents to the first or second mailing. A reminder letter was included with these follow-up mailings.

Data analyses were performed using the BC-TRY (Tryon and Bailey 1970) cluster analysis system. Seventy-three scale items were analyzed and grouped into dimensions because of their relatedness in mathematical space.

After dimensions were identified, they were used to classify hunters into distinct types. In this procedure, each hunter is scored on how much he perceives each dimension contributing to his hunting satisfaction, and then each hunter's pattern of scores over all the dimensions is considered. To type a person requires that his pattern of scores over the dimensions be similar to that of a group of other hunters (thereafter called his type), and that this group's scores be different from other groups' scores.

In performing the typing, only four of the dimensions identified were employed. Five criteria were used in selection of the dimensions: (1) The dimension had to be common to all license type groups; (2) it had to be relatively independent of the other dimensions; (3) the strength of the dimension was considered; (4) the consistency of the items appearing in the dimension over all license types was important; and (5) the degree to which the dimension was directly and clearly relevant to game management was considered (i.e., was the dimension amenable to manipulation). The four dimensions were named: nature, harvest, easy hunt, and out-group contract.

After hunters were typed, Monte Carlo and inferential statistical procedures were used to relate hunt and hunter characteristics to the types. Such things as success in hunting, days hunted, age and education of hunters, and preferences for management practices were involved in this analysis.

In summary, the method of this study involved determining dimensions of the hunting experience perceived as providing satisfaction, typing users according to their preferred mix of dimensions, and relating other user characteristics to the types identified.

Results

Reported here are results drawn from analysis of the 1971 returns by all license types (77 percent of the effective distribution of 2,333 questionnaires) and 694 returns from the in-state regular rifle license holders (74 percent of the effective distribution for this license type). Similar results are available for the other license types.[1]

Dimensions of the Deer Hunting Experience

Cluster analysis of the 73 Likert type items produced nine dimensions for both the inclusive license group and the in-state rifle license type. While the same names are given to the dimensions for both groups, it should be noted that the items describing each dimension were not always the same for both groups. Also, the names were assigned to represent the meaning of the dimension as closely as possible, but a simple name is not totally descriptive. The names assigned, in the order that the dimensions emerged for the in-state rifle group, were: nature, out-group contact, equipment, frustration release, easy hunting, in-group affiliation, skill, harvest, and suspense. Each of these dimensions had at least four items and a dimension reliability exceeding 0.60.

Four of these dimensions were selected for hunter typing based upon the criteria mentioned previously. The four were: easy hunt, harvest, out-group contact, and nature. The items which describe these dimensions are listed below.

[1]Space does not permit presentation of results for all license types. Therefore, typological and prediction results are only reported for the in-state rifle license group. Information on the other license groups may be obtained from the authors.

Easy Hunt
Looking for deer from a vehicle
Hunting in pleasant weather
Hunting where you don't have to work hard to find game
Killing game close to my vehicle

Harvest
Killing game
Shooting my weapon
Being more successful than my hunting companions
Getting meat to eat
Eating game
Getting a quick kill
Showing game I have killed to my family and friends

Out-Group Contact
Knowing there are other hunters around
Seeing hunters in other parties have success
Sharing hunting experiences with other hunting groups
Seeing and talking with game wardens
Being able to count on hunters of other groups for help if it is needed
Seeing hunters from other parties
Socializing with hunters from other parties
Hearing other hunters' shots

Nature
Being outdoors
Being close to nature
Being where things are natural
Camping out while hunting
Seeing some wildlife
The smells, sights, and sounds of the woods and fields
Being where it is quiet
Physical exercise

Typing

After identifying these four dimensions of satisfaction that Colorado deer hunters receive from hunting, the hierarchical clustering routines of BC-TRY were used to identify the types of deer hunters in the sample according to their patterns of satisfaction over the dimensions. In doing the typological analysis, each hunter was scored on each dimension. A pattern across all five scores was established for each hunter. The hunters' score patterns were then compared, and groups of hunters with similar patterns were formed. Several typing iterations were performed on the computer until a stable set of types was found. Nearly all of the hunters were assigned to one of the groups, though there were a few (eight percent) unique individuals who did not fit well with any group.

Results of the typological analysis of the in-state rifle license type are shown in Table 1. The four dimensions selected for typing are across the top of the table and down the left side are the eight hunter types that were found and the number of persons in each type. The modifiers below the four dimensions describe the

Table 1. Colorado deer hunter types based on empirically derived scores on satisfaction dimensions. [a]

Type	N	Percent	Easy hunt	Harvest	Out-group contact	Nature
1	79	11	Moderately detracts (−2)	Moderately adds (2)	Neutral (0)	Most strongly adds (4)
2	23	3	Neutral (0)	Slightly adds (1)	Neutral (0)	Neutral (0)
3	117	17	Neutral (0)	Slightly adds (1)	Slightly adds (1)	Most strongly adds (4)
4	67	10	Slightly adds (1)	Strongly adds (3)	Slightly detracts (−1)	Most strongly adds (4)
5	84	12	Neutral (0)	Slightly adds (1)	Neutral (0)	Moderately adds (2)
6	150	21	Slightly adds (1)	Strongly adds (3)	Moderately adds (2)	Strongly adds (3)
7	53	8	Strongly adds (3)	Most strongly adds (4)	Strongly adds (3)	Most strongly adds (4)
8	67	10	Slightly detracts (−1)	Most strongly adds (4)	Moderately adds (2)	Most strongly adds (4)
U [b]	57	8				

[a]The numbers in parentheses indicate the approximate mean satisfaction level for the type on the dimension.
[b]There were 57 hunters unassigned to types because of the uniqueness of their score patterns across the dimensions.

importance of the dimension to hunter satisfaction. "Neutral" indicates that the dimension neither adds to nor detracts from the hunting experience. The numbers in parentheses represent the mean degree of contribution to satisfaction that the hunters scaled on their questionnaires. The scale ranged from plus four (extremely adds) to minus four (extremely detracts).

In looking down the columns of Table 1, the degree to which each dimension discriminates among hunter groups is apparent. Nature, for instance, is a highly positive dimension and provides little discrimination. Easy hunt, on the other hand, discriminates greatly ranging from moderately detracts for Type 1 to strongly adds for Type 7. The other two dimensions are between these two on discrimination with out-group contact somewhat more variable than harvest.

The row data in Table 1 provide profiles of hunter types with Type 1 being a nature-harvest oriented type who reacts negatively to the easy hunt items. Type 2 might be called a "minimum gratification" type. For this type, only harvest contributes at all to deer hunting satisfaction, and then only in a small way. As a group, members of this type may be potential dropouts from deer hunting. Type 3 individuals gain most satisfaction from the nature aspects of deer hunting, while also gaining satisfaction from harvest and out-group contact, but not easy hunting. Type 4 are nature-harvest satisfied hunters who do not receive satisfaction from out-group contact. In fact, they indicate that meeting and hearing other hunters actually detracts from their experience. Type 5 might simply be characterized as a nature-harvest type, but one that does not have strong feelings about any of the dimensions. Type 6, the largest type with 21 percent of the population, perceives each of the four dimensions as positively contributing to the deer hunting experience. Nature and harvest are strongest for this group. Type 7 hunters are generally positive about all the dimensions. They scored the highest on every dimension, and appear to be gung-ho hunters. Type 8 is composed of hunters who gain great satisfaction from the nature and harvest components of deer hunting, gain satisfaction from being around hunters from other parties, and react negatively to easy hunt aspects of some hunting experiences. The last row shows the number and percent of deer hunters who could not reliably be included in any of the eight hunter types.

Predicting Management Preferences and Social Characteristics from Types

The analyses described above have generated a set of Colorado deer hunter types based upon each individual's relationship to four hunting experience dimensions. The deer hunter questionnaire contained several items about hunters and management of hunting which can be related to the hunter types in order to: further describe the types; assess the validity of the type descriptions; and suggest hypotheses about hunter reaction to imposition of management alternatives. Selected results of these prediction analyses are given in the following paragraphs. Results are based on a multiple range test of all pair-wise comparisons using Scheffe's technique, unless otherwise noted.

Respondents were asked about their feelings toward 10 different management practices which the Colorado Division of Wildlife either was presently using or had used in recent years. These practices dealt with topics such as the taking of bucks only, changing access conditions, timing of big game seasons, and having separate seasons for archery, primitive weapon, and rifle hunters. For three of these management items significant differences between hunter types were found.

For the item, "changing road access so that more hunting areas are easy to reach," the mean score, on a five-point (+2 to −2) favorability-unfavorability scale, for hunter Type 1 (−0.91) was significantly different ($p < .05$) from the mean of hunter Type 6 (0.00) and Type 7 (0.58). The mean of hunter Type 4 (−0.55) was significantly different ($p < .05$) from the mean of Type 7 (0.58).

A hypothesis related to these comparisons was that those hunter types expressing negative or neutral feelings toward easy hunt and out-group contact would express negative feelings toward increased road access. It was also hypothesized that the reverse situation would be true. Type 1 indicated that easy hunt moderately detracts from the hunting experience while Types 6 and 7 indicated that an easy hunt slightly adds and strongly adds, respectively. While Type 1 was neutral toward out-group contact, Types 6 and 7 indicated that this attribute moderately adds and strongly adds, respectively, to the hunting experience. Although Type 4 felt that easy hunt slightly adds to the hunting experience, this type also felt that out-group contact slightly detracted from the experience. The results shown above for these different hunter types support the hypotheses.

Reaction to "changing trail access so that more hunting areas are easy to reach" showed similar results to those for the road access item. The mean scores for hunter Types 1 (−0.74) and 4 (−0.34) differed significantly ($p<.05$) from the means for Types 6 (0.26) and 7 (1.00). In comparing these means to those for the road access item, it is apparent that a more positive reaction to changing trails was obtained. This result was not surprising given the strong harvest orientation of all four types. While improving trail access would likely enable more people to enter an area, it would probably not have nearly as large an effect as improving road access. For many of the hunters in the types indicated, better trails might be perceived as increasing the opportunity to harvest animals while not increasing the number of hunters very much. Still, however, the majority of hunters in Types 1 and 4 were negative toward increasing trail access.

To investigate the relationship between the types and the management item, "holding the deer season early, before elk season" the prediction program of the BC-TRY package was used. This technique was used because of the small n in some data cells. The procedure involves Monte Carlo sampling. The program draws several hundred samples of a type's size from the total n, thus providing a distribution of sample means against which the type's actual mean is compared. The result is a probability statement of the likelihood of finding a mean as or more deviant than the type's mean by chance alone.

The item about holding the deer season first was viewed favorably by all hunter types, except Type 2 whose mean (-0.67) was significantly ($p<0.001$) below the population mean (approximately 0.38). In looking at Table 1, the distribution of dimension scores for Type 2 suggests that it is a minimum gratification type, with a slightly positive reaction to the harvest dimension. In the absence of other information one might hypothesize that this type would be neutral on the timing of the season. But, in looking at results of other season timing items, a reason for the negative response to the item about holding deer hunting first is apparent. This group also negatively scored the item, "holding the deer season late, after elk season." For the item, "holding deer and elk season at the same time," it had a positive score. One possible conclusion from these findings is that the group felt the chances of harvesting something are greater if you can hunt for both deer and elk at the same time.

Illustrative of the social and economic description of the hunter types are the income data. The mean income of the population is in the range \$13,000-\$14,000. Using the prediction program of the BC-TRY package, the mean incomes for Types 3 and 5 were found to be significantly ($p<.05$ and $p<.01$, respectively) above the population mean. The income means for Types 7 and 8 were significantly ($p<.001$ and $p<.01$, respectively) lower than the population mean.

In reviewing all of the income data, those hunter types with relatively low scores on harvest (1, 2, 3, and 5) were above the mean in income, except for Type 2, the minimum gratification type. Those hunter types with high scores on harvest (4, 6, 7, and 8) were right at (Type 4) or below the mean income. Also, it can be observed that those hunter types which appear to be gung-ho hunters are of lower income than other hunter types.

Additional descriptive data are available for the hunter types even though they are unreported here.

Conclusions

The methods employed in this study could be used to investigate the demand for many kinds of fish, wildlife, and other environmental resource related experiences. Users' expressions of satisfaction or dissatisfaction toward elements of the experience can be dimensionalized with cluster analysis and the dimensions used to define types of users. These user types are segments of the user population receiving differential gratification from an experience. Knowledge of different types enables managers of wildlife resources to make decisions based upon the resource, social, and managerial attributes which provide user satisfaction. An understanding of users and their preferences can be enhanced by examining items such as socioeconomic characteristics and management preferences that might be expected to differentiate user types.

There are several conclusions which can be derived from our analysis of the rifle license holder group of Colorado deer hunters. A nature emphasis seems warranted in the production of deer hunting opportunities. Nature was clearly the most positively rated attribute of the experience in terms of providing satisfaction. The contrast between nature and harvest appears particularly striking, and three hunter types (2, 3, and 5) were identified for whom hunting in low harvest areas would not detract from the experience. Two of these groups would be gratified by nature-oriented experiences which include seeing game but not necessarily harvesting it, while the other, Type 2, is likely to be a hunting drop-out because hunting provides them little gratification.

Another conclusion is that out-group contact, commonly called crowding when at unacceptable levels, is quite tolerable within acceptable limits for seven of the hunter types (Type 4 excepted). Types 1, 2, and 5 are neutral toward out-group contact while the other four types feel it adds to their satisfaction. Future research might focus on the point at which different hunter types indicate that there are too many hunters present.

The data show that some Colorado deer hunters gain more satisfaction from the hunting dimensions studied than do other hunters. If these dimensions represent a valid set to describe the managerially relevant aspects of deer hunting, then one might use these indications of satisfaction in allocating and managing game resources. Hendee (1972; 1974) has argued that the hunters who are most dependent on hunting for their satisfactions in life should be catered to more than those who describe themselves as having alternative means of gaining satisfaction. Using this rationale one might argue that those types that value the harvest dimension highly should be given greater consideration when allocating scarce game resources. Implicit here is that hunters emphasizing other hunt attributes have many substitute activities which provide the same kind of satisfaction.

Finally, some conclusions can be drawn from the prediction analyses. Increasing access to game resources through modification of roads and trails would be received negatively by some hunter types and positively by others. Knowledge of the experience preferences of hunters using particular hunting areas would thus be beneficial to making decisions about where to modify access conditions, or in assessing the recreational impacts of road and trail changes.

Data such as those for income can be used to answer questions about the equity inherent in game resource allocation. The kinds of hunter types described, in terms of hunt experience desired, can be related to age, sex, income, and other population descriptors. While the types of hunters can be used to describe experiences desired, the population descriptors can be used to socially describe groups of hunters desiring specific experiences. If these data are compared with local and state population data and with the actual distribution of deer hunting opportunities, the equity implications of present Colorado deer hunting policy can be determined.

In addition to these empirically based conclusions, we can also suggest some general applications of the methods used. Valuing specific hunting sites, estimating demand for hunting experiences, and allocating game related resources are activities for which the methodology can provide information.

Wennergren and Fullerton (1975) have identified that there are large differences between the location and amenity values of hunting sites, and that the total site value is composed of these two components. The methods utilized fit well within these concepts and enable the identification, from the hunters' perspective, of the site attributes which have value. In order to supply highly valued resources, the manager can then manipulate key resource elements to produce a desired mix of site attributes.

In estimating demand, the method can be used to delineate specific hunting experiences for which management might provide opportunity. Rather than treating all deer hunting as one experience, the method enables the identification of more discrete experience packages and the size of the hunter groups relating favorably to the different experiences. In the sense that Wagar (1966) discussed a need to provide a spectrum of recreation facility types within an activity category (e.g., camping), this method allows identification of the experience spectrum demanded. Such information enables deriving economic estimates of willingness-to-pay for specific hunting or other recreational experiences. This would produce demand estimates for specific products rather than for classes of products as have been generated many times. In the present volume, the paper by Miller, Prato, and Young approaches the demand problem from this perspective.

Finally, the output of the method is also relevant to resource allocation decisions (apart from economic demand estimation and site valuation). Presently, various mathematical models are used as resource allocation aids. Very popular are linear programming models, among which is goal programming. The information obtained, utilizing the method described here, about groups and the kinds of experiences which provide them satisfaction can be utilized as the goal sets in these models. Also, information about experience attributes can be used to specify the dimensions of other parts of a goal programming model. For instance, land unit descriptions (e.g., response unit classification) and the identification of management alternatives might be aided by the kinds of information produced by utilizing the method described.

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Influence of Hunter Attitudes and Characteristics on Wildlife Management

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Introduction

The process of collecting information on hunter attitudes, characteristics, and levels of participation is not new. Nor is the desire on the part of the researcher to see this information incorporated into the wildlife management plans of the various state and federal wildlife agencies. What is new is the realization among many researchers that collecting and wishing are not enough. A greater effort must be made to interpret these data into sound, practical wildlife management practices. This means that researchers must form a closer relationship with wildlife managers and biologists in order to better understand the biological, political, and social forces that constrain the fulfillment of the managers' desired goals. Knowledge of these goals will then help researchers enhance the design and effectiveness of their research.

Wildlife managers generally have several technically feasible wildlife management practices that can be employed to achieve a desired goal (e.g., increasing the size of a given population through habitat improvement, changing hunting regulations, stocking, establishing wildlife sanctuaries, etc.) but each of these management practices is linked to a specific set of biological, political, and social (hunter and nonhunter) reactions. A choice that neglects to consider one or more of these reactions may result in the dissolution of an entire management program. Such was the case in 1971 when the Vermont legislature revoked all deer management practices of the Vermont Fish and Game Department—except its deer research function—as a result of the controversy surrounding the department-sponsored antlerless deer seasons in 1969 and 1970. While the decision to use antlerless hunting seasons to control the excessively large deer herd was a nationally accepted management procedure, the department failed to adequately appraise Vermont's social (sportsmen and landowner) and political climate. If such an appraisal had been made and evaluated, a serious confrontation might have been avoided and the department would have retained its management programs.

This paper will focus on the management implications of specific hunter attitudes and characteristics obtained from a recent study by the Vermont Fish and Game Department and the University of Vermont. This cooperative research effort was set up to obtain behavioral information on hunters that could be translated into effective and practical wildlife management practices.

Methods

During February 1974, a 20-page questionnaire was mailed to a 5-percent, stratified random sample of resident and nonresident hunters who purchased Vermont hunting and combination licenses in 1973. A second questionnaire was mailed to nonrespondents 3 weeks after the initial mailing. These two mailings produced a total of 3,539 usable questionnaires—a 53 percent usable return from the sampled population.

The questionnaire was designed to secure information on a broad range of hunter characteristics, attitudes, and levels of participation to determine if current hunting regulations and wildlife management techniques are providing sportsmen with a psychologically rewarding hunting experience. It was felt that observed deficiencies might be corrected through changes in wildlife management practices and hunting regulations.

In addition to the standard socioeconomic questions (i.e., age, income, etc.), hunters were asked to provide detailed information on past and present hunting activities. These included such things as: (1) number of years, trips, days, and hours spent hunting each of Vermont's 22 game species, (2) hunting location for each species by town and type of land ownership, (3) harvest information, and (4) an importance ranking (very important, important, etc.) of statements that might explain the reasons for increased and decreased hunting activities in Vermont between 1970 and 1975. Additional information was obtained from an importance ranking of statements on: (1) management practices for improving hunting in Vermont, (2) criteria for a successful hunt, (3) factors that influenced a nonresident to hunt in Vermont, (4) factors explaining why a person hunts, and (5) threats against a person's right to hunt. Responses to these statements were tabulated through the use of a weighted-factor ranking process.[1] This procedure placed each statement in its appropriate importance category and also established its relative ranking.

Study Results and Management Implications

Because of the complexity of public wildlife management with its diffuse mix of social, political, and biological relationships, a researcher places himself in a somewhat untenable situation when he leaves the security of simply presenting research findings and tries to predict their management implications. This predictive effort is nevertheless necessary because the continued accumulation and refinement of data, in itself, serves no useful purpose. A sufficient amount of sound, substantiated data on the characteristics and attitudes of hunters is now available and it is time to that we researchers venture forth with some practical suggestions for its integration into wildlife management practices.

In the following pages I will discuss the management implications of selected socioeconomic characteristics of hunters and hunter reactions to four pertinent, management-related topics: (1) reasons for hunting; (2) criteria for a successful hunt; (3) reasons for increased and decreased hunter participation; and (4) management practices for improving hunting.

I do not profess to have any special interpretive skills, just a desire to stimulate discussion and interest in the implementation of research findings.

[1]The overall importance of each statement was determined by first establishing a value range for each level of importance. This was accomplished by assigning values of 3 through 0 respectively to the "Very important" through "Not important" responses. The number of possible responses to the statement was then multiplied by 3 (the highest possible value) and the product was divided by 4 (the number of possible responses). The derived value represented the minimum value for inclusion in the "slightly important" category. Doubling this value gives the minimum value for inclusion in the important category, etc. The value for each response is then obtained by multiplying the point value of each response by the number of respondents that checked that level of importance. The sum of the products is the weighted factor rank.

Socioeconomic Characteristics of Hunters

The collection of socioeconomic data (i.e., age, education, income, etc.) has been an integral part of virtually every behavioral study of hunters. Yet, little has been done with the data other than stating that the average hunter is in his mid-thirties, has a slightly higher educational level than the general population, is employed on a full-time basis in a technical-professional position, was raised in a rural area, and receives an income (circa. 1970) at the upper $9,000 level (Watson, Jamsen, and Monerief 1972; Bevins et al. 1968; Garrett 1970; Peterle 1967; Schole et al. 1973; Hendee and Potter 1976; Nobe and Gilbert 1970; Gilbert 1973). These characteristics, and the frequency distributions from which they were derived, obviously have some value beyond their descriptive function. Such "marketing" information could be used as productively in wildlife management as it is currently used by producers of commercial products. A fish and game department is, after all, "producing" a product—wildlife for consumptive and nonconsumptive uses—and must be cognizant of the market characteristics of its consumers if it hopes to survive and prosper.

Using the socioeconomic data obtained in this study as a representative microcosm of the above-mentioned studies, a number of management implications can be discussed.

Age and Rural Living. Vermont hunters tend to fall in the upper age classes; only 15 percent of all hunters are under 25. These findings, which are similar to results of 33 studies by Hendee and Potter (1976), indicate a decreased interest in hunting by the younger generation. A probable cause for this declining interest is a decrease in rural living during adolescence (12-18 years of age). Study results indicate that more than 90 percent of all current resident and nonresident Vermont hunters began hunting during adolescence and more than 80 percent of the hunters lived on farms or in rural areas during their adolescence years. These data appear to indicate that an interest in hunting is developed during adolescence and that rural living is an important factor in stimulating this interest. Since rural living is decreasing in Vermont and the rest of the nation, there is likely to be a corresponding decrease in the number of new hunters. Hunters themselves may also be contributing to this decline. A study by Bevins et al. (1965) shows that three-fifths of the fishermen in their study took children fishing but only one-fourth of the hunters took children hunting.

From a management point of view, this decreased exposure to hunting suggests the need to supplement the current hunter safety program with a program in hunter education. Such a program would expose the value and enjoyment of hunting to adolescents who, through their urban upbringing, may no longer be exposed to it naturally but may choose to hunt. The program would also enhance the quality of the sport and thereby counter the increased criticism that hunting has received in recent years.

Education. The educational level of Vermont hunters is significantly higher than that of the total northeastern states' population. Approximately 43 percent of the hunters had completed 12 years of formal education and 29 percent had completed one or more years of college compared to a 29 and 17 percent distribution, respectively, for the general northeastern states' population. This higher educational level among hunters suggests that today's hunter is more sophisticated and therefore more inclined to challenge the policies that regulate his sport.

Wildlife managers should therefore consider upgrading the quantity and quality of their public information services and strive for greater hunter responsibility and involvement in the wildlife management process. Such an approach will foster increased hunter cooperation and enhance legislative approval of necessary wildlife management budgets and programs.

Occupation and Income. Vermont hunters, by virtue of their employment in craftsman-foreman (29 percent), managerial (13 percent), and professional-technical (12 percent) occupations, and their higher than normal salaries ($9,756 for resident and $14,146 for nonresident hunters compared to $8,928 for all Vermonters and $10,790 for the total northeastern population) appear to have the job security and income necessary to sustain their hunting activities during periods of local and national recession. This also means that these hunters have the financial ability to absorb moderate increases in license fees. Management-wise, these conditions give wildlife managers relative assurance that their vital license-fee-based budgets will remain free of disruptive oscillations and that moderate license fee increases will not result in disproportionate decreases in license sales.

Reasons for Hunting

A definitive answer to the question "Why do you hunt?" would greatly facilitate the wildlife manager's task of providing sportsmen with a rewarding hunting experience. At least nine studies (Schole et al. 1973; More 1973; Potter, Hendee, and Clark 1973; Haulsee et al. 1973; Stankey, Lucas, and Ream 1973; Kirkpatrick 1965; Davis 1967; Hendee and Potter 1976), including this report, have specifically addressed this question and 12 more studies have dealt with related areas of hunter motives and preferences (Hendee and Potter 1976); yet, no definitive answer has emerged. What has been learned is that hunters, like participants in other sports, generally list several nonquantifiable motives for their participation.

To test this phenomenon, Vermont hunters were asked to rank the importance of 11 factors in explaining why they hunt (Table 1). Ten of these factors were unidimensional and one (To enjoy the sport) was multidimensional. Study results

Table 1. Factors that explain why resident and nonresident hunters hunt.

Factor and importance	Weighted factor rank
Very important (7,318–9,756)	
To enjoy the sport	7,890
Important (4,878–7,317)	
To get out into the woods	5,852
To test your hunting skill	4,928
Slightly important (2,440–4,877)	
To get away from work or family	4,179
To obtain meat	3,964
To test your shooting ability	3,710
To be with other hunters in a hunting situation	3,606
To accompany a relative or friend	3,492
To harvest some animals	2,841
To uphold a family tradition	2,505
To gain self-esteem	2,474
Not important (0–439)	
Other	617

indicate that Vermont hunters placed consistently higher importance on the multidimensional factor. In other words, a substantial majority of the hunters gave top ranking to a factor which, in essence, incorporated some or all of the other factors. This finding supports earlier conclusions (Hendee and Potter 1976; Davis 1965; More 1973; and Schole et al. 1973) that a hunter hunts to fulfill several objectives and suggests that researchers have an obligation to delineate those factors that can be enhanced through effective wildlife management.

The ranking of the remaining factors in Table 1 sheds additional light on the motivating forces behind a person's participation in hunting. Hunters placed two socially acceptable, nonconsumptive aspects of the sport—"An excuse to get into the woods" and "To test hunting skills"—in the important category and relegated to the slightly important category factors that were consumptive in nature (i.e., "To obtain meat," "To harvest some animals," etc.) or were not as socially acceptable (i.e., "To get away from work or family," "To gain some self-esteem," etc.). This would suggest that a person hunts not to necessarily shoot game but to participate in the adventurous pursuit of game.

Hunters may also be attempting to avoid the guilt associated with placing too much importance on the consumptive or socially demeaning motivations. For game management, this means that managers must supply the critical mass (of game) to perpetuate a challenging pursuit but is apparently under no hunter mandate to facilitate the easy procurement of game.

Criteria for a Successful Hunt

Several recent studies on hunter satisfaction indicate that the bagging of game is not a necessary criterion for a successful hunt (Hendee 1974; Hendee and Potter 1971; Potter, Hendee, and Clark 1973; Watson, Jamsen, and Moncrief 1972; Stankey, Lucas, and Ream 1973; and Haulsee et al. 1973). These studies suggest that hunting satisfaction depends upon attaining several goals related to the overall hunting experience. Hendee (1974) was critical of the traditional "game-bagged" and the current "days-afield" theories of satisfaction. He proposed a multiple-satisfaction approach to game management that stressed the importance of offering hunters "a range of experiences which, in turn, give rise to various human satisfactions." A subsequent study of Washington hunters by Potter, Hendee, and Clark (1973), conducted to test the validity of this proposition, confirmed the complex nature of hunter satisfaction and suggested that nature, escapism, and companionship were far more rewarding to hunters than shooting, skill, vicariousness, trophy-display, harvest, equipment, and talking to or seeing outsiders.

The dominance of game-related experiences as a means of attaining satisfaction was reported by Stankey and Lucas (1973). Their study of Montana hunters revealed that more than 66 percent of the respondents listed harvest- and/or game-dependent categories, when asked what big game hunting meant to them. They concluded that "taking or seeing an animal is clearly a dominating focus in hunter definitions of quality and continued dilution of the probability of success will lead to a decline in satisfaction levels." Similar game-dominated measures of success were observed by Schole (1973) in a 1971 study of hunter attitudes.

These two theories on hunter satisfaction leave unresolved the relative importance of game-dependent factors in defining hunter satisfaction and provide game managers with little guidance in resolving the management implications of such hunter desires as the enjoyment of nature, escapism, and companionship. To test these two theories and hopefully shed some additional light on their management implications, I asked Vermont hunters to rate the importance of 21 criteria in meeting their needs for a successful hunt (Table 2). As in the previous section on hunter motivation, one criterion was multidimensional ("Just getting into the field in a hunting situation") in that it encompassed a variety of success-oriented desires; the remaining 20 factors were specific to a particular desire.

Response to the various criteria was so diverse that none qualified for the "very important" ranking. There were, however, nine criteria ranked as "important." Table 2 shows that the multidimensional response "Just getting into the field in a hunting situation," was ranked considerably above the other criteria. Of the remaining eight criteria, four were game related, two were concerned with the hunting area, and two dealt with equipment and companionship. Since none of these groupings dominated the upper ranks of the "important" category, it must be concluded that hunters do indeed base their success on several divergent criteria. An analysis of these criteria indicates that the Vermont hunter is very concerned with his probability of success both from a game standpoint (i.e., "Seeing game animals while hunting," "Being able to hunt several species in the

Table 2. Criteria for a successful hunt.

Criteria and importance	Weighted factor rank
Very important (7,327–9,687)	
None	
Important (4,884–7,326)	
Just getting into the field in a hunting situation	6,834
Having the right equipment	6,199
Seeing game animals while hunting, but not shooting any	6,153
Hunting in a familiar area	5,768
Hunting in an area with minimum number of roads	5,509
Having the opportunity to hunt several species of game in the same area	5,506
Getting a shot at a game animal	5,459
Shooting an animal of your choice	5,375
Hunting with a preferred companion	5,072
Slightly inportant (2,443–4,883)	
Not encountering other hunters	4,762
Hunting under ideal weather conditions	4,168
Having easy access to hunting areas	4,081
Shooting one or more birds or animals, but not a full bag	3,858
Obtaining meat for your family	3,493
Shooting a trophy animal	3,347
Participating in associated activities (deer camp activities)	3,073
Hunting where the game is concentrated in a relatively small area	2,549
Not important (0–2,442)	
Shooting a full legal bag limit	2,423
Having camping facilities in the hunting area	2,200
Having a short hunting season with a large bag limit	1,206
Other	866

same area," and "Getting a shot at a game animal") and from a preparedness standpoint (i.e., "Having the right equipment" and "Hunting in a familiar area"). He is apparently only slightly concerned about amenities such as (1) not encountering other hunters, (2) hunting under ideal weather conditions, and (3) having easy access to hunting area. He is even less concerned with the actual harvest of game (i.e., "Shooting one or more birds or animals," "Obtaining meat for one's family," and "Shooting a trophy animal").

From a management point of view these findings suggest that game managers should strive to maintain game populations at levels that will provide hunters with a reasonable expectation of success. The specific game numbers to achieve this success will have to be determined through further research. A greater effort should be made to keep hunters informed on game concentration and access possibilities. These practices address those important criteria for a successful hunt that can be logically influenced by management practices. The remaining criteria are hunter related (skills, equipment, and companionship) or deal with uncontrollable aspects of the area's topography and climate.

Reasons for Increased and Decreased Hunter Participation

The stimulus behind a person's decision to increase or decrease his hunting activities can be a valuable indicator of management's success in meeting hunter needs. To test the adequacy of the management practices of the Vermont Fish and

Table 3. Reasons hunters gave for increased participation in hunting during the 5 years before 1973.

Reason and importance	Weighted factor rank
Very Important	
None	
Important (2,306-3,457)	
Time available for hunting has increased	2,524
Slightly important (1,153-2,305)	
My financial situation has improved	1,681
My present friends or associates hunt	1,628
I want to obtain meat for my family	1,521
Suitable hunting areas are not available	1,199
I now live closer to my hunting territory	1,191
Not important (0-1,152)	
Access to hunting area has improved	1,099
Other	1,124
Game populations have increased	994
My interest has been rejuvenated by reading about hunting	909
My son or daughter is now hunting with me	704
My interest has been rejuvenated by television or movies	669
My physical condition has improved	485
I now own huntable land	409
I have invested money in a hunting dog	382

Table 4. Reasons hunters gave for decreased participation in hunting during the 5 years before 1973.

Reason and importance	Weighted factor rank
Very important (1,660-2,214)	
None	
Important (1,106-1,659)	
None	
Slightly important (554-1,105)	
Time available for hunting has decreased	896
I cannot find sufficient game to satisfy my needs	839
Crowded hunting conditions annoy me	728
My previous favorite hunting area is now posted	706
There are not enough suitable places to hunt	688
Not important (0-553)	
Other	436
I must travel too far to reach a good spot	394
My physical condition limits participation	382
Insufficient finances limit my participation	336
My hunting companions decreased their activities or no longer hunt with me	300
Adverse public opinion toward hunting affects me	263
I moved away from my hunting territory	213
I no longer have hunting dogs	129

Game Department, hunters were asked to indicate the importance of 15 reasons for explaining their increased or decreased hunting activity during the 5 years preceding this study (Table 3).

The 46 percent who indicated increased participation listed more available time as the only important reason for the increase. An improved financial situation, the desire for companionship, the availability of game, and the ease of access to hunting areas were considered only slightly important in their decision. These results indicate that management-controlled factors had little influence on the Vermont hunter's decision to increase his hunting activities.

Similar results were obtained from the 25 percent of the hunters who decreased their hunting activities (Table 4). This group listed a decrease in available time as the primary reason for decreased hunting but only gave it an overall "slightly important" ranking. Other slightly important reasons included insufficient game, crowding, and a lack of suitable hunting areas.

These findings provide little guidance to the manager who is concerned with decreased hunter participation. The uncontrollable nature of time and the highly dispersed hunter reaction to management-influenced reasons (i.e., meat for one's family, better access to hunting lands, etc.) makes program modification impractical.

Management Practices for Improving Hunting

Since wildlife management is a highly technical, biologically-oriented profession, game managers are generally reluctant to seek management advice from hunters. They naturally assume that their management training and depth of knowledge on game characteristics and habits make them better qualified to recommend management practices. This attitude, while sound from a biological standpoint, fails to consider the political pressures that a disenfranchised hunter population can exert upon operation of a wildlife agency. In this section I will discuss the importance that Vermont hunters attach to selected game-management practices.

An analysis of the management practices in Table 5 reveals that Vermont hunters feel that controlling deer-killing dogs and stricter enforcement of game laws and regulations are the most important management practices for improving hunting in Vermont. Hunters obviously feel that the widespread killing of deer by dogs and the poaching of game animals reduce their own chances for success. They may also be expressing their general distaste for the senseless killing and unsportsmanlike behavior. The concern for stricter law enforcement was also observed by Davis (1977), Hendee and Potter (1976), and Eisele (1973).

The previously discussed desire by hunters to have a reasonable probability of success was further reinforced by the top ranking given to the "Stocking of game species" in the "important" category (Table 5). The importance given to stocking appears to indicate a dissatisfaction with the size of current game populations but may also be a reflection of the success that has been achieved in reintroducing the wild turkey to Vermont. Hunters also gave "important" ratings to two other success-oriented management practices: "habitat improvement" and "increased land acquisition." The former enhances the numbers and quality of game animals and the latter would presumably increase the availability of huntable lands.

Table 5. Hunter ranking of management practices for improving hunting in Vermont.

Control and importance	Weighted factor rank
Very important (7,337-9,783)	
Controlling deer-killing dogs	8,678
Enforcing the law	7,956
Important (4,891-7,336)	
Stocking game species	6,177
Having limited anterless deer hunting	6,066
Improving habitats	5,943
Increasing land acquisition	5,462
Limiting number of out-of-state hunters	4,977
Slightly important (2,446-4,890)	
Controlling game management areas more	4,509
Improving access to hunting lands	3,699
Not important (0-2,445)	
Improving facilities	2,101
Other	1,584

A surprising result of this questioning was the importance given to limited antlerless deer hunting. This response testifies to the Vermont hunter's knowledge of deer management practices but was unexpected in light of the controversy on antlerless deer hunting described earlier in this paper. This response also testifies to the importance of sampling hunter opinion on management practices because the post-1971 feeling among legislators was that the majority of Vermont hunters were opposed to antlerless deer hunting.

The low ranking given to the development of more game management areas and improved access to hunting lands reflects the low use rate at management areas (only 13 percent of the hunters surveyed in 1974 indicated that they had used these areas) and the extensive road system that exists throughout the state.

The management implications of these findings are rather clear. Hunters want more game and more publicly owned hunting land, and they strongly support the diligent enforcement of game laws and regulations. Management practices that meet these criteria will receive strong support from the Vermont hunter.

Conclusions

This discussion has focused on the management implications of specific hunter attitudes and characteristics obtained in a 1974 study of Vermont hunters. An effort was made to objectively interpret the data and to suggest ways that it might be effectively incorporated into game-management practices. This departure from the protective cover of objectivity was undertaken to stimulate interest in the extension of behavioral research findings beyond the descriptive state. I feel that researchers have a professional obligation to become active participants in the practical interpretation of their research. Without such participation, behavioral research on hunters will largely remain an academic exercise in futility.

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Managing Fish and Wildlife on Private Lands

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Wildlife Habitat—The "Price-less" Resource Base

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Twenty years ago, in two landmark papers, Jack Berryman outlined the need for a new approach toward wildlife habitat preservation. (Berryman 1957, 1958) Alarmed by the expansion of ever more highly mechanized agriculture, and concerned over the failure of then existing systems to cope with the problem, he laid out in general terms a strategy for the introduction of the profit motive into wildlife management systems. What has happened in these two decades? Did anyone heed Berryman's advice? Has wildlife habitat destruction been halted—or even slowed? This paper reviews the current situation with respect to wildlife habitat on agricultural lands, comments on what is being done, and proposes a new attack on the problem system. I acknowledge, with thanks, the advice and assistance of Berryman and Dale N. Martin of the U.S. Fish and Wildlife Service and the several state officials and wildlife managers who supplied information on their programs.

Travel in this jet age gives the effect of seeing the earth through the wrong end of a spyglass. Details are lost to the viewer. To appreciate what has happened to wildlife habitat, one should travel off the interstate highways and take a close view of the rural scene. To one who sees modern agriculture through the eyes of a small game hunter, or those of a naturalist, the scene is disturbing. We are indeed facing the disappearance of much wildlife habitat, and along with it wildlife and the hunting opportunity that many have enjoyed for the past hundred years or so.

In the Delmarva peninsula, the flatlands are low and sandy and ideal for corn and bean production. These lands have been covered with brush and timber for the better part of two centuries. Today, bulldozed windrows of stumps and brush take the place of the forests; they, too, soon disappear and heavily fertilized fields take their place. The homes of all the species of wildlife we have taken for granted disappear.

In the south, stimulated by the growing demand for paper and foodstuffs, thousands of acres have been converted to the monocultures of pulpwood and cash crops, notably soybeans. In the midwest, what were but a decade ago lush rolling grasslands now lie fallow in winter, black deserts attesting to the new economic mandates of an ever more artificial agricultural technology based on high energy demands, intensive fertilization, chemical weed control, and lots of capital.

Everywhere, land, whether of value to wildlife or as cropland, is being steadily consumed by the assumed essentials of modern life: sprawling cities and suburbia and the highways that have made the modern city both a marvel and a menace (McConnell and Harmon 1976). The fact that these changes in the use to which we have been putting our land are actually occurring is substantiated by a comparison of the Soil Conservation Service's 1976 Potential Cropland Study compared with the 1967 Conservation Needs Inventory. This comparison shows that, in fact, America's cropland has declined from 431 million acres in 1967 to 400 million acres in 1975. Pasture and range has increased from 507 million acres to 570 million, and the land devoted to forests shrank from 445 to 375 million acres. The category "other," which includes urban and water areas, increased from 57 million to 93 million acres. The study further indicates that we are losing 2 million acres of cropland per year to the cities: 1 million that is used for construction, and another million that is "leap-frogged" and made unusable for agriculture by the extended and irregular growth of our cities and towns (Didericksen 1976).

Alarming as these figures are to those who are concerned about America's ability to feed itself, let alone the world, they fail to portray an adequate understanding of the impact of the changes both qualitative and quantitative, on wildlife habitat. It is not just that cropland is disappearing—the fencerows are going with it. In the diminishing hardwood forests the emphasis on fiber production means the loss of den trees, mast producing trees, and the other components that go to make up a diversified and productive wildlife biota.

Many have viewed these trends with alarm in the period since World War II, but there still seems to be a relatively complacent attitude on the part of sportsmen, wildlife professionals, and administrators that suggest we do not understand the size or the urgency of the problem of disappearing habitat on private land.

On public land it may be a different matter. Last year Congress legislated to require an interdisciplinary approach toward management of the national forests that may result in more wildlife habitat. Too, there is hope that the so-called Bureau of Land Management "Organic Act" may move that agency in the direction of a broader perspective toward its responsibilities and result in better wildlife conditions. But these lands are public lands, in the West predominately, and will probably continue to produce game and non-game species on into the future. Furthermore, unless the current anti-hunting movement succeeds, these vast areas of public real estate, and indeed privately-owned forests as well, should continue to serve as wildlife habitat and to furnish hunting opportunities ad infinitum, (Jahn and Trefethen 1974, Cochran 1976).

Alas, the future for wildlife on the agricultural lands of the central, eastern, and southern states, not to overlook the farmed valleys of the West, is at best uncertain, and at worst may be the catastrophe that many envisage.

Compelling evidence of the validity of these apprehensions and the gravity of the problem may be gained from statistics from Illinois, the heart of the farm belt.

In 1960 hunting license sales were 471,398 but declined to 427,404 by 1969 (Moak 1971). Partly because of the continued low cost of an annual license, three dollars, the license sales returned to approximately 475,000 in 1975.* Even more compelling documentation of the status of wildlife is the record of the rabbit harvest: 6,445,000 in 1957, 2,311,000 in 1969, 1,400,000 in 1974, the lowest since records have been kept, and 1,700,000 in 1975* (Moak 1971). In 1939 Yeatter and colleagues did a study of habitat and small game on a 1,117 hectare tract in south-central Illinois. Vance (1976) has recently reported on a resurvey of the same area done in 1975. He reports grass and brushland eliminated and fencerows reduced 84 percent and of lower quality. The bobwhite quail population was only 20 percent of previous estimates, and the count of rabbits was less than 4 percent of the previous tally.

Human Population: the Root Cause

What are the causes of this dilemma? First and foremost, of course, is the fact that our own population stands at 215 million and while it doubtless will continue to grow at a decreasing rate, demographers tell us that there are enough new people "in-the-tube" to push our population toward 300 million by the end of the century. That means there will not only be that many more people to feed, clothe, keep warm, and entertain but that we must do this with a shrinking land base.

A look at the world population is still less comforting. We have passed the 4 billion mark. It has taken us since the beginning of man's evolution, a million years more or less, to reach the first billion. We gained the next billion in only 125 years, the third in about 45 years, and the fourth in 15 years. The predictions are that the next billion will take no longer (Cook 1976). To make these relationships easier to visualize, one can use a distance scale, with each year represented by a millimeter. The first million years and billion people would then be equal to a kilometer; the second billion to 125 millimeters (ca. 5 in.); the third billion to 45 millimeters (ca. 2 in.) of space time; and the fourth and the last billion to but 15 millimeters or slightly more than half an inch!

A world population of 5 billion will intensify the demand that every square inch of land be put into the "highest and best" use from a survival standpoint, that is, production of food and fiber. Still, if we apply ourselves to the problem, we may be able to postpone the day when wildlife in our agricultural areas has disappeared. Given the fact that there will always be land that cannot reasonably be farmed there may well always be a few places left for the wild things.

Characteristics of the American Hunting System

Another factor responsible for the decline of farm game is the concept of "free hunting." Our pioneer forefathers grew up in a vast land in which the land-people ratio virtually guaranteed a free ticket to a wilderness feast. By the coming of the 20th century this cavalier attitude was on the verge of doing away with the last vestiges of America's outdoor heritage. We have lived through the period of the restoration of many game animals, but today the concept of "free hunting" is a major factor in the disappearance of farm wildlife habitat. It is a concept that promotes the illusion that paying the license fee guarantees both game in the bag and a place to bag it and denies the landowner an incentive for maintaining habitat.

*Jack Ellis 1977: personal communication.

It is a bankrupt concept that prevents any but an intangible return on lands devoted to wildlife habitat.

Finally, wildlife habitat is "price-less." Since its product has no place in the commercial markets under American custom and law, it has no commercial value in dollars and cents. Wildlife habitat is then, in effect, a common property resource in the sense that while it is owned by an individual, it is used and enjoyed by the public. Since those who profit from its existence have no legal obligation for its stewardship, they contribute nothing to its preservation. The actual owner, unless motivated by esthetic considerations, bears the burdens of ownership with no compensation. Indeed, to the extent the habitat is an attraction to hunters, hikers, bird-watchers, or any other category of citizens who frequently trespass in the pursuit of their pleasures, habitat becomes a positive liability. When the trespassers are the dregs of the hunting fraternity, ignoring the most elemental concepts of courtesy and behavior, wildlife habitat becomes a positive threat to the owner's peace-of-mind and his property as well (Harmon 1976).

All of these trends and concepts are well known and also generally understood, at least among the ranks of professional land, timber, and wildlife managers and have been since at least the time of Jack Berryman's papers. But what has happened in the interim? Habitat is still disappearing at an alarming rate. Small game hunting opportunities and numbers of small game hunters are dwindling. Habitat for non-game species, often more fragile than that for game species and usually less effectively protected, is perhaps disappearing more rapidly than game habitat.

State Programs for Hunter Access and Farm Game Habitat

Fortunately, several states have active programs of habitat protection in operation and several more are in the process of organizing new efforts.

The Pennsylvania Game Commission reports that "There is a growing interest across the country, especially in the midwest, in doing something for farm wildlife habitat, judging from the inquiries we have received in the last couple of years."* To a significant degree, these programs are aimed more at keeping land open to hunting than they are at protecting habitat or encouraging farm practices beneficial to wildlife. Pennsylvania, where the Cooperative Farm Game Program began in 1936, now boasts a statewide effort that involves 16,000 landowners in 172 projects covering 2 million acres of land. Under this program the landowner gives the game commission control of hunting rights for 5 years, in return for which the landowners are given free signs, increased patrol by enforcement officers, advice and instruction in habitat management, stocked game, seeds and seedlings, forest edge thinning, and a free subscription to the Commission's magazine, *Pennsylvania Game News*. In the companion Safety Zone Program an additional 2 million acres have been opened to public hunting merely by providing posting signs and a free subscription to the magazine. Additionally, the Commission has embarked on a forest game program with large timber land holders, that provides technical advice, posting signs, and increased warden patrol. The forest game program now covers over one-half million acres of forest land open to hunters.

New York has established 45 Cooperative Hunting and Fishing areas comprised of 450,000 acres under the Fish and Wildlife Management Act. The state offers posting, patrol, parking areas, regulation of hunter numbers, and advice on habitat

*John Doebling 1977; personal communication.

improvement in return for permitting hunting. Nevertheless New York is experiencing a continued decline in the amount of land open to hunting and an increase in the number of hunters. In the past 20 years, the hunting population has grown from 1,750,000 to 2,500,000, an increase of 42 percent. A further complication is that today's hunters spend twice as much time afield as formerly. New posting of land against hunting is occurring at the rate of 500,000 acres each year. At this rate there will be no private land available for hunting by 1990 (Kelsey 1977).

At a workshop on fish and wildlife on private land held at Des Moines in 1971, the Ohio Cooperative Hunting and Fishing Program was reported to have grown from 3,445 acres in 1961 to 597,044 acres in 1971, covered by agreements with 3,201 landowners (Keener 1971).

At the same workshop, Minnesota reported on Operation Pheasant, a project designed to acquire prime pheasant coverts in six sample areas of 36 square miles (138,240 Acres) each at a cost of $200,000. South Dakota's Wildlife Habitat Improvement Program had enrolled 75,955 acres in 178 areas under a plan which combines the resources of the federal and state governments and the landowner in habitat protection and improvement. The Agricultural Conservation Program paid 60 percent of costs, the state wildlife agency 24 percent, and the owner contributed 16 percent (Jackson 1971). Apparently not everyone is satisfied with the results from this program because the South Dakota Pheasant Congress has gone to the legislature with a request for an immediate appropriation of $250,000 and a $5 pheasant hunting stamp that would be required by all pheasant hunters for the leasing of pheasant wintering habitat, stocking, and predator control (Johnson 1977).

Michigan, with more than 6.5 million acres of public lands open to hunting, nevertheless started a farm game program in the agricultural region of the lower peninsula in 1936. This was the widely heralded Williamston Plan, designed to provide both habitat and hunting opportunity to the vast bulk of Michigan's population living in the lower third of the state. In 4 years 116 clubs had been enrolled for a total of 500,000 acres. The Williamston Plan had faded away to eight clubs and 22,000 acres as of 1976, a casualty of a declining pheasant population and changing priorities.* Last year Michigan obtained a $1 increase in the price of the small game hunting license, the $300,000 proceeds from which are scheduled to be used in payments to landowners primarily for hunting rights.**

Across Lake Michigan, Wisconsin's dependence on easements as the means of dedicating land to fish and wildlife purposes likewise has dwindled away, the victim of rapid changes in landowners and preferred uses. While the state continues to buy land for stream fishing and wetlands protection, it has turned to acquisition by fee of lands that have value for wildlife and hunting. More than 400,000 acres in public ownership are available as wildlife and hunting areas; and nearly 75,000 acres are covered by stream access easements. Additionally, Wisconsin participates in "Acres for Wildlife," a scheme that involves volunteer improvement for wildlife purposes; and recently the Department of Natural Resources has embarked on an experimental program dubbed Project Respect, a multi-faceted approach toward habitat improvement and protection that involves

*Charles Schick 1977; personal communication.

**Arlow Boyce 1977; personal communication.

the use of various techniques to provide incentives for wildlife related activities.***

The human congestion of New Jersey is legendary. Few outside that densely populated, highly industrialized state realize the continuing interest in hunting and outdoor pursuits that thrives there. In recent years the hunter access problem has shifted from the closing of individual farms to the closing of entire townships. Court decisions make clear the authority of the state to regulate the taking of fish and wildlife, but local officials sometimes have used the pretext of control of the discharge of firearms to restrict hunting. Local sportsmen and wildlife authorities started "Operation Good Neighbor," a variant of the Pennsylvania Safety Zone concept. In one township, Denville, there were 26 complaints of hunter behavior before the program went into effect, 2 in the year following. State officials estimate that in 17 of 21 counties "Operation Good Neighbor" kept the townships open to public hunting (McDowell and Applegate 1976).

In another significant habitat protective measure in New Jersey, non-profit landholding organizations have been given real estate tax relief under the Green Acres Tax Exemption Program. By making their lands available for public recreation and nature observation, 10 such organizations have been certified as eligible for a total of $84,000 of local tax exemption. The total area now included in this program amounts to 10,600 acres (Anon. 1976).

Recent entrants into the farm game habitat protection arena are Missouri and Nebraska. In Missouri's last election, the voters approved a referendum that adds one-eighth of 1 percent to the state's sales tax, with the proceeds earmarked for executing the Missouri Conservation Commission's long-range development program. While the greater portion of the $18-20 million annual revenue will be put in land acquisition and facility rehabilitation and development, a substantial portion will be devoted to the farm game habitat program.*

In Nebraska the legislature has approved a $7.50 habitat stamp that will be required of most hunters. An outgrowth of the 1975 Nebraska Habitat Conference, the habitat stamp, and other fee increases are expected to generate $2.5 million annually. Of the total, 34 percent or $362,000 is scheduled to be applied to habitat improvement on private land, with $500,000 coming directly from the Habitat Stamp. The program will be administered through the state's natural resource districts on a cost-shared basis. Land acquisition will be allotted $776,000 with another $500,000 from the stamp fund, and $345,000 will go toward easements to preserve streams, wetlands, farm pond habitat, and related activities. The habitat improvement fund is designed for just that, rather than for hunter access, with the decision to permit hunting to rest with the landowner. If the landowner elects to permit hunting, the Game and Parks Commission is authorized to pay up to $2.50 per acre for the privilege. Cost sharing with the natural resource districts will normally be on a 3 to 1 basis, so that if the full $862,000 is available, the districts would contribute another $287,000 for an annual total of $1,149,333 devoted to habitat enhancement on private land (Edwards and Huff 1976).

Obviously, the examples I have cited are not a complete listing of what is happening across the country in the protection or improvement of wildlife habitat.

***John Keener 1977; personal communication.

*Carl Noren 1977; personal communication.

Indeed there are very significant omissions, such as a description of the unique role of hunting in the agricultural economy of Texas. But the examples suggest that there is a growing understanding of the problem and a concurrent willingness to cope with it.

More Must be Done

Analysis of these programs and public reaction to them leads to the conviction that they can be made to work—if given sufficient emphasis in terms of education of hunter and landowner, of continuity of contact by technicians and of executive leadership. Certainly what the landowner gets in most existing programs, to be realistic, is little more than cosmetic, and relates much more to hunter behavior than it does to wildlife. That most farmers are not antagonistic to wildlife or hunters per se is demonstrated many times over every year. Farmers characteristically have enjoyed congenial contact with responsible and courteous sportsmen. There is no reason to think they have changed. On the other hand, in areas within commuting distance of metropolitan centers more and more land is being taken up by non-farmers, usually absentee. Many of these owners acquired their property with a definite bias against hunting and trapping and have no intention of permitting any direct molestation of wildlife in any way.

In general, there is no reason to expect that those farmers with a welcoming attitude toward wildlife would not do more for wildlife—and the hunter—if there were a more reasonable incentive. Forty years have elapsed since the states first recognized this problem and began to cope with it. Yet, habitat destruction escalates in agricultural areas. Twenty years have elapsed since Berryman laid out a plan for coping with a trend that can have but an unhappy ending, and six years have gone by since the Fish and Wildlife Service and the Iowa Conservation Commission assembled a group to discuss the situation. Today the issue is more alive, the challenge more explicit, and the result of continued inactivity more apparent, than it has ever been.

It is not enough at this crucial stage to ask why nothing more is being done in more states. We must begin to address the solution, to begin to do something, to act!

It is not as though we were adrift without a concept of what must be done. The literature on the subject lays out a course. Several states have already embarked on it, albeit in a rather tentative way.

It is not that the thinking sportsman lacks an understanding of the dilemma. He is ahead of us on this issue.

Our obstacle is our unwillingness to seek a change in the basic American system. Complacency is the dryrot of any enterprise. We in the fish and wildlife management field must come to terms with the stark and unavoidable reality that unless we take drastic action soon to preserve habitat, a treasured way of life, a heritage of nature, a priceless resource will have been lost.

We will need to accept the fact that in the more populous states it will no longer be possible to suggest to the public that there is a place afield for every would be hunter.

We will have to begin to give hunters a more realistic estimate of the real costs of providing wildlife habitat in competition with other land uses that have driven the cost of farm land to 2 and 3 thousand dollars per acre.

We will have to intensify our efforts to show the farmer that we too are concerned with and about his problems in dealing with wildlife and hunters.

We will have to share the responsibility for wildlife with the non-hunter elements in society in order to secure their support for a productive and useable wildlife resource.

These things can be done. It will take imagination, energy, initiative, patience, and determination. We will have to change laws and pass new ones. We will have to educate, to train, to engage the farmers and hunters together on a mass basis. We will have to work out a whole bureaucratic system to guide, control, and report on the needed effort.

We will have to find ways to change federal farm programs to make them supportive of wildlife instead of destructive.

We will have to make the point that in protecting game habitat we will in large measure be saving the habitat for many kinds of non-game species.

We will have to establish taxation systems that put a premium on wild areas and acres devoted to wildlife management; seek authorization for taking wildlife easements instead of resorting to land purchase; to work with farm organizations to establish the direct lines of support to the farmers.

What must be established is a new system to deal with these problems. I believe the International Association is the logical means by which this new system can be started. It should begin with a session devoted to the detailed analysis of the problem and a review of past and present experience at one of our annual meetings and at the regional meetings; the establishment of a steering and coordinating committee composed of representatives of the various interests; and out of this a plan of action involving an intensive and coordinated national program to explain the problem and define the solutions.

Obviously, all this means a revolution in thought, policy, and action relating to farm wildlife conservation. All of those devoted to wildlife's existence, now and in the future share the ultimate responsibility, be they sportsmen, nature students, scientists, conservationists, whatever. We must find ways to work together—farmers, landowners, wildlife biologists, hunters, governmental agencies at all levels—if this resource at once priceless and "price-less," is to be saved.

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National Evaluation of the Water Bank Program

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Introduction

The Water Bank Program was established in the Department of Agriculture to help preserve wetland habitat areas used by migratory waterfowl for breeding and nesting.

Congress first appropriated funds for the Water Bank Program in FY (fiscal year) 1972. In every year since, the president and the Congress have disagreed over the priority of the Water Bank Program within the scheme of total federal expenditure activities. Finally, along with the appropriation for fiscal year 1976, came a congressional directive for the USDA to evaluate the Water Bank Program within the context of the need for wetland preservation. This paper summarizes the results of the analysis that was provided to Congress.

Conceptualizing the Problem

In a market economy, the mechanism that allocates productive resources for maximum output value is the price system. When the income that can be earned by employing an additional resource unit is greater than its price, then a firm or business will purchase that added unit of input. Prices are the only economic information needed to make efficient allocative decisions.

However, wetlands represent a situation where the market economy cannot be relied upon to attain the goal of efficient resource allocation. The market fails because not all of the consumer products that are created from wetlands can be exchanged in the marketplace. Products that have a market price, such as agricultural crops, residential housing, and industrial plants, can utilize drained wetlands. On the other hand, wildlife, flood control, pollution control, erosion control, and groundwater recharge are all wetland products that have no market price.

These unpriced products all have a value to consumers, but they are not exchanged in the market economy. A landholder may provide the community with added waterfowl, flood control, pollution abatement, and reduced sedimentation, but he does not have exclusive possession of these products, and therefore is not able to require compensation from consumers.

Landholders are able to earn revenue by converting wetland into cropland through the installation of drainage systems. But once drained, the wetland no longer supplies its former benefits, such as wildlife habitat. This incompatibility among alternative wetland uses is not an unusual circumstance for a production resource. In fact, such choices are the essence of economics. So, the fact that wetland is being drained is not necessarily a misallocation. But unfortunately the market system does not generate the information needed to make allocative decisions that will maximize both the market and nonmarket value of output for society. It is not at all obvious from market prices whether a unit of wetland should be used to produce waterfowl or be drained to produce agricultural crops.

Even though the proper wetland allocation is not obvious for society, individual landholders have little difficulty in determining what allocation is most profitable for them. For many, the choice has been to drain the wetland. Very possibly, such actions may be a misallocation of society's resources. But, at this point, we do not have enough information to know.

Measures of Wetland Drainage

Wetlands are an essential link in the habitat requirements of migratory waterfowl, which include breeding, migratory, and wintering habitat. Nearly all migratory and wintering habitat used by waterfowl exists within the United States, making it possible for some 2.25 million hunters in the United States to acquire 75 percent of the waterfowl harvest—from 15 to 20 million ducks each year.

In years when water is not scarce, about 70 percent of the continental waterfowl population nests in the prairie and parkland habitat of western Canada. A part of this important prairie breeding area—the prairie pothole region—extends into the United States, and spreads over approximately 89,800 square miles (232,582 km^2) of North Dakota, South Dakota, and Minnesota. Potholes in this region that are made up of Types III, IV, and V wetland are especially critical habitat for breeding and nesting, as some 18 percent of the breeding ducks nest in this area.

Wildlife biologists contend that the limited supply of breeding and nesting habitat is constraining present waterfowl populations. Therefore, any loss of this habitat has a negative impact. But while waterfowl populations are being constrained by the amount of breeding habitat available, farmers are responding to the economics of agricultural production by more intensively utilizing their land. Even where wetland is not being drained, adjacent land that once served as nesting habitat is being cultivated. This conversion of breeding habitat to cropland is taking place most rapidly in the United States and to a lesser degree in Canada.

Based on a roughhand calculation, the Fish and Wildlife Service estimated that 5 million acres (2 million ha) of valuable wetlands in the United States are protected by public ownership while 15 million acres (6 million ha) of key habitat remain vulnerable to destruction (Peoples et al. 1975).

Surveys of the prairie pothole region indicate that prospective economic returns have been attractive enough to induce a high rate of privately financed wetland drainage. In 1964, the Bureau of Sport Fisheries and Wildlife surveyed 115 prairie pothole counties and measured 2,689,923 acres (1,088,612 ha) of Type III, IV, and V wetlands. The most recent data, covering 113 of these same counties, suggest that 2,466,871 acres (998,343 ha) remained wetlands as of January 1975 (U.S. Fish and Wildlife Service 1974, 1975a). So, over the past 10 years about 8 percent of the Type III, IV, and V wetlands have been drained. The loss rate varied by state, with Minnesota losing the highest percentage. Over the 10-year period, Minnesota lost 95,000 acres (38,447 ha)—28 percent of a 1964 base of 341,000 acres (138,003 ha). North Dakota lost 93,000 acres (37,637 ha) or 7 percent of a 1,367,000 acre (553,225 ha) base, and South Dakota lost 35,000 acres (14,164 ha), or 4 percent of a 983,000 acre (397,820 ha) base.

Wetland Preservation Programs

There are a number of ongoing programs designed to preserve wetlands and provide breeding habitat for migratory waterfowl. By far, the single most important program preserving waterfowl habitat in the pothole region is the Waterfowl Production Area Acquisition Program of the Fish and Wildlife Service. Of the 2.25 million acres (0.91 million ha) of publicly acquired habitat, 62 percent is held by the service as production areas. Water Bank, the most recent program, is the least significant in terms of acreage under agreement, covering only 9 percent of the total protected wetland.

The amount of remaining wetland in the region that is still unprotected from drainage can be roughly calculated from the data on protected habitat. Assuming that 40 percent of the federal refuges and state management areas are wetland, then approximately 1,513,616 acres (612,560 ha) of wetland are currently protected in the 113 county prairie pothole region. Subtracting the protected acreage from the estimate of total wetland leaves roughly 953,255 acres (385,782 ha) of Type III, IV, and V wetland still unprotected.

On land purchased by the Fish and Wildlife Service for waterfowl habitat, the government has full ownership control in perpetuity. There is complete certainty about tenure, and management alternatives can be applied to achieve an optimum level of wildlife production and protection. A land purchase program provides the best protection against wetland drainage and it offers the greatest potential for wildlife production. Associated with ownership, however, are the added costs of development, management, and maintenance.

So far, the Fish and Wildlife Service (1975b) has acquired more than 4.1 million acres (1.7 million ha) in the national system of migratory waterfowl refuges, including 342,396 acres (138,568 ha) in the pothole counties of Minnesota, North Dakota and South Dakota. Under the Waterfowl Production Area Program, 381,867 acres (154,542 ha), have been purchased with 92 percent of this acreage in the pothole counties. In addition to the fee purchase of land, the service has also acquired easements on wetland. Purchased in perpetuity, easements prevent the landholder, and all subsequent landholders, from filling, draining, or burning the area but do not provide for habitat management. This approach serves as a highly effective preservation program. But as a wildlife program, easements are less effective because they do not provide for improvement of adjacent upland habitat. So far, easements have been acquired on 1,033,126 acres (418,106 ha) of wetland, of which 99 percent is in the pothole counties.

USDA's Water Bank Program simply leases waterfowl habitat for 10-year periods. In compliance with the terms of the lease agreement, the landholder develops habitat on upland acres adjacent to wetland, and protects both the upland and wetland for waterfowl. In return for providing and protecting habitat, he receives an annual rental payment.

From FY 1972 through FY 1976, Congress appropriated $42,143,530 to the Water Bank Program. Of this total, $23,236,474 has been used in payments and obligations, leaving $18,907,056 for acquiring future agreements. As of October 25, 1976, 3,288 agreements were in effect, covering 297,532 acres (120,411 ha) of waterfowl habitat. Wetland accounts for 93,137 acres (37,693 ha), and the remaining 204,395 acres (82,719 ha) are adjacent upland habitat.

The average annual payment for all existing Water Bank Agreements is $10.18 per acre ($25.15/ha). Along with higher land values, the cost of Water Bank agreements has increased over time. The average payment rate for agreements originating in 1972 is $8.44 per acre ($20.85/ha), whereas those agreements taking effect in 1977 cost $13.28 per acre ($32.81/ha). This increased cost amounts to an average annual escalation of 9.5 percent per year. Putting all of the remaining unprotected wetland in the prairie pothole counties under Water Bank agreements would cost an additional $40,440,707 per year, based on the current cost of new acquisitions and assuming the ratio of upland to wetland remains at 2.2 to 1.0.

The Water Bank Program can be highly effective as a waterfowl production program if it leases only excellent habitat, but it is much less effective as a wetland preservation program. Under a Water Bank agreement, preservation is assured for no more than 10 years. Even during the term of the agreement, the only penalty for drainage or habitat destruction is the loss of future rental payments and possibly the refund of previous payments to the government. Also, the agreement is not binding on a new owner if the land is sold. To emphasize the temporary nature of Water Bank agreements, one need only point out that 11.8 percent of the agreements, involving some 23,000 acres (9,308 ha), have been terminated. Whether the habitat on this land has been destroyed and the wetland drained is unknown, but the habitat is no longer protected.

Evaluation of Water Bank

Benefit-Cost Analysis

As a rational economic policy, the value of benefits derived from the acquired wetland should always exceed the acquisition payment level. If the administered price is set higher than the value of wetland, resources will be misallocated. As a practical matter, administered prices are set in relation to the opportunity cost of the land's market uses. The payment level of Water Bank agreements is set to have a competitive edge over alternative uses of the land, based on such key factors as land rental rates and the soil's productive capability.

By setting the price for waterfowl habitat higher than competing economic uses, wetland acquisition programs such as Water Bank are assured of attracting landholders. In this respect, the acquisition programs become an artificial market for wetland benefits, offering landholders an economic alternative to drainage and crop production. But, because the administered price is not directly related to the value of waterfowl and other wetland benefits, program costs could possibly exceed benefits.

The primary goal of the Water Bank Program is to preserve breeding habitat for waterfowl and thereby sustain a high level of annual duck production. So to measure benefits from the program it is necessary to determine the program's contribution toward producing ducks. In addition, cost-effectiveness in program management depends on obtaining the most productive habitat per dollar cost.

No data are available on the Water Bank Program's actual contribution to waterfowl production, so this analysis reviews existing research studies that are most closely applicable to Water Bank acreage. Water Bank is probably most comparable to the idled cropland planted to grass-legume mixtures studied by the Northern Prairie Wildlife Research Center. Water Bank acquisitions consist of both wetland and adjacent upland, and the upland must comply with the habitat specifications set by the Soil Conservation Service. In many instances, the landholder is required to develop the habitat by planting a grass-legume mixture.

Given the location of the program's acquisitions and the specifications that must be satisfied, it is reasonable to classify Water Bank agreements as high quality waterfowl breeding and nesting habitat.

In the economic research conducted by Hammack and Brown (1974) the authors used a production figure of 2.7 ducklings per habitat acre (6.7/ha). This figure is equivalent to 4.5 birds per upland acre (11.1/ha) and 6.7 birds per wetland acre (16.6/ha) (assuming a 60 to 40 percent mix in habitat composition). Published research from the Northern Prairie Wildlife Research Center confirms the acceptability of this production figure. Nelson and Duebbert (1973) report that nest densities of 0.5-1.0 per acre (1.2-2.5/ha) and up to 75 percent nesting success in good quality cover were found in large-scale studies between 1965 and 1973. To the authors, this outcome provides hope that lands managed for waterfowl production will produce one or more nests per acre with a nest success of 70 percent or more. Kirsch (1975) relates that high quality grass legume fields with agricultural activity produced as many as 857 ducklings per square mile (331/km^2). Based on information available, Kirsch suggests that a production goal of five ducks per acre of upland habitat is not unreasonable for managed areas.

So 2.7 ducklings per habitat acre (6.7/ha) seems to be a valid production figure for Water Bank acreage. However, crediting the Water Bank Program with this production level implies that the ducks using the protected habitat would otherwise be eliminated from the breeding population. In fact, the ducks would select a less satisfactory alternative nesting habitat. Therefore, this production figure exaggerates Water Bank's contribution to the total duck population, but any adjustment in the number would have to be arbitrary.

Given an estimated level of duck production, the next step is to establish a value on waterfowl. There is no market where consumers can purchase the various uses of waterfowl, whether for hunting, photography, sight-seeing, or education. In the absence of market-generated prices, the value of ducks must be estimated. A hunter survey conducted by Hammack and Brown (1974) provides an approximate value for shot waterfowl. The authors surveyed Pacific Flyway hunters in 1969 and calculated what they refer to as a "first approximation of the willingness-to-pay consumer's surplus." The analysis shows a value of $3.29 per waterfowl in the hunter's bag.

The Fish and Wildlife Service expanded on Hammack and Brown's approach to include all major flyways in the United States. The result is a 1970 weighted average value of $3.68 for each waterfowl bagged in the Central and Mississippi Flyways (Peoples et al. 1975). Inflating this value by 27 percent—to reflect the increase in the consumer price index from 1970 through 1974—results in a 1975 value of $4.67 for each waterfowl bagged.

With duck production estimated at 2.7 per acre (6.7/ha), the hunters' bag would be 1.64 per acre (4.05/ha). This calculation, used by Hammack and Brown, assumes that 24 percent of the new production must be retained as breeding stock to offset natural mortality and that 20 percent of the birds shot are not recovered by hunters. If the value of an additional bird to waterfowl hunters is $4.67, then the value of Water Bank habitat to these hunters is $7.66 per acre ($18.93/ha). By itself, this benefit level compares unfavorably to a Water Bank outlay of $9.03 per acre of habitat ($22.31/ha) or $5.51 per duck in 1975. The ratio of hunter benefit to program cost is 0.85. There are two important qualifications, however, making it inappropriate to judge the program as non-economic.

First of all, the choice of a production estimate of 2.7 ducklings per habitat acre (6.7/ha) is not made with a high degree of certainty. At the same time, the value of hunter benefit is highly sensitive to the level of production. If production is raised to 3.2 ducklings per acre (7.9/ha) with a hunter bag of 1.95 per acre (4.82/ha), the level of hunter benefit exceeds the program cost.

Secondly, there are other benefits that have not been included in the estimated value of waterfowl habitat. In addition to hunters, photographers, bird watchers, and naturalists are consumers of waterfowl. Wetlands also provide flood, erosion, pollution, and sedimentation control, and groundwater recharge. These benefits are widely recognized in land use planning activities and resource development projects, but researchers have not yet valued these wetland uses.

Examination of the program's benefits and costs raises another economic issue. Waterfowl hunters are a primary beneficiary of the Water Bank Program. In fact, their consumptive use of waterfowl prevents any further nonconsumptive enjoyment by other users. Yet, only to the extent that waterfowl hunters also pay taxes do they help pay for the program. In effect, they are being subsidized by the taxpaying public. The same distributional problem exists with other program beneficiaries, but the issue is more acute for hunters because they are the program's intended beneficiaries and are readily identifiable and can be easily assessed.

Failure to charge waterfowl hunters anything less than the full cost of producing the bagged waterfowl creates an imbalance between demand and supply of waterfowl. Demand will always appear to exceed supply and hunters will continue to pressure the public sector to increase the number of waterfowl. In the case of migratory bird habitat acquired by the Fish and Wildlife Service, hunters pay part of the cost through mandatory duck stamp purchases. But in the case of the Water Bank Program, there is no direct hunter contribution.

Comparative Cost Analysis

Because the waterfowl production goals of the Fish and Wildlife Service program and Water Bank are identical, it is legitimate to compare the cost of acquiring wetland habitat under the different programs. The most simple and superficial comparison is the acquisition payment level. Annual lease payments made by the Water Bank Program are not directly comparable to purchase payments made by the Waterfowl Production Area Program. With some simplifying assumptions, however, the annual payments can be converted to a present value lump sum payment. Assuming a 50-year lifespan and a discount rate of 6.375 percent (the rate used by the Water Resources Council for water projects), the present value lump sum cost of a Water Bank agreement in the prairie pothole region is currently \$201 per acre (\$497/ha). Using a discount rate of 10.0 percent (the rate required by the Office of Management and Budget on all non-water projects), the present value lump sum cost is \$133 per acre (\$329/ha). In comparison, the current average cost of a wetland easement is \$140 per acre (\$346/ha). Fee purchases in the pothole region average \$268 per acre (\$662/ha).

This superficial comparison shows fee purchases to be the most expensive acquisition while Water Bank leases and wetland easements are nearly equal in cost. But it ignores the important differences in tenure associated with each type of acquisition. Finally, any cost comparison fails to consider differences in the number of ducks that might be produced from each type of acquisition.

Management Analysis

Whether the level of benefit created by the Water Bank Program is as high as possible is a function of program management. In this area, several weaknesses reduce the program's effectiveness in accomplishing the goals of the Water Bank Act. Corrective action has already been taken to solve some problems, but others continue to detract from the program's effectiveness.

The preservation of wetland, which is basic to the continued production of waterfowl, is hampered by two circumstances. First, Water Bank agreements have been terminated prior to the contract expiration date. Second, Water Bank agreements have been made on wetland with little likelihood of ever being drained.

After four years of operation, 11.8 percent of the agreements had been terminated; a weighted average annual rate of 3.5 percent. If terminations continue at this rate, only 65 percent of the original 1972 agreements will be in effect at their expiration date, December 31, 1981. If expired contracts are renewed but terminations continue at 3.5 percent per year, it will take only 29 years for all the agreements made in any single year to be ineffective.

Neither is preservation accomplished when Water Bank agreements are initiated on wetland that would not be drained in the absence of protective measures. An internally conducted audit revealed a high incidence of just such agreements in Minnesota. Under new procedures set up in 1976, the Soil Conservation Service is required to assess each agreement application to determine the threat of drainage. Priority in the approval of agreements is given to the most susceptible wetland. However, an exception to this priority system exists because of a requirement in the law. The Water Bank Act specifically states that a landholder participating in the Water Bank Program shall not be excluded from other wetland protection programs. This has been interpreted to mean that wetland already protected from drainage by other programs remains eligible for a Water Bank agreement. No preservation benefit can be credited to the Water Bank Program by either enrolling a landholder who has no intention of draining the wetland or by obtaining wetland that is already protected by another preservation program.

Besides wetland preservation, the Water Bank Program is designed to supply productive nesting and breeding habitat. Simply protecting an area of wetland from drainage does not insure that ducks will be produced for the benefit of waterfowl consumers. Two circumstances indicate the Water Bank Program is not making a maximum contribution toward waterfowl production. First, 17 of the participating Water Bank counties are not considered by the Fish and Wildlife Service to be significant locations for habitat preservation. Either the habitat is not biologically useful for breeding and nesting or there is little threat of habitat loss. Secondly, under drought conditions more than 17,000 acres (6,800 ha) of Water Bank Program habitat was released for haying and grazing in 1976. In this instance, the program has failed to protect the habitat in a manner most conducive to duck production.

Placing the Water Bank Program in the Department of Agriculture has also had an impact on administrative performance. The prime responsibility of the Department of Agriculture is to create and maintain the economic and technological conditions that will assure efficient production of abundant supplies of agricultural products. The use of potentially productive cropland to produce ducks for sport hunters is not especially consistent with this departmental mission.

In 1970, a program that would "reduce acres of new land coming into production and . . . . retire lands now in agricultural production" (Water Bank Act) was perfectly consistent with other agricultural programs and policies. After 1972, when surpluses were eliminated, land retirement had little appeal to either farmers, consumers, or taxpayers. The major efforts of the USDA have since been to strengthen markets for agricultural products and to minimize government involvement in farmers' decision making. At the same time, all federal agencies have attempted to hold down government spending. The most obvious consequence has been the comparatively low budget priority given the Water Bank Program. In three of the past five years, executive branch action has been taken to reduce the budget for the program.

The department's agricultural production and farm income interests also are apparent in other management actions. The decision to release Water Bank acreage for haying and grazing is one example. Another example is the ease with which landholders can terminate their contracts without having to reimburse previous payments.

The evidence indicates that the Water Bank Program can be more effectively managed to achieve the goals of the Water Bank Act. One avenue for improving program performance is to improve coordination of the Water Bank Program with the broader scope of activities carried out by the Fish and Wildlife Service. In particular, the several land acquisition programs should be consistent and complementary to one another in accomplishing the goals of wetland preservation and waterfowl production.

Two obvious alternatives would improve coordination between the acquisition programs. One approach is to increase cooperation between the Department of Agriculture and the Department of Interior. The Fish and Wildlife Service could participate in the joint development of criteria and guidelines identifying the type and location of land that should be included in the Water Bank Program. Policy and budget officials could examine wetland acquisition programs as a single package and then divide funds for the various types of acquisition.

Another alternative is to shift the Water Bank Program to the Department of Interior. The advantage the Department of Agriculture has in dealing with individual landholders through its local offices need not be lost by such a change. The Agricultural Stabilization and Conservation Service could continue to perform local administrative duties under a cooperative agreement with the Fish and Wildlife Service. The benefit from this change would be the unity of policy, planning, and budget authority for all federal habitat preservation programs within a single management hierarchy.

Implications for Future Analysis

This evaluation report on the Water Bank Program has presented quantitative measures of benefits, costs, and the effectiveness of the program based on the limited information currently available. It should be viewed as an initial attempt to construct an analytic framework and, where possible, to fill in that framework with appropriate information. One constraint on the evaluation effort was a total reliance on secondary sources of information and data.

What is always enlightening about this constrained method of investigation are the information gaps and the shortcomings of previous research efforts in meeting the needs of public policy officials and program managers. Policy and management decisions have to be made, regardless of the quality or quantity of information available. What decision makers want is better information in the future than has been available in the past. For all government programs, legislators and government executives basically want to know, in the broadest terms: What are the benefits? What are the costs? Who receives the benefits? Who pays the costs? This report helps to partially answer these questions as they relate to the Water Bank Program.

The questions will continue to be asked in the future. Hopefully, the decision makers will be provided with better information than is currently available. The challenge to researchers is readily apparent: improve the quality of existing data, and even more important, begin filling in the gaps where information is absent.

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Public Access Hunting: A 1974 Pilot Study Evaluation

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Introduction

In New York, as in most eastern states, the majority of all lands, including those most productive of both agricultural and forest products, are privately owned. Since the greatest proportion of wildlife habitat and hunting opportunities occurs on private lands (Bevins et al. 1968), it is apparent that wildlife managers and natural resource planners must consider and negotiate with the landowners. It is generally accepted in the eastern United States that access to these private lands is vital if recreational demands for hunting, fishing and other outdoor activities are to be met.

Two studies of New York landowners have shown that private posting of rural lands increased from 25 percent in 1963 (Waldbauer 1966) to 42 percent in 1972 (Brown 1974). The 1972 study further concluded that

> of the 42 percent of posting landowners, 97 percent indicated that a behaviorally-related reason on the part of recreationists contributed to their decision to post. Landowners had personally encountered bad experiences with recreationists, friends or neighbors had encountered such experiences, landowners felt recreationists had the reputation of damaging property, or landowners felt endangered by the presence of various recreationists on their property.

The conflict between hunters and landowners is centered on the question of how public game can be harvested from private lands in a manner that least infringes on the desires of recreationists and the rights of landowners. The interaction of these two groups must seek a balance point, so that both can operate in a safe and reasonable manner. Many studies have shown the need for more sportsman-like behavior, respect for the landowner's property, increased public safety and the need to reverse the posting trend (Barclay 1965; Kelley 1968; Stoddard et al. 1969, and Brown 1974).

The New York State Department of Environmental Conservation (DEC) began to respond to this need in 1958 by establishing the Fish and Wildlife Management Act (FWMA). The FWMA legislation provided for a cooperative program between DEC and rural landowners, in which the landowner agrees not to post portions of his land in exchange for increased law enforcement patrols, installation of "posted" signs near buildings and dwellings, free trees and shrubs for habitat improvement, and free technical fish and wildlife management services. This program now includes approximately one-half million acres (202,430 ha). While further expansion is now limited because funds are scarce and law enforcement officers are fully committed, this type of program is one answer to the public access problem, and it has been well received. The acceptance of this program is probably due to the fact that New York landowners have generally been more concerned with a process that assures the safety of their families and property, than with cash payments in return for opening lands for recreation (Brown 1974).

In 1974, the Agricultural Stabilization and Conservation Service (ASCS) instituted a pilot program in five countries in each of the following states: Alabama, Iowa, Michigan, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania and South Carolina.[1] This program allowed farmers associated with ASCS to apply for cash payments in return for public access hunting agreements. The program was limited by the available funding, but it did provide a source of additional income for farmers who could offer suitable wildlife habitat for public hunting and who were already participating in the ASCS Cropland Adjustment Program.

The ASCS program was generally concerned with providing assistance to farmers, and in-house evaluations did little to determine the overall impact of the program on the problem of public access. Because the authors have research interests in the area of public access, they began an evaluation in New York to further explore the impact of the ASCS program on public access, posting rates, and landowner attitudes toward compensation for hunting access privileges.

Methods

The 1974 ASCS Public Access Hunting participants included 325 farmers from the five participating New York counties. These counties and number of participants were: Broome (42), Cayuga (59), Delaware (39), Niagara (51) and Orleans (134). The 1975 study sample consisted of all farmers in the first four counties and every third participant from an alphabetical list in Orleans County, for a total of 235 farmers. Mail questionnaires were sent to all farmers in the sample, and 91 percent were returned after three reminders. Because the study was also concerned with the impact of such a program on surrounding property owners, a second sample was obtained from 1975 county tax maps. This sample systematically selected one landowner with over 10 acres (4.05 ha) whose property adjoined that of each ASCS 1974 participating farmer. The 235 adjoining landowners were sent mail questionnaires similar to those sent to participating farmers, and 67 percent responded after three reminder letters.

In addition to the New York surveys, questionnaires were sent to state wildlife agencies in each of the 10 states where the ASCS program was operative to determine (1) the degree of ASCS-state coordination, and (2) state wildlife agency evaluations of the degree to which the ASCS program contributed to their overall hunting access programs.

Results

Participating and Adjoining Landowner Characteristics

Participating landowners compared to the adjoining landowners were slightly younger in age (mean of 52 years vs. 56 years), were from a rural or village background (92 percent vs. 84 percent), and had an equal level of education (mean of 12 years). Fifty-three percent of the respondents in both groups had hunted in the past two years, and the vast majority of all respondents were male (96 percent of the participants and 91 percent of the adjoining landowners).

[1]ASCS had previously offered public access payments to farmers as supplemental agreements to cropland diversion contracts as early as 1966. For details on the 1966 ASCS cropland adjustment program in Michigan see Boyce 1967.

Table 1. Total net income contributed by farming to ASCS participants and adjoining landowners.

Net income from farming	ASCS participants	Adjoining landowners
None	11.7%	26.4%
Less than 21%	19.0	32.6
21–40%	8.3	9.7
41–60%	8.3	0.7
61–80%	2.9	3.5
81–100%	49.3	27.1

ASCS participating landowners were more dependent upon farming than adjoining landowners for their major source of income (Table 1). Nearly one-half (49 percent) of the ASCS participants received over 80 percent of their total net income from farming activities, whereas only 27 percent of the adjoining landowners depended this heavily upon farming. Table 1 further shows that although the ASCS participants were considered to be farmers, 11.7 percent claimed they had no farming income, and an additional 19 percent indicated that farming contributed to less than 20 percent of their total net income.

ASCS participants and adjoining landowners both tended to reside on the properties studied (88 percent and 80 percent, respectively). Fifty-four percent of both groups had posted their properties prior to 1974. However, a slightly greater proportion of participants than adjoining landowners allowed hunting (Table 2).

Impact of 1974 Program on Landowner Participants

ASCS program participants estimated the total use of their land in 1974 to be 14,601 hunter-days. This included a range of 10 to 400 hunters per landowner, with a mean of 72. Several respondents commented that they could only approximate the number of hunters because some did not register at all, and others did not register for each separate hunting day, as was requested under the program guidelines.

Forty percent of the participants indicated that the number of hunters had greatly increased, 38 percent claimed there were a few more hunters, 19 percent claimed an equal number, and only three percent claimed there were fewer hunters than in previous years. Although there were comparatively greater hunter numbers, 86 percent of the ASCS participants reported no problems, 14 percent reported a few problems, and only 1 percent reported numerous problems.

Table 2. People allowed to hunt prior to the 1974 hunting season by ASCS participants and adjoining landowners.

	ASCS participants	Adjoining landowners
Family, friends, and neighbors only	29%	29%
Anyone, with permission	48	44
Anyone, permission not necessary	23	19
No one permitted	0	8

Nearly all of the ASCS participants (97 percent) stated that they would participate in the ASCS program if it were offered again. Those few who would choose not to participate again formed two groups, one which had sold their farms or felt they could lease them privately for more money (1.5 percent), and a second group which experienced hunter safety problems or had neighbors complain about the program's impact on them (1.5 percent).

Impact of 1974 Program on Adjoining Landowners

Only 52 percent of the adjoining landowners were aware that one of their neighbors had participated in the 1974 ASCS program. When questioned on any increase in hunter numbers in 1974, an even smaller proportion, 28 percent, felt that there were more hunters than in the previous year. Forty-four percent said there was no increase, and 28 percent did not know if there was any change in hunter numbers.

The vast majority of the adjoining landowners (87 percent) indicated hunter-related problems did not increase during the 1974 season. Nearly half (48 percent) experienced no problems, 35 percent experienced no increase in problems, 13 percent felt that hunter-related problems had increased, and the remaining 4 percent felt that the number of problems had actually decreased. When a problem was encountered, the adjoining landowners attempted various solutions. Twenty-one percent talked to the hunters involved, 33 percent posted their land, 16 percent took several approaches (i.e. talked to hunters, posted, talked to ASCS participating landowner or talked to the ASCS county office), and 30 percent claimed that they took no action. One-half of the adjoining landowners who posted their land as a solution to their 1974 hunter-related problems had experienced more problems that same year.

Although the number of hunters was shown to increase substantially during the 1974 program, only 46 percent of the adjoining landowners posted their land the following year, an 8 percent decrease from the 54 percent who posted prior to the 1974 program.

Attitudes Toward Public Access Hunting Programs

When asked to evaluate if a landowner should be compensated for allowing hunting on his land, the majority of both groups felt they should somehow be compensated. Table 3 illustrates the responses of both groups to compensation via different sources of funding. Respondents were further questioned on their choice between the ASCS program (at the 1974 \$1.00 to \$2.00 per acre (0.4 ha) rates for suitable hunting habitat) or the current New York program. Both programs were briefly described to facilitate their decision making; the results are presented in Table 4.

ASCS participants were decidedly in favor of the ASCS program, and for some form of compensation for allowing public hunting on their land. The majority favored government sponsored programs, which would be consistent with their 1974 participation in the ASCS Cropland Adjustment Program, and with previous contact experiences with ASCS programs. While 97 percent of ASCS participants had indicated that they were in favor of rejoining the program if offered again, 11 percent indicated the FWMA program to be preferable to the ASCS program. Those 11 percent who changed program preference toward the FWMA were, in

Table 3. Proportion of New York ASCS participants and adjoining landowners desiring compensation for hunting privileges, and preferred sources of compensation.

	ASCS participants	Adjoining landowners
No compensation desired	6.7%	33.1%
Compensation, by:		
Hunters	15.4	28.4
State programs	20.2	18.2
Federal programs	32.6	10.1
State and federal programs	9.1	3.4
Hunters and state-federal programs	5.8	1.4
Hunter license and state programs	6.8	0.7
Other programs	3.4	4.7

some way, indicating that the cash payment via the ASCS program was not their only consideration for a viable public access hunting program. Although 54 percent of the ASCS participants had stated that they posted prior to the 1974 program, 97 percent of the total group indicated an interest in joining either the ASCS or FWMA public access program.

The majority of adjoining landowners, on the other hand, preferred either no compensation or compensation from hunters using private lands. Adjoining landowners also exhibited a less dramatic preference for the ASCS program over the FWMA program, and 36 percent desired neither program. Since 45 percent of the adjoining landowners who chose the ASCS or the FWMA program posted their land in 1975, the posting trend appears to be reversible if acceptable programs are available.

Evaluation by State Wildlife Agencies

Evaluation of the ASCS public access program, from the standpoint of wildlife agencies of the 10 affected states varied considerably. In nine of the 10 states, some degree of coordination of programs took place. The wildlife agency of the tenth state indicated it was not contacted by ASCS.

The investigators felt that the location of a successful hunting access program, from a statewide perspective, would necessarily consider at least four related factors: (1) existing game populations, (2) wildlife habitat, (3) current hunter de-

Table 4. Public access program preferences of New York ASCS participants and adjoining landowners.

	ASCS participants	Adjoining landowners
FWMA	10.6%	16.1%
ASCS	85.1	40.5
FWMA or ASCS	1.4	2.8
Undecided	1.0	4.2
Neither program	1.9	36.4

mand, and (4) areas of high posting. Each of the nine state agencies contacted by ASCS were consulted about at least one of the above determinants for location of counties in which the pilot program would take place. Five of the 10 states were consulted about each of those factors. While state wildlife agencies felt their recommendations were utilized in varying degrees, 8 of the 10 agencies indicated the ASCS program was implemented primarily in counties which had definite access problems.

Only 2 of the 10 affected state agencies saw any conflict in the ASCS program and their own public access programs. In both cases, these conflicts were more potential than immediate, although they represented valid concerns. Both of the concerned state agencies feared that paying landowners a cash subsidy might hasten the time when the majority of landowners would demand a cash payment for opening their lands to hunting. These officials realized that their states currently did not have the financial capabilities to offer a cash subsidy, and their states were relying on volunteer cooperative programs or programs offering modest services rather than cash to cooperating landowners.

These, and other state wildlife agencies expressed a related concern that the per acre access subsidy be more closely related to the quality of the hunting resource and the local demand for it. They pointed out that a program which offers similar subsidies to all qualifying farmers in a county not only fails to maximize quality acreage newly available to hunters; it also misrepresents the market for hunting access of various types and qualities, and could lead to later misunderstandings among farmers in areas where states might want to form cooperative agreements.

Thus, while all state agencies recognized the potential value of the 1974 ASCS public access program, most wildlife agencies recommended that future programs develop more selective criteria for selection of counties and individual farms by establishing quality standards to insure that good hunting access is provided where it is most needed.

Discussion

With increased rates of posting throughout much of the United States on lands that remain huntable after urbanization and other land development forces take their toll, improved public access to good hunting habitat is a major goal of many state wildlife programs. The ASCS public access pilot program is one applied example of how increased access might be achieved. Even though it now looks as though this program may not be continued in pilot phase or broadened within the next few years, it is instructive to examine this effort closely for knowledge we may gain toward establishing future public access programs.

ASCS state staff in New York felt the program was highly successful. ASCS had more than enough public access applicants to use funds allocated to the program. Although no goal was set in terms of hunter-days to be served by the program, the 14,601 hunter-days provided by the pilot program seemed adequate.

The ASCS program was also successful from the point of view of participating farmers, 97 percent of whom indicated they would participate again if the program were reoffered. Furthermore, ASCS participants indicated they preferred that program to New York State's program (which offers services rather than a cash subsidy) by a ratio of 8 to 1. The program was also successful in that it created few conflicts with adjacent landowners; only 13 percent felt hunter-related problems increased over the previous year, and new posting as a result of the program was minimal.

Perhaps the greatest weakness of the ASCS program involved its lack of coordination with access scarcity. While there were some input in New York from DEC as to the pilot counties chosen, and while ASCS County Committees attempted to adjust landowners' fees within limits to relative quality of their hunting acreage, there was no coordination with DEC concerning location of specific tracts chosen. Thus, there is high probability that many of the parcels which DEC would rate as high priority, due to combinations of excellent habitat and poor existing access, were not included in the ASCS program. This premise is further supported by the prerequisite that a landowner had to be a previously enrolled ASCS farmer participant to quality for inclusion in the program. As farm acreage has steadily declined in New York, it is obvious that many choice areas for hunting are owned today by nonfarmers. Nevertheless, in a well-coordinated program, ASCS could cooperate with farmers, and the state agency with nonfarmers in counties of concern.

The suggestion that the ASCS program did not aggregately include the highest quality hunting resources in areas of high demand is reflected in the summary cost per hunter-day data. New York owners of 85,673 acres (34,685 ha) were paid a total of $145,420 for an estimated 14,601 hunter-days, or $9.96 per hunter-day. While hunter willingness to pay has not been comprehensively investigated in the Northeast since 1966 (Bevins et al. 1968), at that time only 38 percent of small game hunters would pay over two dollars per day to hunt. Fifty-two percent of big game hunters would pay over two dollars, but only 19 percent would pay more than five dollars.

Undoubtedly, the vast majority of rural landowners once believed that hunting was essentially a free good, one that they should offer hunters at no charge. As our population increases, huntable acreage decreases due to incompatible land uses, and hunter density increases at an accelerated rate. Combinations of new landowners with new values, and increased hunter problems are resulting in changing landowner attitudes toward hunters. If this course continues, it appears that with the exception of free hunting that a landowner might offer a friend, relative, or neighbor, landowners will generally be compensated for allowing hunting, either by a government program or by the hunter directly, in the not too distant future.

Until systems are evolved to allow equitable landowner compensation on a statewide or nationwide basis, however, it seems that foresighted wildlife managers would strive to maintain as many free hunter-days on private lands as possible, and oppose steps that would unnecessarily escalate landowner demands for financial or other means of compensation. If so, landowners would currently be compensated only for prime habitat, in areas having insufficient access.

Further studies are necessary to determine the lower limit acceptable for cash payments in exchange for public access hunting. This would allow an equitable rate for those landowners who do not choose to participate in a "service" type program but have a parcel of land with excellent hunting habitat in an area of definite hunter access problems.

Results of this study suggest that once landowners receive compensation for allowing hunting, they expect it to continue, and rationalize that it should continue. In 1973, the year prior to the ASCS public access program, 71 percent of the

1974 participating landowners allowed anyone to hunt who asked permission. While this study could not accurately determine how many landowners felt they should be compensated at that time, by 1975, after a one-year experience in the program, only 7 percent felt they did not need compensation for allowing hunting. Similarly, 63 percent of adjoining landowners allowed anyone asking permission to hunt in 1973, but one-third of these landowners felt they did not require compensation in 1975. The magnitude of adjoining landowners not desiring compensation is even more striking because 36 percent of adjoining landowners indicated no interest in either the ASCS or New York State program, whereas only 2 percent of ASCS participants disapproved of both programs.

Although we cannot definitely conclude that a causal relationship exists, of adjoining landowners who were aware that a neighbor participated in the ASCS program, 58 percent posted in 1974, while only 41 percent of those not aware of a neighbor's participation posted. Since the majority of surrounding landowners were not full-time farmers, and were not eligible for the program, these data suggest that some may have posted because they felt it inequitable that they were providing the same service free of charge for which a neighbor was compensated. Examining adjoining landowners who were aware, versus those who were unaware of a neighbor's participation, there were no other observed differences (e.g. age, living on the property in question, degree of hunter problems perceived) that might account for this difference in posting.

Summary

In summary, future programs aimed at opening lands for hunting should not be examined only in terms of gross number of acres opened or hunter-days provided. The impact of these programs on remaining private acreage open to hunting, and landowners controlling this acreage, should also be examined. Because a certain degree of landowner dismay is to be expected when there is a discrepancy between services offered and payments received, a clear justification should be provided for landowners who are chosen to receive special compensation. In the case of landowners and hunting privileges, the most straightforward and rational basis for awarding special compensation on a short term basis appears to be quality of habitat provided, in combination with shortages of existing access. In the long term, however, it would not be surprising that owners of good hunting resources would control access (e.g. by posting) in order to receive compensation.

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Soil Conservation Service Assistance in Managing Wildlife on Private Lands in Texas

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Introduction

The Soil Conservation Service (SCS) has been assisting Texas landowners manage wildlife habitat for the past 40 years. The Texas Parks and Wildlife Department, the Fish and Wildlife Service, the Texas Agricultural Extension Service, and others also provide assistance in managing wildlife resources on private lands in Texas.

SCS recognizes that wildlife populations are important products of the land and all lands can be managed within their capabilities to increase wildlife populations. The goal of the Soil Conservation Servive is to assist landowners in the conservation, development, and productive use of their natural resources. When landowners request wildlife management[1] assistance. SCS personnel have been trained and are prepared to provide the requested information. The purpose of this paper is to present how the Soil Conservation Service in Texas performs its responsibility of assisting landowners to manage for wildlife.

Technical Assistance Delivery System

Two hundred thirty four of Texas' 254 counties have Soil Conservation Service offices. The 20 counties without offices are provided assistance by personnel from adjoining counties. Each field office works in cooperation with a soil and water conservation district, a legal entity of state government. Locally elected directors determine conservation objectives within their districts. Landowners request conservation assistance from the soil and water conservation districts and technical assistance is provided to the districts by the Soil Conservation Service according to a memorandum of understanding.

Field offices are staffed by personnel with diverse training. Nonprofessional personnel, called conservation technicians, assist in the application of conservation measures, but all conservation planning is performed by professional employees. Technical disciplines within the professional ranks include: range management, agronomy, wildlife management, forestry, etc. For the purpose of this presentation, all the people who work in the field offices are referred to as soil conservationists.

The Soil Conservation Service in Texas has 14 professional wildlife biologists serving as staff specialists. These biologists are headquartered at some of the 25 area offices throughout the state and at the state office at Temple. They provide technical leadership in the wildlife program by training field personnel, reviewing results of field office work and providing technical standards that establish the minimum quality level of each wildlife habitat improvement measure. Most of these biologists spend a high percentage of their time training soil conservationists in the principles and techniques of wildlife management. However, upon request

[1]For purposes of this discussion, wildlife management includes fisheries management.

from a field office, a SCS biologist will work directly with private landowners having complex management requirements. Personnel are trained in groups where interchanges of questions, answers and problems encountered can benefit those who have had different experiences. Individual training is given in specific techniques—such as inventories and evaluations of wildlife habitat, pond construction to facilitate fish management, and specific methods of improving wildlife habitat.

How does this training relate to on-the-ground assistance? Soil conservationists are taught that conservation involves multipurpose planning whereby the landowner can protect the long term productive capability of his land, including its wildlife resources. During training activities personnel are taught numerous conservation practices which are used in formulating conservation plans. A handbook is maintained in each field office which defines these practices and includes details of how to plan and apply each practice. This handbook, the field office technical guide, serves as a reference to field personnel to assist them in planning conservation practices when the staff specialists are not present.

All conservation measures are applied by landowners or land users. A landowner must understand the basic principles of conservation, including wildlife management, in order to make intelligent choices regarding the use of his natural resources. Soil conservationists use their training to assist landowners to make land use decisions directed toward the long term conservation of soil, water, plant, wildlife, and related resources. Final decisions rest with landowners, and the final conservation plans are their plans. Soil conservationists, well trained in principles and techniques of wildlife habitat improvement, have the basic tool necessary to inform the landowners of the benefits of improving or maintaining their wildlife habitat.

Conservation Planning

The Soil Conservation Service classifies land according to land use; i.e., rangeland, woodland, pastureland, cropland, wildlifeland, recreationland, and urbanland. In many instances the same acreage has more than one use; consequently, the same planned area may be classified as having a primary land use, a secondary land use and, possibly, a tertiary land use. In Texas, wildlifeland is most commonly planned as a secondary land use.

It is not uncommon for a rancher to be concerned with both livestock production and leasing a portion, or all, of his ranch for hunting. This part of his ranch has two land uses—rangeland, the primary land use, and wildlifeland, the secondary land use. The rancher may request SCS assistance through the local soil and water conservation district in developing a conservation plan that increases, or maintains the carrying capacity of his ranch for livestock and wildlife.

After the soil conservationist receives a request and determines the objectives of the rancher, he undertakes an inventory of the natural resources of the ranch. He determines soil types, general topography, plant communities relative to soils, available water supply, sites for potential water sources, the condition of forage plants, etc.

A work sheet is used to determine the range condition and evaluate the forage preferences of different animal species. This work sheet, along with information in the field office technical guide, is used by the soil conservationist to determine which plants are of high value, moderate value, and low value for domestic livestock and wildlife. In order to qualitatively evaluate the woody vegetation, another work sheet is available to the soil conservationist. This work sheet enables him to evaluate the present condition and the reproductive success of woody vegetation for a browse analysis. In short, the tools are available to the soil conservationist to enable him to conduct his inventory in a fashion that gives wildlife habitat equal consideration when planning conservation of the ranch's resources.

After the inventory is completed, he analyzes the results for problems. He may determine, for example, that the vegetation is overbrowsed, and, in order for the rancher to meet his expressed objectives, browsing pressure must be reduced immediately if the overall carrying capacity is to be increased. After the problem has been identified, alternatives will be formulated and presented to the rancher. One alternative is to harvest more deer, especially does. Another alternative is to increase the ranch's carrying capacity with food plots or by supplemental feeding. Another alternative is to reduce the number of domestic livestock in most direct competition with desired wildlife. The rancher then makes his decision. He may choose from the alternatives presented to him or he may formulate yet another alternative. The soil conservationist can make the greatest impact if he conducts a thorough inventory, identifies all major problems, and presents reasonable and practical alternatives. After the decision is made, the rancher and the soil conservationist develop a conservation plan tailored to desires and needs of the rancher and his ranch resources.

To summarize the previous several paragraphs, the soil conservationist determined the objectives of the landowner, conducted a resource inventory, determined conservation needs, and formulated alternatives and presented them to the landowner. The landowner selected the alternative that best satisfied his objectives and needs, and it was recorded as his conservation plan.

Hunting leases in some areas of Texas may return up to $10 per acre (0.4 ha). Most leases, however, return $1 to $3 per acre. Wildlife habitat improvement alternatives are more readily accepted by landowners who can receive income from their wildlife resources. Many ranches and farms are not leased for hunting. Soil conservationists have a more challenging task in presenting wildlife alternatives to these landowners.

Some landowners simply want wildlife on their property and can afford costly wildlife habitat improvement measures plus reduced agricultural income. Other landowners are willing to forego some agricultural production to retain and improve wildlife habitat, but they cannot afford to make costly habitat improvements. Measures such as high fences to control big game movements and enable intensive herd management are extremely expensive and very infrequently applied. Presently one mile (1.6 km) of deer-proof fence costs $5,000–$10,000 to construct.

An excellent example of a less expensive measure is construction of a firebreak around large pastures of rangeland. If a landowner desires to improve quail habitat, the width of the firebreak can be doubled and one-half of the firebreak disked or plowed every other year. This measure stimulates annual forb production. Proper grazing use and planned grazing systems are other examples of low cost conservation measures that can be designed to benefit wildlife.

Other landowners emphatically do not want to plan for wildlife habitat improvement on their property. Crop predation by wildlife or experiences with trespassing by illegal hunters are the most common reasons given by this group. They receive as much technical assistance as others in developing a conservation plan to meet their objectives. However, the wildlife management alternative is not included in their conservation plans unless the numbers of a wildlife species in combination with domestic livestock are causing resource deterioration. In most field offices in Texas, statements that these landowners do not want to plan wildlife habitat improvements are included in the soil and water conservation districts' copies of the conservation plans. These statements document that the existing and potential value of the landowner's wildlife resource was discussed and that it was his decision to plan a conservation program which did not include measures beneficial to wildlife.

Most landowners are interested in managing their lands to provide wildlife habitat if management is inexpensive. They are generally interested in methods and techniques that are not costly—whether in time, money. or sacrificed agricultural production. The challenge is ever present for SCS wildlife biologists to discover and evaluate wildlife management techniques these landowners will accept. Once a technique gains acceptance, all field personnel must be trained in how and where this technique applies in order to include it in conservation plans.

Conservation Practices

The field office technical guide contains many conservation practices. Minimum levels of acceptable quality for planning and implementing each conservation practice are called standards. Minimum requirements necessary to implement practices so they achieve their intended purposes are called specifications. Another important task of the SCS wildlife biologist is to incorporate the latest pertinent information derived from research and experiences into the specifications.

Relatively few conservation practices are specifically designed to benefit wildlife. Examples are wildlife upland habitat management, wildlife wetland habitat management, field borders, fishpond management, and wildlife watering facilities. Many other practices can have great impact in maintaining or improving wildlife habitat.

An excellent example is the conservation practice, brush management. Brush management is defined as the management and manipulation of brush stands by mechanical, chemical or biological means on rangeland, native pasture, pastureland, recreationland, and wildlifeland. As of 1973 the service had provided guidance to Texas landowners in applying 8 million acres (3.24 million ha) of brush management with wildlife habitat maintenance/improvement consideration.

There are many modifications of the brush management practice that can be applied which will maintain or improve wildlife habitat. All specifications for this practice have a section entitled, "Wildlife Considerations." Specifications vary depending upon the major land resource area. Such techniques as retaining brush on less productive soils, maintaining adequate strips along natural drainageways, and leaving motts of brush in large, open pastures are discussed in detail in this section.

One of the most important considerations is controlling the brush on the more productive soils and retaining the brush on the less productive soils. This measure increases forage production for domestic livestock and wildlife while retaining cover for wildlife. In pastures where there is a wide space between areas retained in brush and areas where brush has been controlled, interconnecting strips of brush which serve as travel lanes are retained.

In south Texas where the topography is relatively level and uniform, brush management is usually applied in strips. Landowners are encouraged not to control strips wider than one-quarter mile (0.4 km). The basis for this recommendation is experience and research in Texas which has revealed that deer do not readily move more than one-eighth mile (0.2 km) from protective cover.

In order to determine the width of the strips of brush to be retained on a specific site, soil conservationists are trained to station a man within the brush to be treated. Another man with a white handkerchief in his pant's back pocket walks away from the stationary man in several different directions. The average distance at which the handkerchief is no longer visible to the stationary man is computed. This distance is multiplied by two to determine the width of the strips.

Sometimes landowners request assistance that results in wildlife habitat being removed or reduced in quality for the sake of some other land use. Landowners are continually being made aware of the impact of their land use decisions upon natural resources, including wildlife. Hopefully, some features to maintain or improve wildlife habitat will be included in every conservation plan. It is recognized that the level of management is somewhere between that occurring on public lands managed by a wildlife agency and lands managed by individuals, or groups, with no interest in wildlife.

Fishpond management is one of SCS's wildlife-related conservation practices. In 1976 the SCS in Texas assisted with fishpond management on more than 5,000 ponds. In most ponds the only management applied was stocking with fish, but in some cases additional management techniques such as fertilization, weed control, pond renovation, spawning devices and proper harvest were applied. Detailed guidance on all the aforementioned aspects of fisheries management are found in field office technical guide specifications. Stocking is a minimum level of management that can occur in a new or renovated pond that has no wild fish populations within the drainage area of the pond. The complexity of assistance depends upon management needs and the pondowners' objectives.

A Texas High Plains farmer who grows irrigated corn may normally disk or burn his corn residue in the fall. The soil conservationist tries to convince the farmer to leave the corn residue through the winter for soil protection and wildlife habitat improvement. If the farmer takes this advice and retains the corn residue through the fall and the winter for the express purpose of benefitting pheasant and waterfowl, at least two conservation practices have been applied—crop residue use and wildlife upland habitat management. Crop residue use is defined as using plant residues to protect cultivated fields during critical erosion periods. Leaving corn residue from fall harvest to spring planting falls into the framework of this definition. In order for this measure to meet the SCS standard for wildlife upland habitat management, essential habitat components—food, water, and cover—must be adjacent or nearby in sufficient quantities to support a population of the wildlife species desired.

Conservation plans developed in the Hill Country, Trans Pecos, and the Rio Grande Plains generally have more wildlife habitat management features than other land resource areas in the state. Plans developed in land resource areas which are intensively farmed generally have the least wildlife habitat management provisions. In the former areas, ranching and farming operations are more compatible with providing wildlife habitat because much of the native plant community is managed for domestic livestock production. In the latter area much native grassland has been converted to cropland and it is difficult to modify an agricultural cropping system to provide habitat for wildlife adapted to a native grassland plant community.

Implementation of Plans

Soil conservationists assist in planning more acreages of wildlife habitat improvement than are implemented. The Soil Conservation Service in Texas is constantly searching for reasons for lack of application and methods to close the gap between planning and implementation.

Some reasons for this discrepancy have been identified. At the time a conservation plan is developed, the landowner intends to perform all the features of the plan. Implementation is usually planned over a period of a few years. But before all planned components have been applied, the economic situation of the landowner may change. He may then be unable to forego some economic return for the sake of enhancing or maintaining wildlife habitat and he can save money by not applying any of the wildlife management provisions. It is common for a farmer or rancher to make decisions on the basis of his current cash crop—for example, grain sorghum. His farming operation can be modified in several ways to maintain and improve wildlife habitat. With the prices of agricultural commodities constantly fluctuating, it is likely that within one or two years after his plan has been developed, it may become more economical to change his cash crop from grain sorghum to cotton. There are fewer opportunities to modify a cotton farming operation to the benefit of wildlife habitat than there are in a grain sorghum operation; consequently, all features of the original conservation plan are never applied.

Another reason for lack of implementing practices that maintain or improve wildlife habitat is that the landowner does not completely understand the plan components. The ultimate responsibility for this failure rests with the SCS biologists. Field personnel should be so thoroughly trained they feel very comfortable in communicating wildlife habitat management to anyone. Realistically, this is a very difficult task but it is one of the major goals of all SCS biologists.

Interacting with the first two reasons is a third — limited time for follow-up assistance. Once a plan has been formulated, written, and given to the landowner, the soil conservationist's job is not completed. This is especially true regarding wildlife habitat management. Every detail of management cannot be written into a conservation plan. Contacting a landowner periodically to determine if objectives have changed, or features of the plan are unclear, will increase the implementation of conservation plans.

Summary

The major points about the Soil Conservation Service's wildlife management assistance in Texas are:

1. Soil Conservation Service biologists in Texas spend much of their time training field personnel in principles and techniques of wildlife habitat management.
2. Field personnel use their training in assisting landowners to develop conservation plans that include wildlife habitat improvement/maintenance features.

3. Wildlifeland is most commonly planned as a secondary land use in Texas.
4. Most landowners are interested in incorporating wildlife habitat management provisions into their conservation plans so long as costs and/or sacrificed agricultural production are reasonable.
5. Standards and specifications for all conservation practices establish minimum quality levels and minimum requirements for planning and implementation.
6. Wildlife habitat management planned exceeds wildlife habitat management implemented. Reasons for this discrepancy are: (1) change in priorities; (2) failure by SCS personnel to communicate management techniques; and (3) limited time for followup assistance by SCS personnel.

Goals and Procedures of Wildlife Management on a Large Western Ranch

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Introduction

Vermejo Park is a 479,000 acre (193,000 ha) ranch in northeastern New Mexico (eastern Colfax and western Taos counties). It is part of the famous Maxwell Land Grant of 1841. The original grant of 1,715,000 acres (691,000 ha) was to Carlos Beaubien and Guadelupe Miranda. Lucian B. Maxwell, Beaubien's son-in-law, inherited the grant in 1864. In 1867 the grant was sold to an English syndicate, The Maxwell Land Grant Company. After 1887 the grant was subdivided into smaller properties. (Pearson 1961).

In 1902 William H. Bartlett, a wealthy Chicago grain speculator, purchased 205,000 acres (82,600 ha) of the grant in the vicinity of Vermejo Park (Pearson 1961). Bartlett invited numerous guests and clients to the ranch and was interested in improving the hunting and fishing on the property. He developed five lakes, a fish hatchery, improved roads, and built numerous fishing lodges for his guests (Laurie 1976). In 1911 Bartlett reestablished elk at Vermejo Park with a transplant from Wyoming (Barker 1976). This elk herd has probably attracted more attention than any other in the state. It was the first to be reintroduced after the species had been exterminated from the entire state in the early 1890s (Barker 1946).

In 1926 Vermejo Park was sold to three Los Angeles businessmen headed by Harry Chandler. Chandler organized an elite hunting, fishing, and recreational retreat known as the Vermejo Club. Membership in the club was by invitation only, and the cost for a lifetime membership was $5000. Members included Douglas Fairbanks, Mary Pickford, Herbert Hoover, F. W. Kellogg, Harvey Firestone, Cecil B. DeMille, Thomas W. Warner, and Andrew Mellon. During this period the famed New Mexico conservationist, Elliot S. Barker, worked for the Vermejo Club as wildlife manager. The Vermejo Club was disbanded during the depression, and the land was leased for cattle operations (Laurie 1976).

In 1945 W. J. Gourley bought 108,000 acres (43,500 ha) of the W. S. Land and Cattle Company. In 1948 he acquired Vermejo Park Ranch, and in 1956 he purchased the 90,000 acre (36,300 ha) Ponil Ranch. Gourley continued to expand Vermejo Park until he acquired a total of 479,000 acres (193,000 ha). Big-game hunting and trout fishing became important considerations of the ranch operation. Lakes were improved and stocked with trout. In 1957, several hundred elk were purchased from Yellowstone National Park at $5 each. Gourley also purchased young wild turkeys. The young birds were raised at ranch headquarters and released into the wild when full grown (Laurie 1976).

Vermejo Park was offered for sale by the Gourley estate in 1970. The National Park Service, the U. S. Forest Service, the State of New Mexico, and several private groups were interested in the property. In August, 1973 Pennzoil Company purchased the entire estate for $26.5 million dollars.

Vermejo Park remains as one of the largest blocks of privately owned land in the United States. Elevations range from 6,000 ft (1,830 m) to 13,000 ft (3,960 m). Five major vegetation types are represented (Kuchler 1964): gramma-buffalo grass; juniper-pinyon woodland; ponderosa pine-douglas fir; southwestern spruce-fir; and alpine meadows. Portions of Vermejo Park are presently under consideration for inclusion in the National Park Service's Natural Landmarks Program.

Resident big-game animals include elk (*Cervus elaphus canadensis*), mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americana*), bison (*Bison bison*), black bear (*Ursus americanus*), and mountain lion (*Felis concolor*). Other mammals of interest are bobcat (*Lynx rufus*), coyote (*Canis latrans*), grey fox (*Urocyon cinereoargenteus*), cottontail (*Sylvilagus* spp.), black-tailed jackrabbit (*Lepus californicus*), varying hare (*Lepus americanus*), raccoon (*Procyon lotor*), badger (*Taxidea taxus*), ermine (*Mustela erminea*), long-tailed weasel (*Mustela frenata*), Abert's squirrel (*Sciurus aberti*), red squirrel (*Tamiasciurus hudsonicus*), muskrat (*Ondatra zibethicus*), and beaver (*Castor canadensis*). Numerous small rodents of the families Sciuridae, Geomyidae, Zapodidae, Heteromyidae, and Cricetidae are also present.

Gamebirds include wild turkey (*Meleagris gallopavo*), mourning dove (*Zenaidura macroura*), scaled quail (*Callipepla squamata*), mallard (*Anas platyrhynchos*), pintail (*Anas acuta*), green-winged teal (*Anas carolinensis*), blue-winged teal (*Anas discors*), cinnamon teal (*Anas cyanoptera*), American widgeon (*Mareca americana*), shoveler (*Spatula clypeata*), redhead (*Aythya americana*), common goldeneye (*Bucephala clangula*), bufflehead (*Bucephala albeola*), and Canada goose (*Branta canadensis*). Raptors of interest include wintering bald eagles (*Haliaeetus leucocephalus*) and a nesting pair of ospreys (*Pandion haliaetus*).

Seventeen fishable lakes and 60 miles (111 km) of trout streams are on the property. Gamefish inhabiting these waters are rainbow trout (*Salmo gardineri*), cutthroat trout (*Salmo clarki*), and brook trout (*Salvelinus fontinalis*). The brook stickleback (*Culaea inconstans*), listed as endangered in New Mexico, is found in one of Vermejo's lakes.

Ranch Operations

Two separate, but interrelated, operations supply income to Vermejo Park. These are the guest operation and the cattle operation. The guest operation consists of hunting, fishing, and certain non-consumptive uses such as backpacking, hiking, and horseback riding. The guest operation provides approximately 55 percent of the gross ranch income. There is also an active logging operation at Vermejo. However, rights to a major portion of the harvestable timber were sold before the property was purchased by Pennzoil. Consequently, Vermejo is not receiving any income from timber sales.

Hunting Operation

Unlike many privately owned hunting operations, Vermejo Park is not a game farm. Moreover, animals are not kept in pastures with game-proof fences; all are completely wild and free-ranging.

Approximately 22 percent of New Mexico's elk population is located at Vermejo Park (New Mexico Department of Game and Fish, unpublished data). In contrast, Vermejo represents less than 1 percent of the state's area. The hunting operation at Vermejo depends primarily upon this elk resource. Mule deer formerly provided much of the hunting opportunity, but as in many other areas of the west, Vermejo's mule deer population has declined drastically. In addition to several hundred elk hunters, a limited number of mule deer, pronghorn, wild turkey, black bear, and mountain lion hunters are accommodated each year. Hunters are lodged at three fully staffed guest lodges throughout the ranch. Ranch policy requires that all hunters be guided by a ranch employee.

During the period 1974–76, 1,192 elk hunters visited Vermejo Park. This included 976 bull elk hunters (many held either-sex validations), and 216 cow elk hunters. The ranch charges a minimum of $1,300 per hunter for a 6-day bull elk hunt. Certain high quality hunts are $2,000. The fee for a cow elk hunt is $300. Elk hunting has produced an income to the ranch of approximately $400,000 annually since 1974.

A total of 904 elk were harvested at Vermejo Park during the period 1974–76. This represented 16 percent of the state-wide harvest. The harvest at Vermejo was composed of 579 bulls, 291 cows, and 34 calf elk.

A major difference in elk management philosophy of Vermejo Park and government wildlife agencies is the emphasis on quality rather than quantity. Our definition of a trophy bull elk is one which has at least six antler points on each main beam. Data have shown that 91 percent of the 6 by 6 bulls harvested at Vermejo Park are at least 4 years old. Bulls with the best antlers are generally 6 to 8 years old. While young age-class herds showing maximum harvestable surpluses generally represent good management on public lands, older age-class herds, with a higher male to female ratio, are necessary when large numbers of trophy class animals are desired. Cow hunts are required to check population growth when this type of management is followed.

One of the most productive elk herds in the United States is the White River herd in Colorado. Examination of bull elk at check stations between 1961 and 1965 showed that 13.7 percent (101 of 739) had antlers with six or more points to a side (Boyd 1970). Check station data for 1971 and 1972 indicated that this percentage had decreased to 8.9 (31 of 346) (Boyd and Lipscomb 1976). For comparison, 44 percent (256 of 579) of the bulls taken at Vermejo 1974–76 had six or more points on each antler. Thus, Vermejo Park provides a high quality hunt which also has an excellent success rate.

Several ongoing research projects provide basic management information on Vermejo's deer and elk herds. A study of elaeophorosis (elk blindness caused by the nematode *Elaeophora schneideri*) was completed recently by a graduate student from Colorado State University. Vermejo Park and the National Rifle Association are jointly funding a mule deer fawn mortality study conducted by the Wild Animal Disease Center at Colorado State University. A population dynamics study and an evaluation of trophy elk management are presently in progress. Hopefully, results of these studies will provide the necessary information to properly manage Vermejo's elk and deer herds for maximum production of trophy animals.

Fishing Operation

The majority of Vermejo's lakes are man-made reservoirs, ranging in size from 6 to 80 surface acres (2.4 to 32.3 ha). The streams are small, having average summer flows of 3 to 15 cubic feet per second (85 to 422 liters per second). Gamefish inhabiting these waters are rainbow trout, brook trout, and cutthroat trout. The lower elevation lakes contain only rainbow trout, while the higher lakes and streams may contain all three species.

As with the hunting operation, quality is stressed in the fishery program. The fee charged for fishing is $75 per person per day ($25 for the fishing permit and $50 for room and board at one of Vermejo's guest lodges). Guests are limited to a daily catch of 12 fish. During the period of 1974–76, Vermejo's lakes and streams received over 8,000 days of use, and produced a revenue of approximately one-half million dollars. An estimated 42,000 trout were harvested during this period. Measurement of over 13,000 trout indicated the mean size was 13.4 in (340 mm). Since most of the lakes are restricted to the use of flies and artificial lures, many fish were caught and released unharmed by the guests. The harvest of 42,000 includes only the fish actually kept by the fishermen.

Most of our lakes have no permanent source of running water, with the main source being the spring runoff. Because of this lack of flowing water, there is no trout reproduction in the lakes; consequently virtually all of the trout must be stocked. Adequate reproduction occurs in all of our streams and no stocking is necessary.

The stocking philosophy at Vermejo differs from that of most state wildlife agencies. The rainbow trout stocked at Vermejo average 12 to 13 inches (30–33 cm) in length. State agencies are usually charged with providing maximum fishing opportunity for maximum numbers of fishermen at a minimum cost per fish. Most trout fishermen in the western United States pay less than $10 per year for a fishing license. The amount of money available for hatchery and stocking programs is therefore limited by the income derived from the sale of hunting and fishing licenses. At Vermejo, guests pay $25 per day for the fishing permit. Consequently, we are able to afford a higher cost per fish than a state agency. In addition, since almost 70 percent of the guests are return business, we have to be very conscious of customer satisfaction. A person paying $10 per year to fish in public waters may be satisfied with fishing all day and catching eight rainbow trout ranging in size from 8 to 10 inches (20–25 cm). However, the same fisherman paying $25 per day will generally expect fishing of considerably higher quality.

Several management projects are underway to improve and maintain the fishery resource:

1. Each year lake surveys are conducted to evaluate production potential.
2. Several hundred marked fish are stocked in each lake. Tag returns are used to determine growth rate, turnover rate of stocked fish, and population size.
3. Several of our lakes are very shallow and fertile, resulting in dense growths of aquatic weeds during the summer. The dense vegetation creates problems for fishermen, and at certain times causes oxygen deficiencies which result in summer-kill or winter-kill. A program of aquatic weed control has been followed the past three summers.
4. Another effort towards reducing the possibility of winter-kill is the use of LPG bubblers during the winter. A regulator device, manufactured by Frabeth Industries, Rye, Colorado, is attached to a 5-gallon (19-liter) LPG bottle. Holes are cut in the frozen lakes and these devices are lowered to the bottom. The LPG is released at a rate of 1.5 gallons per month (5.6 liters per month). The

action of rising gas bubbles creates a convection current which causes the warm benthic water to rise to the surface. This warm water melts the surface ice and maintains openings of 1 to 30 ft in diameter (0.3 to 9.2 m).

5. Cutthroat trout have been stocked by helicopter into four remote lakes above 11,000 ft (3,350 m). Previously these lakes were barren of trout, but productivity studies indicated they could support a trout population.
6. Cutthroat trout populations have declined over the past 20 years in many western states. In many cases this has been attributed to population displacement by brook trout and hybridization with rainbow trout (Behnke and Zarn 1976). This appears to be the situation in Costilla Creek, our most popular trout stream. An attempt is being made to preserve the cutthroat trout in this creek. A structure, designed to prevent the upstream movement of trout, was placed 8 miles (13 km) below the headwaters. The stream will be electrofished above the structure. All brook trout, rainbow trout, and rainbow-cutthroat hybrids will be removed and placed in other waters. Pure cutthroat trout will be returned to the stream. Hopefully this will result in a pure cutthroat fishery in Costilla Creek.

Development of Hunting and Fishing Enterprises on Private Land in Other Western States

Teague (1971) indicated several constraints to development of wildlife enterprises on private land: (1) Many people still believe wildlife enterprises on private land to be commercialization of the public's fish and game; (2) failure of resource agencies to recognize the private sector as a full partner in wildlife management; (3) landowners' fear of unrealistic tax assessments; (4) lack of good economic data for planning; (5) lack of low-cost credit to small landowners; (6) antiquated laws and public misunderstanding which restrict realistic game harvests in many states; and (7) the lack of an efficient marketing channel.

Can an operation similar to Vermejo Park be successful in other western states? First of all, most landowners do not have the vast land resource comparable to Vermejo. This means that most potential operations of this type will be on a smaller scale. However, more important than property size is the length of the established hunting season. The length of the 1976 New Mexico elk season was 36 days, stratified into six hunt periods. For comparison, the season lengths in several other western states (Colorado, Arizona, Utah, Washington, and Oregon) averaged 14 days (range 10-16). The longer hunting season in New Mexico allowed Vermejo Park to distribute hunter pressure and ensure a quality hunt each of the six periods. Had the length of the New Mexico season been equal to that of any of the above states, Vermejo probably would have decreased the number of hunters accommodated by 30 to 40 percent. This would have resulted in a corresponding decrease in the income derived from elk hunting.

As a method of encouraging good game management on private lands in other western states, state game commissions may wish to consider longer hunting seasons in areas where a major portion of the land is in private ownership and good game populations are present. The longer hunting seasons could benefit the landowner, sportsmen, and wildlife alike. The landowner generally has limited facilities such as camphouses, four-wheel drive vehicles, horses, tack, and guides. In many instances, these facilities, not the wildlife resource, determine the number of hunters a landowner will accommodate. With a short hunting season, it is not economically profitable for many landowners to manage their property for wildlife. Consequently, land management practices are devoted strictly to agriculture and wildlife suffers the ill effects. However, if a longer hunting season was allowed, the landowner could run several hunts at different times and increase his income accordingly. If a landowner can make a profit by providing hunting and fishing on his property, he is more likely to follow land management practices favorable for wildlife rather than production of other crops. Good game management on private land usually improves wildlife populations on surrounding public land, and will result in better hunting on these lands. Other benefits of wildlife enterprises on private lands have been discussed by Teague (1971).

It has already been mentioned that most potential operations of this type will be smaller than Vermejo. This can lead to financial difficulties in terms of funding necessary management oriented research. There are several solutions to this problem:

1. The landowner should cooperate with the state game and fish department. Quite possibly the state agency is looking for a place to conduct just such a study. With the landowner's cooperation, certain research studies could be conducted on private land to the mutual benefit of the landowner and the state agency.
2. Landowners should maintain contact with regional colleges and universities. There are numerous graduate students looking for projects and study areas.
3. Fishery and wildlife students could be hired on internship programs during the summer. This would provide the landowner with a relatively inexpensive source of technical assistance on field projects and would provide valuable experience for the students.
4. Local 4-H clubs could be invited on the property for wildlife habitat improvement projects.
5. Several landowners with similar research needs could share the cost of hiring professional consultants.

As public lands become more crowded, the quality of hunting and fishing experiences diminishes. This fact alone should place operations similar to Vermejo Park in high demand by serious sportsmen. I think quality oriented hunting and fishing operations can be successful in other western states, providing that: (1) good game populations or the potential for good game populations exists; (2) the landowner is willing to devote the time and money necessary to develop the resource; and (3) the state hunting seasons are set in such a way to encourage landowners to pursue wildlife management as an economically profitable business.

An important factor to consider in developing a wildlife management plan for private lands is that management goals may differ significantly from those of agencies charged with the management of public land. A plan that may not be economically feasible on public domain, may prove to be very lucrative on private land, if based on sound biological data and principles.

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The Maintenance of an Urban Deer Herd in Winnipeg, Manitoba

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Introduction

Urban and industrial development in large cities often results in a reduction of natural habitat to disjunct remnants which do not contain viable populations of many wildlife species. In many cities, golf courses, city parks, undeveloped industrial land, and water bodies are the only substantial areas of wildlife habitat remaining. River banks serve as movement corridors between these blocks of habitat.

It is still possible to see white-tailed deer (*Odocoileus virginianus*) tracks in the mud and snow near the junction of the Red and Assiniboine Rivers in downtown Winnipeg, Manitoba. Deer in a city is not unique to Winnipeg since they are also found in or near other North American cities such as Ottawa, Calgary, Minneapolis and Milwaukee. What is unique is the total number of deer that have adapted to city dwelling in Winnipeg.

Over one-half million people and 200 deer cohabit the greater Winnipeg area on what is largely private land. While this deer herd is still flourishing on dwindling available habitat, only careful city planning and management of green areas will insure that some free-ranging deer, as well as many other species of wildlife, will continue to exist in urban Winnipeg.

The significant concentrations of deer in or near Winnipeg are shown in Figure 1. Birds Hill Provincial Park contains a small deer population which moves daily to surrounding fields for food in late fall and winter. They must cross a major highway with a 65 mph (105 km/hr) speed limit. The 12-mile stretch of highway along the western side of the park is a major hot spot for deer-auto collisions in Manitoba.

The new Beaudry Provincial Park just to the west of Winnipeg contains 20–25 deer in winter. These deer undoubtedly use the Assiniboine River as a travel lane for dispersal to and from this wintering area.

A half section of bush just north of the St. James Rifle Range contains 20–25 deer in winter. We do not have detailed information on their movements and use of the area.

A 1.5 km^2 wooded area just west of the Winnipeg International Airport has contained at least 25 deer for the past 3 years. In December, 1976, 60 were observed during aerial surveys. Occassionally deer wander onto the airport runways and must be quickly chased off. In 1976, 18 were hit by cars on the streets or illegally shot by poachers and boys with .22 rifles. However, they have maintained their numbers over the years and have greatly increased since last year.

The largest concentration of deer in Winnipeg is in the Tuxedo-Charleswood Area (southwest portion of Winnipeg) and the area we intend to discuss for the rest of this paper. The management considerations for this deer population di-

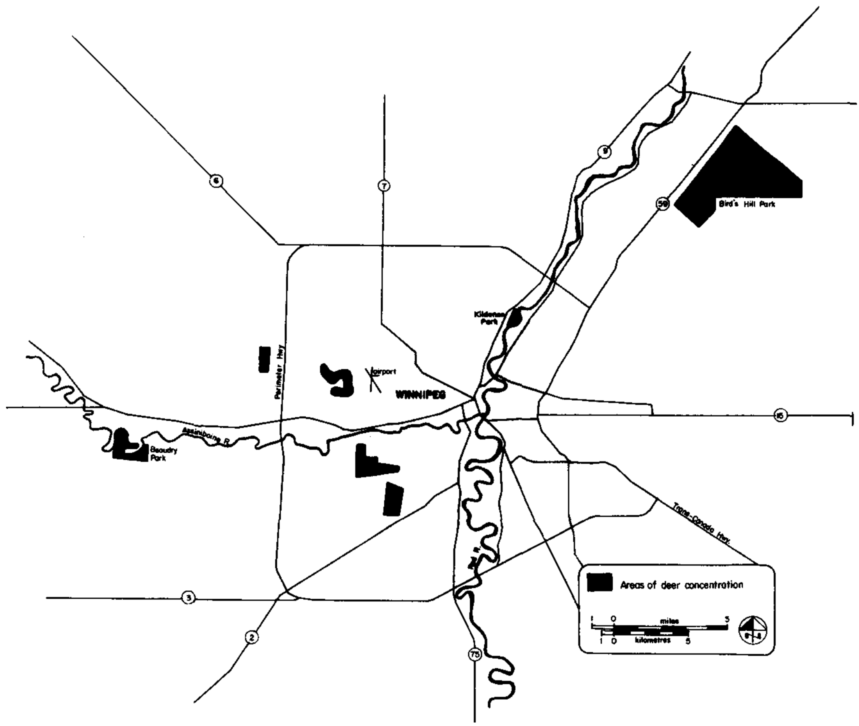


Figure 1. Areas of white-tailed deer contractions in the greater Winnipeg area.

rectly apply to those found elsewhere in or near the city. A study of this urban deer herd was initiated in 1971 to determine (1) how free-ranging deer could be maintained and enhanced for aesthetic appreciation and education of city dwellers, and (2) if this herd could be used as a "biological barometer" of the annual status of deer herds elsewhere in the province.

Materials and Methods

Sixty-five deer were live-trapped, color-marked with ear streamers, and released for subsequent observation. Two of these, an adult male and female, were instrumented with radio collars and tracked for 13-month and 3-month periods, respectively, for detailed information on daily movements and habitat use.

Aerial transect surveys have been conducted annually since January 1972. Total numbers of deer observed were used to indicate long-term trends and status of the population.

Herd composition, age-sex ratios, habitat utilization and behaviour were obtained from ground observations along streets, roads and trails. Most deer hit by vehicles on city streets were obtained for examination of general physical and reproductive condition, incidence of parasites, and food habits.

Status of the Deer Herd

Relative Abundance

White-tailed deer are not indigenous to Manitoba. Mule deer (*Odocoileus hemionus*), the true natives, probably have never occurred in densities found in most parts of its geographical range. We are not certain of the whitetail's arrival date, but they undoubtedly moved north and west from Ontario, Minnesota and North Dakota along major river valleys as the aspen-oak forest and aspen parkland were cleared and settled. Seton (1909) could not find any reference to whitetails in Manitoba in diaries and journals of explorers and fur traders in the early 1800s. He decided that it first appeared in Manitoba about 1881.

According to annual reports of the Department of Agriculture "large numbers of deer" were noted in the Charleswood and Birds Hill areas of Winnipeg as early as 1906. The Game Guardian suggested that a radius of 20–30 miles around Winnipeg be permanently closed to the hunting of any game animal. Specific references to city deer since then are scant; 1946 was noted as a year in which deer in Charleswood were poached in significant numbers. In 1950 and 1957, Charleswood deer apparently were in extremely low numbers. However, in January 1967, deer were believed to number over 250 and numerous complaints were received from nursery owners who thought the deer should be controlled.

Nearly 100 deer were in the Charleswood area from 1971–73 (Table 1). The severe winter of 1973–74 reduced the herd by 33 percent. However, herd recovery was rapid during two successive years of mild winter weather. This winter (1976–77) there are easily 150 deer or 30 deer/km^2.

The Charleswood herd illustrated the tremendous reproductive potential of deer in a short time span, particularly when they are on a good food supply. Our data indicate that during the severe winter, adult females were in good condition, the only sex-age class with fat reserves throughout the critical winter and early spring periods.

Available Habitat

In 1926, the 50.3 km^2 St. Charles Wildlife Refuge was established as a game preserve in response to a request by local residents. Most of the land within it is privately owned. As we examined aerial photos of the area it became obvious that

Table 1. Aerial deer surveys in the Tuxedo-Charleswood Area, 1972–76.

	No. of deer observed	Percent change over previous year
Jan. 3, 1972	81	–
Jan. 15, 1973	67[a]	−17
Dec. 18, 1973	88	+33
Dec. 19, 1974	59	−33
Dec. 10, 1975	109	+85
Dec. 14, 1976	138	+27

[a]Incomplete survey.

Table 2. The change in the amount of available habitat for deer in the Tuxedo-Charleswood Area.

Year	Area (km²)	Percent of the original habitat
1926	50.3	100
1948	14.3	28
1959	12.7	25
1968	6.2	12
1976	4.9	10

the area of available habitat (that is suitable escape and over-winter cover) for deer shrank from 50.3 km^2 in 1926 to 4.9 km^2 in 1976 (Table 2). We estimate that 10 percent of the original habitat remains in the form of Assiniboine Forest, a 285 ha natural park set aside by the City of Winnipeg, and in undeveloped areas on industrial property (Figure 2).

Movements

The Charleswood deer herd in largely sedentary. Some seasonal range shift may occur during or just after the breeding period and again in the spring after the snow recedes and before fawning (late March-May). In summer, the herd scatters out several kilometers from the wintering area to isolated woodlots, wooded fence rows and farm lots. We recognize that immigration-emigration of individuals probably occurs along the Assiniboine River. However, marked individuals have all been re-observed or recovered within the city limits and within 2–3 km of their initial capture site. Man-made barriers such as fences, building and heavily used streets probably prevent much exchange of deer between St. James and Charleswood.

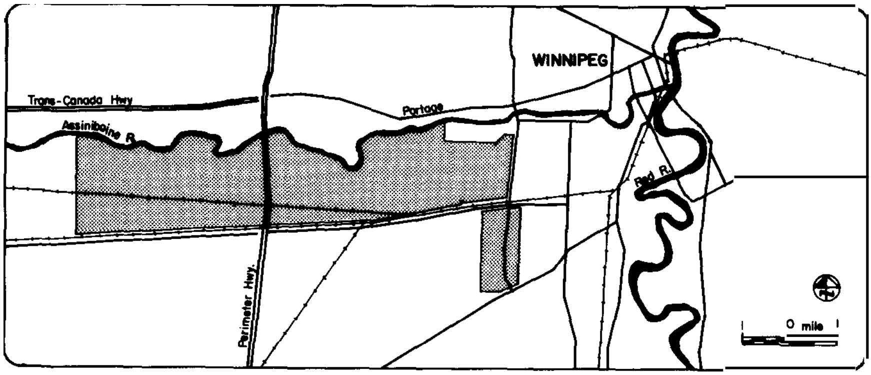
Food Sources

City deer densities are as high or higher than densities anywhere in Manitoba. One major reason is the close association of winter cover to readily accessible food sources. Major winter foods include sugar beet tailings left in fields, waste hay and grain around riding stables, waste hay at a garbage dump and concentrated alfalfa pellets and powder near a processing plant. Native foods such as snowberry, red-osier dogwood, chokecherry, rose and bur oak are present and eaten when available. However, they are not present in sufficient quantities to support the present deer herd if they had to rely on native food alone.

The location of the sugar beet fields, riding stables, and alfalfa processing plant directly influences where major deer crossings on streets will be from year to year. Groups of 20–25 deer may rest during the day nearly 2 km from a beet field. They must cross a double track, main railroad line and major street. Adequate resting cover is available adjacent to the field although they appear to return to "traditional" resting areas.

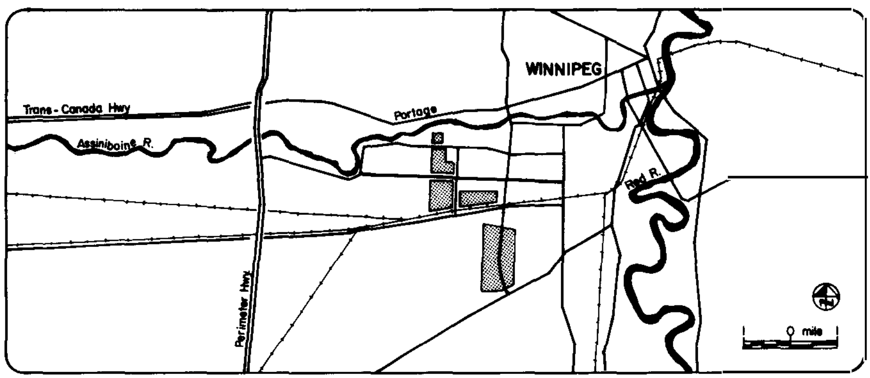
Mortality Factors

The greatest single mortality factor operating on this deer herd is vehicles. An average of 27 deer are killed on city streets in Charleswood. Most of these occur in



Boundary of St. Charles Wildlife Refuge

A.



Remaining deer habitat

B.

Figure 2. The relative area of available deer habitat (A) in 1925 and (B) 1976 in Charleswood.

the October-early December period and again in March-April. Deer move from resting areas to feeding areas across several major streets and railroad tracks on a daily basis requiring a minimum of two crossings per day per deer. Thus a herd of 25 deer cross a road 50 times per day during the dawn-dusk periods when rush-hour traffic is often greatest. Add the street traffic volume (170 vehicles/day) to the train traffic volume and the chances of a deer being hit become even greater. The paradox is that from late December through early March, no significant mortality occurs even though crossings continue. The radio-transmittered female was marked as a fawn in late 1971. She was not reobserved until 4 years later when she was retrapped across the street from her original capture location. She was then instrumented with a radio collar and her daily movements monitored from January through May. She crossed the street daily but was never hit.

Dogs are an occasional problem for deer, particularly in late spring when deer are in their lowest nutritional plane. Several deer are lost to dogs every year; the City of Winnipeg has a leash law that has been difficult to enforce. However, dogs are not a significant mortality factor.

Harassment by people occurs. Snowmobilers have been a problem in the past. We have observed children on bicycles and minibikes, horseback riders, motorists, and children with guns and bows and arrows chasing deer. They are not significant problems and the deer have adapted very well under most circumstances.

Illegal shooting does occur. Young boys with .22 rifles, native hunters, and poachers are a decimating factor on the deer population but overall they do not significantly influence the base population.

Parasites and diseases are not significant mortality factors. Of particular interest is the incidence of the nematode *Paraelophostrongylus tenuis*. The incidence in city deer is the highest anywhere in Manitoba. There are no reported cases of this parasite in any of the zoo ungulates such as elk, moose, caribou, or mule deer even though whitetails are free-ranging along the west side of the zoo.

Management Implications

City Development

There are several major commercial and urban developments proposed or underway which will have direct effects on the future of the deer herd. Most effects will be detrimental, but some will be compatible with maintaining deer through proper city planning.

Assiniboine Forest was set aside by the City of Winnipeg in 1974 as a nature park in which public use was limited. A master plan for development of the forest is being drafted by the Assiniboine Forest Task Force. Members of the task force include city planners, wildlife managers, botanists, zoologists, and environmental specialists. The intent is to prepare long-range development plans of the forest to insure that public use and preservation of the area are compatible.

Urban expansion is slowly closing in around Assiniboine Forest. New low density housing developments are proposed or under construction on three sides of the forest. Highrise apartments have been proposed on the northeast side if the Winnipeg City Council approves the sale of a private golf course there. While most of the low density housing developments will further remove tracts of escape and resting cover for deer, these areas will still be utilized for daily movements and dispersal between remaining blocks of deer habitat.

A major freeway has been proposed through the northern portion of the forest. Wilkes Avenue which bounds the forest on the south will soon be upgraded from its present gravel two-lane condition to accommodate the increased truck traffic volume associated with the piggyback terminal.

The freeway will eliminate deer access to the northern portion of the forest and the Assiniboine River. Provision for deer crossing Wilkes Avenue on the south will have to be made.

Construction of a controversial Canadian National Railway (CNR) piggyback terminal began in 1976. The City Council of Winnipeg and area residents did not accept a federal environmental impact study of the site. The development was opposed because of its location near a residential area, the increased truck traffic volume, street relocation, noise pollution, and additional railroad crossings. In spite of these objections, the terminal is proceeding and will be completed late this year.

The major travel and dispersal route of deer between Assiniboine Forest and industrial plant forest will be eliminated by the terminal. This winter nearly 20 deer were still crossing the construction area daily between resting and feeding areas.

A federal radar facility was proposed for installation on a 40-acre (16 ha) forest site nearly two years ago. It is still in the proposal stage. If the facility is constructed, deer access to the wooded portions could still be provided through low fencing (restricts dogs and people, yet provides free access to deer). However, any development of the side street as an entrance to the freeway will also become a major barrier to deer use of the proposed radar site.

Deer Management Program

All land is wildlife habitat. The degree in which this habitat is available and can be used is important to maintaining deer in a city environment. Certainly providing habitat requirements for songbirds in a city is much more easily done than providing the same for deer. Given the pressures of urban and commerical development on this deer herd, can a free-ranging deer herd be perpetuated in urban Winnipeg? We think that it is possible.

First of all, it is unrealistic to think that 150 deer can be maintained in the present available habitat. Their use of remaining habitat will have to be intensively managed, restricted or controlled. We believe that the long range goal for the deer herd should be to maintain them free-ranging as long as possible and to gradually adjust to a base population that remains viable but well within the natural capacity of the area to support them. This may be 25-30 deer if they were to rely on Assiniboine Forest alone.

One of the major objectives of Assiniboine Forest is to preserve habitat for deer. If they are to remain free-ranging for as long as possible, a deer underpass for Wilkes Avenue and the mainline of the CNR tracks will have to be constructed. Since the piggyback terminal will eliminate the major dispersal route from Assiniboine Forest, a secondary route will have to be developed in association with the underpass. We have been evaluating the studies in Colorado concerning mule deer use of underpasses (Reed et al. 1975). White-tailed deer commonly go under an open expanse bridge near Beaudry Provincial Park. Any underpass for deer will have to be relatively open. Building an underpass just for deer will be an expensive venture requiring strong justification for financing.

On-site management of Assiniboine Forest will include: (1) maintaining a major portion of the forest isolated from visitor use; (2) fencing to restrict people and dogs but to allow access to deer and other animals; (3) fencing to prevent deer-vehicle accidents on major streets and freeways; (4) developing existing habitat to provide a stable natural food supply; (5) creating an Assiniboine Forest Advisory Committee composed in part of wildlife managers to advise the city on specific wildlife management problems; and (6) providing for removal of surplus deer through live-trapping and transplanting whenever deemed necessary.

Low density urban housing and light industrial development are generally compatible with deer in the present situation. Such types of development in the agricultural and movement corridor areas would be the most compatible with maintenance of a deer herd.

The large forested area on the industrial forest property has never been specifically managed for wildlife or deer habitat. Wildlife managers could provide advice to plant managers on how to enhance deer habitat on their property with minimal effort.

Summary and Conclusions

The perpetuation of a free-ranging deer herd in Winnipeg hinges on the preservation and proper planning of Assiniboine Forest. Political and socio-economic pressures are continually bearing upon the area for other uses. Even some city officials suggest that the forest should be held in reserve for expansion of the Assiniboine Zoo. Urban developers see the property as ideal for low and high density housing. While some types of development adjacent to the forest are compatible with maintenance of a deer herd, the forest itself is essential to deer for the isolation and escape cover which cannot be guaranteed elsewhere.

The deer herd is flourishing. The population is too high to maintain itself solely on natural food sources. Deer have persisted in Winnipeg since whitetails first "invaded" Manitoba in spite of a 90 percent loss of habitat. Deer have demonstrated a remarkable adaptability to persist despite human harassment and loss of habitat. While they have adjusted to "city life," they cannot be described as semi-domesticated by any means.

This deer herd can be used by resource managers to illustrate to decision makers the use of this resource and to the general public the effects of various ecological and biological factors operating on any deer herd in the province. For example, the Charleswood deer herd has demonstrated its ability to quickly recover from the effects of severe winter conditions, to adjust to diminishing available habitat and to tolerate human pressure.

To maintain a free-ranging deer herd in Winnipeg will be a real challenge to city planners and wildlife managers. The costs will be great and whether Winnipegers are prepared to finance it rests with them. Donations are given to support indoor art galleries. Possibly deer maintained as living outdoor art forms for aesthetic appreciation have equal importance and priority with the people of Winnipeg.

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Managing Nongame Wildlife on Private Lands

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Introduction

The National Audubon Society was managing endangered species some 70 years before the Endangered Species Act was passed. In 1902, Mr. Guy Bradley was hired by the forerunner of the National Audubon Society to protect a colony of wading birds from plume hunters in southern Florida. Because egret plumes were worth their weight in gold, plume hunters shot Mr. Bradley on July 8, 1905. In 1910, legislation was passed outlawing the sale of plumes in New York City. With the market under control, the killing of egrets, herons, terns and Audubon wardens was essentially over; but the battle to save their habitat was just begun and is still going on.

Today National Audubon and other wildlife management agencies must still keep a watchful eye on the marketplace. With alligator hides bringing $18 per foot, certain raptors selling for thousands of dollars, durum wheat at $6 per bushel, unbroken North Dakota prairie at $500 per acre, the wildlife manager who ignores the effect of the marketplace on what he is trying to accomplish is extremely naive.

Part of the reason the National Audubon Society is a leader in endangered species management is because 50 years ago no other organization felt it could afford to expend money and manpower on species which had no commercial value. The demand for eagles, egrets, and whooping cranes was so low that no public money was invested in their management.

In the 1970s enough people were willing to spend enough money for the privilege of seeing an Everglade kite or a black-footed ferret that politicians at the federal level were willing to offer their constituents the Endangered Species Act. More recently several states have developed good nongame wildlife programs and are showing an interest in preserving critical wildlife habitat. In the preservation of unique habitat, The Wilderness Society has done an outstanding job, likewise The Nature Conservancy, Sierra Club, National Wildlife Federation, Wildlife Management Institute and other privately endowed wildlife organizations.

With those wildlife managers who suddenly find themselves concerned with species which are not considered "economically important," National Audubon is glad to cooperate. We hope you can profit from our experience in managing some of the following plants and animals.

Wood Stork

In 1954 the last virgin cypress (*Taxodium distichum*) swamp in the United States was preserved as the Corkscrew Swamp Wildlife Sanctuary near Immokalee, Florida. The remnant virgin swamp covered 425 acres (170 ha), providing nesting habitat for about six thousand pairs of wood storks (*Mycteria americana*). The nesting population was estimated at 6,000 pairs as late as 1961. Since 1970, we have not had more than 3,800 pairs attempting to nest. We do not know whether this apparent decline is caused by a shift to other sites or reflects an over-all decline in the Florida population; we suspect the latter.

Production of young has varied from 17,000 in 1961 to zero in years when the nesting attempt was abandoned. In the past 20 years, the nesting attempt has failed 10 times. During this interval, an estimated 75,615 young have fledged at the Corkscrew Swamp Sanctuary. We have not had more than three consecutive years of production. In the period from 1974 through 1976, for example, production was 3,800, 5,900, and 4,100 respectively. In 1977, however, the extreme cold and rain resulted in zero production.*

The nesting cycle is closely tied to the hydroperiod which has been drastically affected by the Corps of Engineers in response to agricultural and urban development. Nesting attempts often fail, both here and in nearby Everglades National Park, because surface water is either too high or too low.

Although wood storks nest in the cypress swamp, they feed in nearby wetlands—marshes, shallow ponds, ditches—anything that contains water and fish. Being tactile feeders, they depend on concentrations of fish resulting from falling water tables. The nesting season usually begins in December or January and continues through March. An unusually cold or rainy spell may cause the adults to abandon eggs or young in the nest, When surface waters are too widespread, the forage fish are likewise, and the "grocery flight" from open pond to cypress swamp is discontinued because the payload is too light. In contrast, an extreme drought may cause the storks to abandon their nesting attempt almost before it begins.

In an effort to counteract these extremes, National Audubon purchased about 6 square miles (1,536 ha) of wetlands adjacent to Corkscrew Swamp in 1968. In 1969 a pilot project was begun on 63 acres (25 ha) of abandoned tomato fields to study the feasibility of supplementing natural fish production in ponds which could be stocked, fertilized, and manipulated through water level control. Space does not permit a detailed report on results at this point, but research in progress (Hansen unpublished) indicates that this is a mangement tool that, under certain condition, may spell the difference between success or failure of the annual crop. Information on costs can be obtained from the National Audubon Society Research Department, 115 Indian Mound Trail, Tavernier, Florida.

Everglade Kite

In 1966, the U.S. Bureau of Sport Fisheries and Wildlife included the Everglade kite, ***Rostrhamus sociabilus*** on the list of endangered species. It has been estimated that 80 percent of the birds are concentrated in the southwestern part of Lake Okeechobee. In 1938 this area was leased by the State of Florida to the National Audubon Society as a wildlife sanctuary. A warden-naturalist has patrolled the area on a year-around basis ever since.

In the past decade, our data show the number of observed nests on Lake Okeechobee fluctuating between zero and 28. For reasons as yet unexplained, the number of nests increased markedly in 1973 to 28, while for the preceding 10 years it had not exceeded five (Chandler and Anderson 1974). The number of nests in 1974, 1975, and 1976 was 23. When this manuscript was written, the 1977 season was still in progress, with 5 nests under observation. It was obvious by February 1

*Hansen; personal communication.

that the severe winter had frozen a few eggs and apparently had severely reduced the population of the apple snail (*Pomacea caliginosa*).

Production of fledglings has varied from zero in 1971 to 14 in 1972, 21 in 1973, 23 in 1974, 23 in 1975, and 20 in 1976 (Chandler unpublished).

Lake Okeechobee water levels are controlled by the U. S. Army Engineers. Drawdowns apparently weaken the support for the cattail (*Typha sp.*) in which the kites usually nest. High winds often overturn these nests, dumping eggs and/or young into the water.

In 1973 Warden Chandler noticed a kite egg lodged in a cattail clump. He assumed the egg was from a destroyed nest but could not find traces of the nest. He cut several cattail leaves and stems, built an artificial nest in which he placed the single egg. The adult kites remained nearby. To Chandler's surprise, the kites accepted the nest and laid another egg two days later.

Warden Chandler later decided to place nests which were about to capsize in aluminum baskets. The kites readily accepted nests in these baskets and losses from wind damage decreased accordingly.

Warden Chandler's considerable experience enabled him to predict those nests which could not withstand winds of the velocity sometimes reached on the lake. Such nests are now routinely transferred to baskets placed on poles at the same height above water as the original nests.

Our original baskets, made of aluminum straps, were too shallow and expensive. The wind frequently blew the nests out of the saucer-shaped containers. Chandler designed a basket, 14 inches in diameter by 8 inches deep (35.5 cm by 20.3 cm), of welded wire which has given highly satisfactory results. In the last 3 years, over 90 percent of the fledgling kites came from these baskets.

The approximate cost per basket is $6 for the materials.

The kites usually begin nesting in early January. In recent years the duck season has extended through January 20. Some concern has been expressed over the effect of duck hunters and nesting kites occupying the same habitat at the same time. On June 1, 1976, Warden Chandler informed the Assistant Secretary of Interior that, for years, he had received nothing but the finest cooperation from hunters, fishermen, and airboaters in regard to the kites. He told Secretary Nathaniel Reed that closing any portion of Lake Okeechobee to any of these recreational pursuits would, therefore, be counterproductive. The kites are so tame that uncooperative recreationists could easily wipe them out. He did point out the overlap of the duck hunting and kite nesting seasons and he recommended that possible effects should receive serious study.

The Everglade Kite Recovery Team now has this potential problem under consideration and their recommendations should be forthcoming soon.

Least Tern

In 1966 on the Paul J. Rainey Wildlife Sanctuary in Vermilion Parish in southwestern Louisiana, we built an island in Belle Isle Lake. Approximate dimensions were 70 yards (64.2 m) by 20 yards (18.3 m); with an average height of one yard (.9 m) above mean high tide.

A floating dragline with a 12 yard bucket worked 71 hours building a foundation about 70 yards (64.2 m) by 160 yards (146.7 m). This was allowed to settle for 3 months, then the dragline returned and spent 36 hours adding another layer of earth. One month later, 3,000 cubic yards (2,307 cu.m) of ground oyster shell were spread on the island. Total cost for materials and construction was about $15,000 (Lege 1968).

On May 4, 1967, a flock of about 300 least terns (*Sterna albifrons*) occupied the island. Upon arrival the flock contained a few Forster's and black terns. When the least terns started nesting they apparently drove off the other species, although one pair of black terns nested that year. Since then, about 300 pairs of least terns have nested there annually to the exclusion of other tern species.

Production of young for the past decade has held fairly constant, averaging about 500 annually. We have banded a total of 651 young terns in the last 3 years. Studies of nesting behavior are under way (Lege unpublished).

The least terns apparently refuse to nest among the vegetation that normally invades the bare gravel; therefore, this must be eliminated by mechanical or chemical means if the tern colony is to be maintained.

Reddish Egret

Although the other species of egrets and herons have recovered quite well from near extinction at the hands of plume hunters, the reddish egret (*Dichromanassa rufescens*) has not. No one seems to know why. Most of the entire population now occurs on National Audubon wildlife sanctuaries.

Early references to reddish egret populations are so sketchy that it is difficult to piece together long-term populations trends. In Florida the species was apparently extirpated about 1927 (Howell 1932). Eleven years later it reappeared in the Keys when a nest was found by Thomas C. Desmond (Desmond 1939).

About 40 years ago, the National Audubon Society transferred eggs from Green Island, Texas to Florida (Sprunt 1954). They were flown to Jacksonville and placed in the nests of herons in a nearby rookery. Most of the eggs failed to hatch, but at least one young reddish egret was raised by the foster parents and survived for about a year. In the last 40 years there has been a slow but steady increase in Florida until the population now is estimated at 200 pairs.

In Louisiana there are no acceptable breeding records for the early part of this century. There were between 30-50 pairs by the early 1970s and a survey by John Portnoy, sponsored by the U.S. Fish and Wildlife Service, indicated 151 pairs in 1976.*

Texas has apparently always been the stronghold of the reddish egret. In 1920, T. Gilbert Pearson (Pearson 1921) found 500 pairs on the Second Chain of Islands. On Green Island, near Harlingen, he estimated between 5,000-10,000 pairs of herons of which "the dominating species was the Reddish Egret."

In 1965, Alexander Sprunt, IV estimated only 55 pairs of herons, all species combined, on this same Green Island, of which about 30 were reddish egrets. This Green Island population of reddish egrets has since recovered to between 500–700 pairs. We estimated the total Texas population at 1,600 pairs in 1976.

A very tentative aerial estimate for Mexico is 350 pairs, compared with a total of 2,000 pairs for the United States, or an over-all population of 2,350 pairs. These are obviously very rough estimates but apparently the best available.

We strongly suspect that the drastic decline on Green Island in the mid-sixties was caused by heavy doses of insecticides washing into the Intracoastal Canal.

*John Portnoy 1976; personal communication.

Following the ban on DDT, this and other species of wading birds are gradually increasing. By far the most significant increase has been on Green Island which the National Audubon Society has leased from the State of Texas until 2005.

We believe that protection by private, state, and federal enforcement personnel is adequate; we wish we could say the same for the quality of the environment.

Roseate Spoonbill

Published references on roseate spoonbill (*Ajaia ajaja*) populations prior to 1850 are of little consequence. The early ornithologists who mention spoonbill colonies include Bartram, Barton, Wilson, Audubon, Nuttall, Williams and Gambel (Allen 1942). From their comments we can assume that spoonbill colonies existed over much of south Florida and along the Texas coast.

Between 1850 and 1890, however, nearly all spoonbill colonies within our borders were destroyed. The end of the Civil War was followed by settlement of Gulf Coast wilderness; an ecological change to which the spoonbills could not adjust. The use of feathers by the millinery trade reached a peak in the 1890s. The beautiful feathers of the spoonbill were never in millinery demand, probably because their brilliant colors fade in a short time. Unfortunately, however, the big pink bird with the flat face is inordinately shy at nesting time and will abandon its nest at the slightest provocation. The shooting of egrets in colonies containing spoonbills would undoubtedly cause desertion by the latter even though no spoonbills were actually killed.

Because the coastal lagoons of Texas were more accessible than the mangrove swamps of Florida, spoonbills were first driven out of the Lone Star State; later they were very nearly extirpated as breeding birds in Florida. There was apparently a small breeding colony surviving in southwestern Louisiana by the turn of the century.

Any wildlife species dependent on wetlands is threatened by very powerful forces. Defeating the plume hunters was child's play compared to stopping the three government bureaus engaged in stream straightening and drainage, plus the private developers who want to destroy the mangrove swamps and estuaries on which spoonbills depend.

Robert Porter Allen, whose monograph on the roseate spoonbill is still the classic for this species, concluded that the return of breeding spoonbills to Texas and Louisiana was from a nucleus in Mexico, able to wander north and spread east along the Gulf. To quote Allen (1942), "the National Audubon Society offered these flocks protection and encouragement and they have prospered remarkably." Today, 35 years later, the spoonbill population in Texas is fairly stable. The largest colony is on an Audubon Sanctuary known as Vingt'un Islands in Galveston Bay. This colony contains between 400–700 pairs of "pink curlews." We estimate the total Texas population at 1,500–2,000 pairs.

On Vingt'un Islands, planting salt cedar (*Tamarix gallica*) helps not only in stabilizing the island against erosion, but provides nesting habitat readily used by spoonbills.

Louisiana still has small colonies of spoonbills on the Sabine and Lacassine National Wildlife Refuges. There is also a small colony of about 12 pairs on Audubon's Paul J. Rainey Sanctuary.

Recovery by the south Florida population has been somewhat slower in spite of the protection offered by several Audubon Sanctuaries in that part of the state. A small colony of about 20 pairs has persisted on Cowpens Key near Tavernier for several decades, but doesn't seem to increase significantly.

In Tampa Bay, spoonbills disappeared as nesting birds about 1912. In 1975 warden-biologist Frank Dunstan discovered 20 nests on Alafia Banks. The species renested there in 1976 and we hope it will continue to do so from now on. We estimate the total nesting population in Florida at 550 pairs. We suspect the Florida population of both breeding and non-breeding birds is heavily dependent on birds from the West Indies.

In summary, when spoonbills began to migrate once more to the Texas coast about 1920, there were laws to protect them and wardens to enforce those laws. Shortly thereafter the National Audubon Society established sanctuaries along the coast such as the Vingt'un Islands in 1932, the Second Chain of Islands in 1934, Green Island in 1955, and several other areas where spoonbills are known to congregate.

Eastern Brown Pelican

Most of our work with this endangered species has been in cooperation with the states of South Carolina, Florida, Louisiana and Texas. We maintain wildlife sanctuaries on several islands in Tampa Bay, Florida, which provide breeding habitat for between 500–700 pairs of birds. We also have the Alexander Sprunt Memorial Sanctuary near Charleston, South Carolina with 1,500 nesting pairs and a few pairs still occupy at least one sanctuary on the Texas Gulf coast.

Although there is strong suspicion that the virtual extirpation of breeding brown pelicans (*Pelecanus occidentalis*) in Louisiana and Texas in the 1950s was due to insecticides, this does not explain why only the brown pelican was known to suffer so severely. A breeding population in the "Pelican State" was re-established through the joint efforts of the Louisiana Wild Life and Fisheries Commission and the Florida Game and Fresh Water Fish Commision. This population built up to 400 in 1975, when another die-off occurred. This time the available evidence clearly indicated insecticide as the cause of death.

Florida's population has remained relatively stable in recent years although degradation of the water in Tampa Bay, for example, could limit the food supply. Turbidity resulting from harbor deepening and dredging by the Corps of Engineers is a constant threat.

We hope we have seen the last of dredge and fill projects which destroy mangrove swamps and salt marshes in the estuaries. The fight to save our Rookery Bay Sanctuary south of Naples, Florida has been long and costly. At this moment, it appears that the habitat of the pelicans and other marine birds, mammals, and reptiles has been saved from the housing developers.

One of the most destructive dredge and fill projects was built in Tampa Bay in 1966. The retaining levee around the landfill broke, allowing silt to cover the extremely fertile shallow bay bottom, surrounding an Audubon Sanctuary known as Whiskey Stump. It took considerable legal talent, time, money and public demand to force the developers to clean up their mess. After 10 years, however, the productivity of the area has been fairly well restored. A certain developer is painfully aware of the cost of destroying the habitat of an endangered species.

Whooping Crane

In the late 1940s, Robert Porter Allen, Audubon's tireless wading bird research man, studied the behavior and food habits of the whooping crane (*Grus americana*) on its wintering grounds (Allen 1952). Allen's work helped to spark sufficient interest and public support to enable the U.S. Fish and Wildlife Service to establish the Aransas National Wildlife Refuge.

In recent years, the feds have lacked the money and manpower to properly manage their refuges. When Audubon recommended research on the wintering birds at Aransas, they were told they would have to do it themselves, as Allen had done 30 years before. Consequently, David Blankinship is studying the food habits, the habitat, and the behavior of the whooping cranes at Aransas (Blankinship 1976).

On the nearby Second Chain of Islands and Matagorda Island, where wintering cranes spend part of their time, our routine patrol keeps disturbance to a minimum.

It is possible that the population at Aransas may someday approach the carrying capacity of the refuge. If so, a study of various factors that might limit that capacity is in order, and that's what we're doing.

Miscellaneous Sanctuaries and Wildlife

In addition to the wildlife species and sanctuaries, mentioned above, there is a total of 69 sanctuaries either owned or operated by the National Audubon Society and its local chapters. To mention just a few, there is the Rowe Sanctuary in Nebraska in the heart of the sandhill crane (*Grus canadensis*) staging area; Eagle Rock in Colorado, stronghold of prairie falcons, (*Falco mexicanus*), golden eagles (*Aquila chrysaetos*), and other raptors; the Starr Ranch in southern California harbors a few cougars plus a very diverse flora and fauna; our naturalist at the Sespe Condor Sanctuary helps monitor the condor (*Gymnogyps californianus*) population, works with the Forest Service and Fish and Wildlife Service in artificial feeding experiments, and lectures throughout the region on the plight of this endangered species (Logan, Klataske, and Wicht 1976).

Alkali Lake in North Dakota is an important waterfowl production and prairie restoration area. Eastern Egg Rock in Maine is the site of a puffin (*Fratercula arctica*) restoration project. We have salt marshes in Connecticut and on the Hudson River, a cypress-tupelo swamp in South Carolina, a plantation on which we are managing timber, domestic crops, and wildlife, also in South Carolina.

In addition to work with these plants, birds, and mammals, in recent years we have cooperated with Louisiana, Arkansas, and Mississippi in an attempt to restore the alligator to its former range. We are managing this species on several of our sanctuaries in the Southeast.

Space does not permit mention of the unique features or the wildlife management and interpretive programs found at other sanctuaries. We have descriptive brochures of all of these which are available from our central or regional offices, or from the Sanctuary Department in Sharon, Connecticut.

In a few cases, Audubon land is leased to the state or federal government to be operated as a wildlife refuge. The National Audubon Society would like to thank the various state and federal wildlife agencies for their cooperation in the past. If there is any way we can be of help with any wildlife management problem, be it with endangered species, game or nongame, in the biological, social, or political arena, we will be glad to do so.

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Resource Management Information for Decision Makers and Users

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National Overview: Cooperative Extension Service Aids Wildlife Management

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Introduction

Wildlife management needs the Cooperative Extension Service. Wildlife occupies private land covering two-thirds of our nation and the Cooperative Extension Service was developed to aid the managers of those lands. Extension has people in every county who convert scientific and social information to public action. Aid to agricultural production was the goal of the Smith-Lever Act which established the Cooperative Extension Service in 1914. Now, Extension aims to serve all people (Smith and Berryman 1962). In 1929 Leopold reported that the enormous and powerful machinery of agricultural extension had not been employed for wildlife concerns. He saw inputs through agricultural high schools, county agents and the farm press. Today, wildlife is an active partner in Extension, but only a minor shareholder.

Bode (1938) updated the youthful extension efforts in wildlife conservation to 1937. Berryman (1960) called wildlife extension a new and potent management tool. At that time only 17 states had wildlife extension programs. In 1976, 23 states reported that 46 persons had duties as wildlife extension specialists (Benson in press). Those data underestimate persons dealing with ocean fishery programs and overestimate the number of terrestrial wildlife specialists. These few wildlife specialists serve as independent resource practitioners and catalysts that move the machinery of the larger Cooperative Extension Service toward meeting educational and management goals relating to wildlife.

We extension wildlife specialists believe that a significant part of wildlife management can be carried out through our organization. However, it is imperative that the slow progress we have made in 63 years be speeded up. All states have wildlife needs that extension can handle best. Unfortunately, over half of the states lack specialist positions. In addition, the magnitude of needs associated with wildlife limits the scope of programs within states that have wildlife extension personnel.

In preparing for the future, we must understand the place of extension in wildlife management. We must understand the educational techniques unique to extension. We must know what jobs are being done and the type of individual doing the job successfully. We will explore those criteria by reviewing literature and by examining the results of the author's 1976 survey.

Extension in Wildlife Management

Smith and Berryman (1962) described Extension as an extensive organization with its nerve center on university campuses, grassroots in local communities and channels extending to the nation's capitol. Although there is no national coordinator for wildlife interests, the entire services of Extension are available through the wildlife specialists. Specialties from associated Extension disciplines include agriculture, agronomy, livestock, range management, forestry, recreation, community development, home economics, youth, chemicals and other industries and audiences. They operate within a communications network having media specialists that direct messages to forestry, agricultural, and associated audiences.

The Extension network is often overlooked by traditional wildlife managers. Only 4 percent of the wildlife specialists surveyed formulated their objectives and priorities from public agency input. Conversely, wildlife agencies and organizations were the audience of 38 wildlife specialists 1–20 percent of their time and 7 specialists spent 21–40 percent of their time with wildlife agencies and organizations. I speculate that agencies utilize the expertise of specialists when offered, but fail to use it adequately as a planned and integrated part of management efforts.

Techniques of Extension Education

Extension wildlife specialists communicate in a direct and active way to help people help themselves. The survey documented that personal and group contacts, respectively, ranked highest followed by written and electronic media (Table 1). Gilbert (1975) reported that state conservation organizations ranked magazines, pamphlets and newspaper articles highest, followed by personal appearance programs, television programs, field contacts, and radio programs. Similar techniques were used by both groups, but conservation organizations used written media to contact more general publics. Extension used media to augment personal contacts. Communication was not considered an objective in itself, but rather a tool of education for a planned and audience-oriented program.

State organizations and extensionists have the objective to use education and communications techniques to promote understanding and to influence opinion.

Table 1. Percent of time extension wildlife specialists ($N = 46$) spent using communication techniques for educational purposes (Benson in press).

Communication technique	Number of specialists using technique Percent of time					Total number of specialists
	1–20%	21–40%	41–60%	61–80%	81–100%	
Personal contacts	19	11	11	2	2	45
Group contacts	26	10	8	1		45
Newspapers	38					38
Audio-visual	30	2	1			33
Newsletters	29	2		1		32
Radio	31					31
TV	28					28
Magazines	22					22
Other ($N = 5$)	2	4	1			7

The personal and active educational process used by Extension is the most influential means of promoting understanding and opinion change. Cutlip and Center (1971) listed several "laws" of public opinion that relate the importance of events and self-interest to opinion change. They explained that active and personal approaches turn objectives into events. They concluded that people ignore opinion unless it affects them. Messages must be stated in terms of the audience. Persuasion is predicated upon acceptance of messages relating to personal needs and drives that are in harmony with group norms and loyalties. They stated that people do not accept ideas separated from action, but tend to reject appeals for action unless a motivational force is provided.

Another important law is that listeners must have confidence in the speaker or they are less likely to listen or to believe. Messages must be credible and are best transmitted through mass media coupled with face-to-face reinforcement. Awareness is developed through mass media. Adoption of messages is aided by personal experiences. They also explained that opinion is most likely to change when conclusions are explicitly stated, rather than allowing the audience to draw their own.

A close look at Extension reveals that personalized education in the interest of a defined audience is a common practice by wildlife specialists. They work with knowledgeable and respected county agents that understand needs within the community. Specialists add credentials and credibility from the university environment to agents at the grassroots level, thus enhancing the credibility of both. The ability to serve wildlife without supervision from management agencies allows wildlife specialists to escape the "company man" criticism. They are not part of the often criticized "hunting and fishing organizations," that by necessity have self-interests and organizational missions. Specialists can say and do what is best for wildlife. The university allows independence while maintaining high standards of conduct.

Individuals in Wildlife Extension

Extension wildlife specialists are trained in natural sciences with expertise in education, ecology and management of wildlife populations and their habitats. Forty-eight percent of the specialists have a Ph.D., 37 percent have masters degrees, and 15 percent have bachelors degrees.

The autonomy of their position allows one-fourth of their efforts to be self-motivated from needs that develop. An additional 23 percent of time is spent giving direct aid in response to general requests.

Smith and Berryman (1962) gave an excellent description of a theoretical wildlife specialist. I would like to believe that their description is correct.

> The specialist will have more than adequate professional experience and technical training with equivalent skills in communication and educational techniques. He will be a dynamic individual with the courage to stick to principles in spite of personal and political pressure. He will be an astute diplomat with the ability to remain objective and unbiased. He will be able to evaluate research findings and promote and instigate research where required to further his educational program.
>
> The wildlife extension program will be based on sound objectives and established priorities as determined by proven needs and developments. The program will include the traditional educational approach, but also recognize the advantages of applying legitimate influence and pressure through the medium of committee, commission, advisory board, and personal contacts, both inside and outside the extension service. His program will be based upon sound principles of wildlife and related resource management, which may or may not coincide with current policies of resource management agencies or users of natural resources. His program will attempt to resolve such differences when they occur. His program will recognize the competitive demands upon soil, water, plants and space, and intimately relate the wildlife resource to total resource development. His program will be based upon the conviction that the wildlife resource is a recreational, esthetic and economic asset to our nation and is worth fighting for.

What Wildlife Specialists Are Doing

The scope of wildlife work is enormous. Specialists deal primarily with education about wildlife and habitat management followed by wildlife-based and wildlife-influenced private enterprises (Table 2).

Audiences include any demographic region or wildlife interest group. Rural producers require assistance with damage problems and wildlife-based enterprises. Wildlife agencies and organizations need help to provide management, production, and recreation on public and private lands. Urban and rural sectors seek greater knowledge about wildlife because of recreational, aesthetic and ecological concerns. Owners of rural and urban areas need assistance with managing the land for wildlife as a hobby. Clients represent youth and adults. Most specialists spend a small percent of their time with youth and slightly fewer specialists spend greater periods with adults.

The Future

Wildlife extension is slowly growing up. We have sufficient staff to merit coordination yet not enough to serve all needs. The Extension form of teaching basically follows the theoretical principles of education and opinion change. Extension networks cover a wide range of expertise that wildlife management agencies still neglect. Wildlife management agencies are usually closer to wildlife issues than extensionists, so it becomes their responsibility to keep us active on important and major issues. Being separate, perhaps we can lend an overview, freshness, and the broad-based expertise necessary to get a job done.

Those concerned with the future of our wildlife resources can and should work with Extension wildlife personnel to generate greater public understanding and appreciation for wildlife. With your enthusiasm and expertise and our resources,

Table 2. Percent ot time extension wildlife specialist (N = 46) spent on various extension tasks (Benson in press).

Task	Number of specialists performing tasks Percent of time					Total number of specialists
	1–20%	21–40%	41–60%	61–80%	81–100%	
Natural resources education	34	2	4			40
Youth programs	25	2	2	1	1	31
Habitat management	22	6				28
Pesticides and pollution	27					27
Other (N = 30)	18	4	4		1	27
Fish farming	23	2	1			26
Wildlife enterprises	26					26
Landowner/sportsmen relations	25					25
Animal damage control	15	7		1		23
Fish pond management	18	3				21
Fish bait production	13					13
Marine fisheries	9		1	2		12
Game bird production	11		1			12
Fur farming and harvest	10	1				11

we can have an impact greater than the sum of our independent efforts. In cooperation, then, we can insure the conservation of wild things that have always been an integral part of our heritage and will be our ecological legacy.

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National Overview:
Portrait of One Extension Wildlife Specialist

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History of Position

The state I will be discussing is in the east north central region. It is a major agricultural state with a population of about 11 million. Seventy percent of its people live in major metropolitan areas which are highly industrialized.

In 1951, the chief of this state's fish and game agency, a former member of the faculty of the state land grant university, was instrumental in the creation of a new position on the staff of the Agricultural Extension Service. This position was entitled Extension Specialist, Wildlife Conservation. It was to be funded by a grant from the state fish and game agency. This full-time position was filled on July 1, 1951.

Project goals for the first year included: development of a wildlife newsletter for distribution to all county agents to broaden their understanding of wildlife; provision of assistance to farmers in the solution of wildlife problems; creation of greater awareness and appreciation for wildlife through news stories, radio broadcasts and illustrated lectures; and assistance to the state fish and game agency in "selling" programs to improve farm game habitat. Other goals related to farmer-sportsman relations, conservation education in 4-H camps and the development of 4-H club projects in wildlife management. This first wildlife specialist set his goals pretty high and his results that first year were noteworthy. He made good progress in all areas, but three were especially interesting. He noted in his first annual report that the state now had its first 4-H wildlife management project; that 165 miles of multi-flora rose had been planted, and 285 acres of odd areas had been developed to benefit wildlife. Remember, this was 1951–1952.

This specialist survived eight years of travelling over a state without interstate highways; presenting his own budgets to the state fish and game agency annually, and working toward his annual goals before resigning to enter a prestigious eastern university to pursue a Ph.D. in land economics. His successor, a recent M.S. graduate in wildlife management from the hiring institution, started on January 1, 1960. He still holds this position 17 years later.

Sources of Support

Total financial support of this position continued to be provided by the state fish and game agency through 1961—a period of 10 years. That year, one-half of the support was withdrawn and assumed by the state extension service and the following year the other half was similarly assumed.

This change in funding source had both benefits and drawbacks. First the benefits. As long as someone else was paying the bill, this specialist never really felt like he was a full-fledged member of the extension staff. Once the Land Grant university was funding the position, chairmen and administrators took a stronger interest in the program. This change also strengthened the youth aspects of this program. Naturalists selected, trained, and supervised by this specialist to staff conservation education programs in 4-H camps were never really made to feel like a part of the camp staff as long as the camp corporation had no direct investment in them. Withdrawal of state fish and game agency support forced camps to hire their own naturalists, in whom they then had a vested interest. The major draw-back to this change in support affected the specialist's relations with the state fish and game agency. No longer tied directly to it, his contacts with it decreased. The other major draw-back was a temporary slump in the 4-H camp conservation education program. Camp corporations were not financially able to assume the salary of a naturalist immediately, so some camps were without such a position for a couple of years.

Working Relationships with Others

The effectiveness of an extension specialist is directly proportional to his relationships with his peers. Let's look first at his relationships within the land grant university. The specialist of whom I am speaking was originally placed in the Department of Zoology in the College of Agriculture. His immediate supervisor was the chairman of this department, who had virtually no knowledge or appreciation of extension education. As a result, this specialist received little, if any, support or encouragement.

The creation of a College of Biological Sciences at this Land Grant university in 1966 removed zoology from the College of Agriculture and the wildlife specialist was moved to a Department of Entomology. Here he operated without direct contact with other natural resources specialists. Finally, in 1968, a School of Natural Resources, including a Division of Fisheries and Wildlife Management, was created and with it came a permanent home for the wildlife specialist. It put extension foresters, a parks and recreation specialist and this specialist into one unit with an administrator who understood extension and the role of the wildlife specialist.

There is another relationship enjoyed by extension specialists which can have profound effects on their programs. This is the relationship with other members of the subject matter unit of which he is a part. As I stated earlier, this specialist has been a member of the faculty of a School of Natural Resources in a College of Agriculture since 1968. Here he associates daily with researchers and resident teachers in fisheries and wildlife management. Due to this working relationship, in 1968 this specialist was asked by the dean of the college to assume temporary leadership of a depredating bird control research project. Today, this specialist continues to "temporarily" involve himself in this research. A contract adjustment was made to facilitate this added responsibility, resulting in a loss of 35 percent of the extension wildlife specialist's time to research. Another challenge presented itself as rapidly increasing numbers of students with interests in fisheries and wildlife management overtaxed the ability of resident instruction faculty members to service their needs. When this happened, this specialist agreed to assist wherever possible. As a result, he is now an advisor to approximately 30 students, including 5 honors students and 5 graduate students. No contract adjustments have been made to accomodate this added responsibility.

Finally, it became apparent several years ago that wildlife majors at this specialist's university were woefully lacking in communications skills. You guessed it, the wildlife "communicator" was asked to develop and teach a course entitled "Communicating Wildlife Interests and Concerns." Again, no adjustments in his contract were made. The end result is a faculty member who is now responsible for an ongoing research project, advising students, and teaching a course, in addition to trying to maintain a commitment to the extension education program in fisheries and wildlife.

Outside of the university, the specialist has enjoyed a close working relationship with others concerned with the management of natural resources. He counts among his closest associates the Soil Conservation Service biologist, the U.S. Fish and Wildlife Service biologists, including leaders of both a wildlife and fisheries unit, and many members of the staff of the state fish and game department. It should be pointed out that most of these continuing relationships are largely due to this specialist's own efforts rather than efforts by the other agencies to involve him.

Major Program Areas

This extension fisheries and wildlife specialist identifies three major programs in his annual plan of work. These are: general wildlife appreciation and management, sub-divided into youth and adult segments; vertebrate pest control; and aquatic management. Of course, time must also be planned for extension responsibilities including reporting, service on extension committees; and other administrative tasks.

The first program, wildlife appreciation and management, is a broad, general one. Its objectives are to stimulate interest in fish and wildlife resources and to assist interested individuals and groups to manage these resources more effectively. It is under this program that 4-H and other youth work falls. Here too are serviced all requests for help in identifying and producing all nondomestic terrestrial vertebrates. This program involves approximately 20 percent of the specialist's time.

The second program area deals with vertebrate pest control. Activities in this area are of two general types. The first involves responding to individual requests, both letters and phone calls, from county agents and individual citizens seeking help in the control of vertebrate pests. Over 250 such requests were handled last year, ranging from bats and squirrels in attics to snakes in basements; meadow voles, birds and deer in crop production areas; and such unusual problems as tree frogs drowning out the performers in an outdoor drama. A close working relationship with the U.S. Fish and Wildlife Service enables this specialist to make use of many of the animal control leaflets which the service prepares in answering these requests. The second major activity involves serving as a teacher in many county, area and state-wide meetings. Significant among these is the specialist's annual participation in the training sessions for commercial and private pesticide applicators. He devotes approximately 15 percent of his time to vertebrate pest control activities.

This specialist has served as the principle source of information on aquatic management subjects in his state since his position was created. Originally focusing on farm ponds, this program has expanded to include virtually all privately managed waters of the state. Over 400 individual requests for assistance are received and responded to annually. Many of these are for aid in identifying specimens of aquatic vegetation, sometimes partially decomposed. He also conducts about 25 pond management schools annually in which over 2,000 private impoundment owners and managers participate. In addition, he conducts annual training sessions for over 300 persons requiring certification as applicators of aquatic pesticides. The principal device used in this program area is an extension bulletin on aquatic management which is revised about every four years. This bulletin is considered among the most "popular" extension bulletins in his state and over 100,000 copies have been printed and distributed in the past 15 years. The specialist devotes about 30 percent of his time to the conduct of educational activities in aquatic management.

These three major program areas account for about 65 percent of this specialist's time. The remaining 35 percent is spent serving on a variety of extension, school and college committees, completing the reports required by all extension workers and in similar tasks.

This specialist annually reaches over 6,000 people through direct contacts in educational meetings and indirect contacts such as written and telephone responses to requests for fish and wildlife management assistance. He also reaches thousands more with his monthly radio tapes (made available to over 50 local radio stations) on timely wildlife subjects, his occasional television appearances, and the news releases and educational publications which he authors.

Problems and Solutions

I don't want to give the impression that the specialist does not have problems. He does. One of his biggest is the frustration caused by the numerous new challenges for educational assistance which he encounters, but does not have time to respond to. This problem could be remedied by the hiring of additional specialists, a need which has been articulated and documented annually. A second problem is the increasing costs of printing, telephone and mail service, and travel. State extension services have experienced budget restrictions in recent years and the usual way to cut costs is to reduce expenses. The specialist is now required to operate on less money for these expenses than he had five years ago.

One of the biggest strengths of the extension specialist program is its ability to respond to people's expressed needs. This requires sufficient personnel to service these needs and adequate support to enable specialists to prepare educational materials, travel to conduct educational programs, and continue to increase their knowledge and understanding of their chosen field. This should include field visits as well as the opportunity to attend and participate in professional meetings such as this one.

All of these problems result from fiscal constraints placed on state extension services. Several things can be done to ease these problems. Mr. Berryman will be discussing some of these later in todays program, but I would like to relate those I have identified, for I am the extension wildlife specialist I have been discussing. First, recognition at the federal level of the role of the extension wildlife specialist by the creation and staffing of a position in the Federal Extension Service would strengthen the identity and direction of this program in individual states. Second, a better understanding of the role of these resource management professionals by other natural resources managers and their support at the state level will insure added fiscal support. Finally, recognition by state extension administrators that fish and wildlife resources deserve the same level of support as the more traditional subject matter areas of agronomy, entomology, and horticulture would help.

Conclusions

The people of my state have benefited from extension wildlife programs for over 26 years. With your interest and support they can benefit to an even greater extent in the future and states without extension wildlife specialists can benefit through the creation of such positions. It should include faculty status in a department of fisheries or wildlife management or related department at the Land Grant university. It should be funded in such a way as to afford the specialist the same freedom of expression as other university faculty members and it must have adequate fiscal support. I believe in the Cooperative Extension Service, its educational programs and delivery systems, and the role which it can play in providing up-to-date fish and wildlife information to the public.

National Overview:

NOAA's Sea Grant Program and Resource Users

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Introduction

The evolution of publicly supported programs is a topic which has the voting public's attention. Investigative reporters and consumer groups have attacked some programs as being ill-conceived, poorly administered or straying from intended goals. Perhaps there are merits to some arguments, but the vigil kept by the public has certainly fostered a suspicion of the ability to "solve problems by more government." Those of us who are involved in conducting programs with public mandates can attest to the fact that public accountability is in vogue. As tiresome as evaluation can become, its absence is likely not favored by many people. This dialogue has less to do with Sea Grant per se than with the origin and special objectives set forth for this session. However, you should be aware that Sea Grant has been frequently evaluated by government overseers enroute to becoming the example to be discussed here. For the task before you, the Sea Grant program can perhaps serve as the paradigm from which can be shaped a well-funded public education program in fish and wildlife extension, worthy of public support.

Initially we will focus on what Sea Grant is, what it strives to achieve, and the tools used in achieving its goals. With this task accomplished, there may be more interest in the description of the concepts, laws, and administrative arrangements which enable the program to function. This approach, when embellished with a select few examples chosen to reflect natural resource issues, should furnish suitable information to decide whether or not Sea Grant provides a pattern from which to trace the public education you desire.

The Trilogy

Sea Grant is a program consisting of three related components. Research, advisory services, and education are a trilogy in that they are three related components which differentiate Sea Grant from other publicly funded programs. Advisory Services is the Sea Grant phrase for the public education effort most widely known as extension. In essence, Advisory is the portion of Sea Grant which contributes to the achievement of Congress' stated desires for utilization of marine resources by the education and development of citizens knowledgeable of marine resource use. This requires that Advisory personnel strive to teach skills, concepts, and tools which can be useful in assisting citizens to become informed marine resource users and decision makers. To those involved in extension work, there is nothing original in this description of what Advisory Services is and seeks to do.

Effective Advisory programs marshall the talents of capable personnel into group and individual efforts on projects specified by resource users to be impediments to improved resource utilization. The key element in the process is the significance given to involvement of those to be educated in development of sound educational programs. This is the way it must be if Advisory Services programs want to avoid becoming involved with the mundane business of being information couriers. Peter Drucker, although writing for a different audience, simply states the difference between our concept of Advisory Services and that of information transfer. "They (the intended audience) must understand it because they have been through it, rather than accept it because it is being explained to them" (Drucker 1970).

It is a necessary condition that an effective Advisory program be founded on this approach, but the approach will not provide the needed sufficient condition. The establishment of a sound working relationship among the local Sea Grant director, the local leader of Advisory Services, and the Washington office of Sea Grant is critical to optimizing the use of Advisory Services' resources in public education. Advisory Service professionals, working as specialists or agents, possess specialized strength in one professional discipline. As such, they desire to have their expertise used directly and frequently in formulating and delivering programs. The astute Advisory program leader is aware that his personnel tire of being classified as information couriers who swoop down on audiences to bombard them with literature or as people dependent on the talents of campus-based academicians to solve problems. We should probably prompt few negative reactions from peers by saying that the challenge to the three tiers of administrators previously cited rests in steering Advisory personnel toward fulfilling our public education job by utilizing their own professional expertise, utilizing existing resources of information, and elucidating problems for researchers when these resources are inadequate. The point is that while Sea Grant probably represents a trilogy which your group may not be interested in or capable at this time of duplicating, much can be achieved in public education on natural resources with something less ambitious.

Historical Sketch and Current Perspective

The National Sea Grant Program was enacted into law into 1966, setting in motion a most creative and innovative effort to explore, develop, conserve, and manage the nation's ocean resources. No other oceanic program has the breadth of scope and the diversity of purpose commensurate with the important oceanic challenges facing us.

The Marine Advisory Service assists people to objectively solve problems through voluntary educational assistance. This is accomplished by helping them develop skills and providing them with marine resource information. In turn, user needs are communicated to marine researchers and other sources of marine expertise and marine information.

Sea Grant presently has an annual base budget of $27 million and supports over 700 individual projects incorporating the efforts of over 200 companies, and 160 educational institutions. These figures serve to indicate that Sea Grant people have been effective in giving life to the idea that a pragmatic program of research, education, and Advisory Service could only be developed by cooperative efforts in which the resource users serve as senior partners.

To secure Sea Grant support for a desired program requires that the applicant provide matching funds from non-federal sources in the amount of one-half of the federal Sea Grant funds sought. This means that one-third of the total amount devoted to the project must come from business, the state, or universities. As you might perceive, this requirement was cause for concern in the program's infancy. Over the past 10 years the matching fund aspect of Sea Grant has provided a clear indication of participant support. At the current time, 14 state legislatures provide funds in the state budget specifically earmarked for Sea Grant. It is now a rare occurrence when the matching fund requirement poses a problem. In fact, it is a desirable aspect we feel you should thoroughly consider in your forthcoming deliberations. Local funds represent a commitment to the program you seek. They no doubt help cement the partnership sought between those capable of launching an effective public education program founded on sound technical information. A requirement for local financial involvement also helps assure that the program is responsive to people affected by natural resource utilization.

Sea Grant began with a novel approach in its grant monitoring relationship with grantees. Rather than fitting grantees into a single mold, a system of progressive status was created for grantees seeking support for the trilogy approach. Coherent Area Project, Institutional, and College support were the terms given to describe the ladder depicting success. Coherent Area project grants are made to programs containing a core of expertise in marine affairs. Institutional support is awarded to those institutions having a broad base of competence in marine affairs and a positive, long-range commitment to improving the utilization of marine resources. Following a minimum of three years at the institutional level, those programs demonstrating sustained outstanding achievement can be considered for Sea Grant College status. Sea Grant funds are provided on an annual basis for renewal of all three programs so long as the grantee attains and maintains a high quality program relevant to local needs.

Valuable contributions to public education can be made by talented Extension personnel using their own skills and existing information. In fact, Sea Grant effectively functions in this manner in many instances. The concern we have over letting this alone "fill the sails" is that the university system has much more to offer in both the extent and duration of the desired wind.

Marine Advisory Services

The Facts and Figures

Without the investment herein of describing Advisory Services as one part of a cooperatively funded, primarily university-based, program of national significance, the forthcoming focus on the facts and figures of Advisory Services would certainly have made the authors uneasy. The evolution of a program from an idea involves the skills of knowledgeable people and the development of new communications systems. Individuals with Extension experience, affectionately dubbed "retreads," were prominent in launching and keeping the ship afloat in the late sixties. Sea Grant benefited immensely from their toil in establishing an aggressive program designed to serve those using the products of the marine environment. One element of the early Sea Grant strategy was to establish Advisory programs in all coastal and Great Lakes states and Trust Territories. Thus, an early investment was made in a network as opposed to building strength in a few states. Time and events proved the wisdom of the choice to avoid a program of discrete entities. Today Advisory programs in public education exist in 27 of the 30 coastal states. Only Illinois, Indiana, and Ohio do not have active programs.

Due to the diversity of problems in coastal areas, and the setting of priorities at the local level, individual programs differ. This fact, coupled with a shortage of funds in the early history of Sea Grant, increased the need for communication among programs. The Office of Sea Grant (OSG) in Washington as the parent funding agency joined in several efforts to improve the effectiveness of programs operating on limited resources. Encouragement was given to prospective grantees to explore the possibilities of linkages with their state's Cooperative Extension Service (CES). By exploring the feasibility of Extension involvement, it was reasoned that an existing body of expertise and resources could be utilized. This was not a marriage forced on the unwilling, but certainly more than one of convenience when the participants were found willing. Approximately one-half of the Advisory programs are incorporated in CES at the respective universities. Consequently, a close relationship developed between the Sea Grant Marine Advisory Service and Cooperative Extension Service to the point that in 1974 a formal memorandum of understanding was reached and signed by both agencies.

The agent and specialist designation of CES when used in Sea Grant, in many instances, indicates a difference in the level of training, more so than field versus campus location of staff. Advisory specialists are often housed in coastal offices due to manpower shortages, access to audiences or the presence of marine research facilities. Regardless of staff location or the working relationship between Advisory and CES, Advisory staff within a state report to a designated Advisory Services program leader. The program leader most often serves as the principal investigator when application is made by the university for Sea Grant support. Within the CES structure, the Advisory Service program leader functions as a state leader would for agricultural programs.

In absolute terms, over 275 persons are involved in Sea Grant Advisory Service programs. Approximately \$6.6 million of federal funds will support Advisory Services in fiscal year (FY) 1977. On a national average, the salary and support for the average Advisory staff member is approximately \$40,000.

Marine resources such as fish, water, and sand are highly mobile and commonly within the domain of public ownership. The mobile nature of resources and the people that use the resources, coupled with the fact that most are publicly managed to some extent, necessitates that the Advisory Service work with numerous audiences and public agencies. Thus, in many instances the agencies of government are the most effective audience with which to work. This is something about which you must be cognizant when shaping the comprehensive natural resources extension program you desire. An aversion to working with audiences often at cross purposes and those representing the public sector is something of a rare professional disease among Sea Grant Advisory professionals.

Program Administration

Within the Office of Sea Grant we have a program manager for Advisory Services. The program manager and local Advisory Service leaders have developed working relationships which resulted in three noteworthy administrative arrangements. A separate grant was made to a consortium of Pacific Coast Advisory programs in 1972 to facilitate program activities regional in nature. The Universities of Alaska, Washington, California, Oregon State, and the University of British Columbia found benefits in working together on common problems. The Pacific Area Sea Grant Advisory Program (PASGAP) found numerous opportunities to share talent among the participants and develop regional publications. The mobility and similarity of many of the resources coupled with the differences in staff expertise among programs made talent sharing a technique which paid handsome dividends. Regional talent sharing activities of PASGAP have ranged from seafood sanitation workshops to business management workshops for fishermen. The workshops are team taught by participating programs and invariably held at several locations within the region. The most visible cost saving element of PASGAP is in the preparation and publication of the printed matter necessary to conduct a successful program. Advisory bulletin needs are screened for regional relevance, shaped by an editorial board, and published for regional use. A directory of marine services for vessel operators, a first aid guide for mariners, and a compilation of films for use in marine education represent the type of publications which serve a regional audience at low cost.

A second regional Advisory program was formed in 1974. The New England Marine Advisory Service (NEMAS) sought to meet the significant opportunities for regional work afforded by several states in a small geographic area with a large population. NEMAS functions with a full-time director responsive to an executive board comprised of participating programs. Aside from NEMAS' record of accomplishments, it is important to note that NEMAS membership consists of Sea Grant supported Advisory programs, the National Marine Fisheries Service, and a commercial visitor's aquarium. Clearly, a regional approach, where warranted, is a beneficial means of directing more resources to the public education programs this organization seeks to establish.

A second noteworthy administrative arrangement which evolved from the close working relationship of state Advisory program leaders and the OSG program manager for Advisory Services, was the need for support of a training effort. Applicants for Advisory positions as well as individuals eventually hired seldom demonstrated any exposure to the Extension education philosophy and technique. Perhaps this was attributable in part to the prevalence of applicants from outside of colleges of agriculture where one expects ample opportunity exists to learn the merit of applied research and public service. Oregon State University and Cornell subsidized the first three national Advisory Service training workshops. The needs and benefits of such workshops having been demonstrated, the Office of Sea Grant processed a special grant to the University of Florida in 1975 to hold a fourth national training workshop for new Advisory Service personnel. Future training needs can now be handled by this means, by involvement in summer Extension workshops at Land Grant universities, and by the evolving interest of the regional Advisory programs to train their personnel. Emphasis is given here to the partnership between local Advisory Service program leaders and the OSG program manager for Advisory Service to guide the evolution of Advisory Services.

In 1972 a directive from the administrator of the National Oceanic and Atmospheric Administration (NOAA) established the NOAA Marine Advisory Service (NMAS). The intent was to facilitate the improved access Advisory personnel sought to the research results and talents within NOAA. Sea Grant, as part of

NOAA, to effectively serve marine audiences frequently overlooked information contained within other components of NOAA or tried and failed to receive information known to be beneficial. A directory of personnel within NOAA assigned to respond to Advisory information requests was found to be a useful device. Cooperative programs with the National Marine Fisheries Service and the National Environmental Satellite Service, elements of NOAA, are examples of beneficial programs which can be shaped by utilizing linkages between elements of the same agency. NMFS in responding to the charge of developing a national plan for marine fisheries, used local Advisory programs to obtain fishing industry input through workshops. The Humboldt State (California) Advisory program utilized the imagery of a NESS satellite to locate ocean water temperature contours favored by albacore tuna. The objective is to assist fishermen in reducing their search time so that costs may be reduced or harvests increased. It is numerous opportunities similar to these which provide the payoff to interagency cooperation. Not only are audiences directly assisted but the agency receives first-hand experience in the use of systems originally conceived as helpful to certain groups and learns of additional users for their information.

Project Examples

The authors have attempted to provide information about Advisory Services which will be useful in deliberations on how to increase the resources available for fish and wildlife Extension while resisting the temptation to delineate the complete history of Sea Grant. However, in doing this perhaps the range of projects with which Advisory is involved has not been brought into sharp focus. The following brief descriptions of projects were selected to represent the range of subject matter with which Advisory is involved.

Each Advisory program has a staff member assigned to be the editor or communications specialist. The communications specialist not only makes sure the mechanics of information transfer work smoothly but also controls the quality of the educational material. In 1976 a group of Advisory communicators from different universities received support for projects national in scope. Pooling their talents to produce products which none could manage alone, the communicators published an annotated bibliography, *Sea Sources,* listing 200 of the most popular Sea Grant publications. Ninety-eight one-minute radio tapes designed to highlight activities at Sea Grant universities across the country are now being broadcast by over 100 stations.

At Clemson University, marine advisory agents demonstrated the University of Rhode Island improved fish trawl system to South Carolina fishermen. In a three-month trial period aboard one fishing vessel, the fisherman landed 35,000 pounds of five commercial species. That total was within 10,000 pounds of what the annual average for the five species had been for the entire fishing fleet in the state over a five-year period. The fisherman's gross income increased spectacularly, and—as a result—eight other boat owners now have ordered nets, all being manufactured locally. The use of the new net has diversified the fishing effort in the state, also. Previously, most of the effort had been limited to the harvest of shrimp.

In 1976 approximately 13 percent of Advisory funds were devoted to marine recreation projects. The construction and placement of floating tire breakwaters to protect marinas was facilitated by experienced Advisory workers. The breakwater system, started by researchers at the University of Rhode Island several years ago, uses scrap automobile and truck tires tied together to form floating rafts up to 20 feet wide and 100 feet long. The rafts, which are anchored at the bottom, provide an effective wave dampening effect, and, unlike far more expensive stone jetties, result in a minimal disturbance of the marine ecosystem. Through Rhode Island's cooperative efforts with marine advisory programs in New York and New Hampshire, there are now some 15 floating-tire breakwaters in place in New England and the Great Lakes. One such breakwater, installed last year in Dunkirk Harbor on Lake Erie with assistance from the Goodyear Tire and Rubber Company, has made the town marina useable again and has provided both peace of mind and substantial dollar savings for local boat owners.

Without technical assistance, it is clearly difficult and, in some cases impossible, for the American public to make intelligent, rational decisions about the uses of its own coastal areas. To this end, local Marine Advisory Service programs throughout the country have devoted much of their energy to marine science and education. The educational efforts of the Marine Advisory programs range from the general—nature walks, tours of marine science centers and aquaculture facilities—to the specific—technical conferences for citizens interested in coastal zone management and the political processes that affect it. At Oregon State University, for example, the Marine Advisory agents held a series of workshops to explain the functions—biological, commercial, aesthetic, and economic—of Oregon's estuaries. A workshop held at the mouth of the Columbia River was only one focal point in the series, but it served to point out both the uses and demands on a single estuary and the political realities of attempts to make changes affecting it.

Delaware's Marine Advisory Service organized a workshop last year for members of the recreation industry; federal, state and local officials and representatives of the oil and gas industries to discuss the probable impacts of oil and gas development off the Delaware-Virginia-Maryland coast. The workshop, like a number of others sponsored by various Advisory Services programs, served as a vehicle for groups with different goals, ideas, and objectives to sit down together and discuss the future before problems developed.

The access, credibility, and knowledge Advisory established with marine audiences over the past few years is helping agencies with marine resource responsibilities do a better job of managing marine resources for the public good. There is much we could recount here but instead opted to elaborate on a case involving Advisory and the Coast Guard. The Coast Guard, housed in the Department of Transportation, has responsibility for replacing or converting the Loran A navigation system with the more sophisticated Loran C. The users of the system range from pleasure boaters to oil tankers in ocean waters near the United States. When the news of the change reached the Extension oceanography specialist at Oregon State University, an education program was developed to inform mariners of the significance and implementation schedule for Loran C. Through a series of town hall meetings and special Loran C workshops, the specialist provided information to mariners and in return was exposed to the significance of heretofor unseen problems in making the transition smooth and the new system effective. Through discussions with the Coast Guard this specialist recognized the need for a research project on methods to achieve the benefits envisioned for Loran C. The Coast

Guard subsequently reviewed a one-year research project proposed by the specialist, funded it at $100,000, and passed the funds through the Office of Sea Grant. Thus, an Advisory Services program has completed the circular trip from identifying a problem, developing a public education program to treat it, and then seeking further research when existing information is insufficient to meet the task. The early work on the research project is exposing many excellent sources of information which can be incorporated into existing Advisory programs. Good public education provided the credibility attractive to another agency in improving its assigned development and implementation responsibility. Advisory-research-Advisory, the chain is of increasing value to agencies at all levels.

Summary

In terms of exposure to individuals, Advisory Service personnel, through talks, workshops, publications, seminars, exhibits, and special courses were responsible for an estimated 20 million contacts in 1976. With these contacts and communicators devoted to creative use of annual reports, news releases, bulletins, and video tape, Sea Grant received the visibility necessary to dispel concern that the value of public education will be a secret. The Office of Sea Grant approach is to build strong local programs attuned to the needs of a community, then help new programs evolve based on these local talents, by fostering work on high payoff regional and national endeavors. Due to the public ownership of many marine resources, public agencies are both participant and audience in Advisory work. The value of public education via Advisory Services reaches beyond the creation of a more informed citizenry capable of making better decisions to the improved ability of public agencies to serve the citizens. A foundation of agents and specialists, coupled with innovative management and financial support from the Office of Sea Grant, to permit the evolution of public education programs, is an approach with no substitute.

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Case History:
Ten Years of Education on Lake Management

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Lakes are a major natural resource in many parts of the nation. Since water-based activities rank at the very top of outdoor recreation pursuits, lakes are heavily used by the public. While fish management is practiced on many lakes, and reservoirs receive attention relative to water levels, comprehensive management of lakes is rare.

A 10 year effort is making such management less rare in Wisconsin. The emphasis in this paper will be on the educational component of that effort.

However, it would be inappropriate to fully segregate the educational component even for purposes of this paper; the central conclusion of the paper is the importance of structurally integrating the educational function with the other functions of a resource management program. Interaction between the administrators of governmental agencies and the educators in academia is often marked by bitterness rather than integration (Henry 1976). The Cooperative Extension Service has had considerable success in bridging that gap with a problem-solving orientation to education (Schoenfeld 1975). The story of lake management in Wisconsin begins as a joint venture of Extension and the Wisconsin Department of Natural Resources.

1968-73: Demonstration

Why?

The Inland Lake Demonstration Project (Born 1974) was not only a joint venture of two agencies, it was also an attempt to bridge the goals of environmental quality and economic growth—one of the most serious societal divisions of this decade.

The Upper Great Lakes Regional Commission, an interstate economic development agency, funded the demonstration project. The grant to the Wisconsin agencies was based on the premise that the long-term economic viability of tourism in the region was dependent on recreational lakes of high environmental quality.

What?

In order to demonstrate what could be done to manage lakes, the philosophy of Extension that had worked so well in agriculture was adopted. Laboratory concepts were tested in real lakes under natural conditions just as new varieties of alfalfa are eventually tested in the fields of operating farms. Pilot projects were carried out at a dozen lakes selected on the basis of physical characteristics of the lake and the interest of local officials.

Who?

Determining "what can be done" is only half an answer to the management question. The question of "who can do it" must also be answered.

While the state conducted the demonstration project, it could not provide individual and continuous management care for 9,800 lakes. Local units of government at the county, city, and town levels had shown little interest in taking responsibility.

Thus, a major task of the demonstration project was the examination of other institutions regarding their potential for lake management. Sanitary districts were examined; as special purpose units of government, they had taxing ability, but their management authority was limited to sanitation. Voluntary lake associations had shown a great deal of interest in individual lakes, but they had neither taxing nor management authority. This analysis led to the conclusion that a new institution was needed—a lake district.

1974: Institutionalization

Public Participation

Designing a new institution requires consideration of many issues. Foremost among these issues was development of a mechanism to utilize the human resources available to a lake in the management of that natural resource. A survey based on a stratified random sample revealed that lake property owners exhibited demographic qualities (high income, education and age) characteristic of organizational leaders. They had purchased their property for solitude and beauty and they strongly supported controls on development and motorized recreationists (Klessig 1973). However, as seasonal residents who did not vote locally, lake property owners lacked the political influence necessary to prompt local governments to act. The lake district concept provided that all residents and all property owners could participate in the decision to create the lake district and in the decisions of the annual meeting. The concept also provided that the budget and other major decisions be decided by direct participatory democracy at the annual meeting of this special purpose unit of government.

Equity: Who Benefits and Who Pays?

Lake property owners who form a district expect to benefit directly from a higher quality lake. The lake should be more attractive for aesthetic enjoyment and recreational activities. Property values should also rise. Therefore, the members of the district should pay part of the cost of lake management, and the district should have taxation powers to insure that every property owner pays a fair share.

However, the lakes of Wisconsin are publicly-owned and are extensively used by the general public. These users should also pay part of the cost of maintaining or improving their recreational resources. This share could be collected at the lake at great administrative expense or the state could provide cost-sharing grants to lake districts from general purpose revenues. The latter option was recommended.

Jurisdiction

Lake districts clearly need management authority in the lake to dredge, control water levels, harvest weeds, etc. But the lake is a product of its watershed.

Farming practices and land use in the watershed directly impact the lake. However, local governmental units are very jealous about their police powers, especially zoning. Political realities dictated that lake district activities in the watershed be limited to voluntary contracts with the landowners. The districts could spend money in the watershed, but could not exercise any police powers.

The sanitary district powers to inspect private septic tanks and to provide for public sewers was also considered too controversial to include in the lake management concept, although a further study was recommended.

Intergovernmental Relations

To improve relations and coordinate programs, the lake district concept included a county board member and a town board member on the five-member Board of Commissioners. The other three commissioners would be elected at the annual meeting.

The management plan of the district would be reviewed by the Soil and Water Conservation District and by the Regional Planning Commission before being submitted to the Department of Natural Resources for public hearing and approval. Since both the district and the state had to approve the plans and since both would be paying the bill, the basic institutional arrangement for lake management would be a state-local partnership with each partner having a veto power (Klessig 1976).

Enabling Legislation

The recommendations of the Inland Lake Demonstration Project were presented to the Wisconsin Legislature in the form of draft legislation. Lake management, however, was not new to the legislators, the press, or lake property owners. Early in the demonstration project, explicit attention was paid to the educational function. Where demonstrations were taking place, local political leaders and the local press were directly involved. Regular contacts were also made with statewide press and state political leaders. In addition to press releases and presentations, several movies, a slide/tape set, and a booklet on *Understanding Lakes and Lake Problems* (Born and Yanggen 1972) was produced for general audiences. The Educational Telephone Network, which permits two-way instructional communications at nearly 100 locations simultaneously, was also employed.

The legislation became Chapter 33 of the Wisconsin Statutes. The two major components of Chapter 33 are (1) a procedure for the creation of lake districts, and (2) an appropriation of state revenue to aid such districts. The statute directs the Department of Natural Resources to provide grants and technical assistance to districts while the educational function is assigned to the university.

1975: Awareness and Creation

Conferences

To carry out the educational function, the University of Wisconsin-Extension hired two lake specialists (a natural scientist and social scientist). However, even before the bill was signed and the specialists hired, tentative plans were made for informational conferences in 1974. Over 700 people crowded into the first regional conferences.

In 1975, six additional conferences were held throughout the state. Extension specialists coordinated the logistics with local Extension agents and the program with personnel from several state agencies.

The central purpose of the conferences was to create awareness of the new program of lake management among lake association officers, local officials, and local resource management professionals. It was hoped that the awareness would then "diffuse" throughout the lake communities.

Local Meetings

Diffusion via the articulate conference attendees was very rapid. Immediately the Extension specialists received requests from lake associations, chambers of commerce, and town boards to explain the new law to individual lake communities. Most groups requested presentations on summer weekends and holidays when second home owners were at their cottages. In the first two years of the program, the Extension specialists attended several hundred local meetings.

Such meetings are usually opened with the basic slide/tape set on lakes and their problems to expose the audience to the full range of problems and solutions. Individuals often have strong feelings about the cause and solution to their problem. However, the audience is firmly reminded that the purpose of the initial meeting is to decide on the type of organization for the lake community (Klessig and Yanggen 1975). It is important that the question of organization be settled first. If the lake district is chosen as the desired form of community organization, that district will be the appropriate forum for later discussions and decisions regarding management solutions.

Discussion of the lake district alternative usually occupies the central part of the meeting. The most serious reservations relate to the taxation powers of the district and to suspicions of control by the Department of Natural Resources. The historical ties of Extension to local communities and its traditional educational role have enhanced credibility on such sensitive concerns.

If a group decides to form a district, the balance of the meeting is spent discussing mundane details of the procedure and developing a strategy appropriate to the local political situation. The steps taken by a typical community are shown in Figure 1.

Administrative Codes

The legislature provided an annual appropriation of roughly $1 million for grants to lake districts. Eligibility, priorities, and procedures for dispersement were not spelled out in Chapter 33. Consequently, the Department of Natural Resources developed administrative codes for that purpose.

Extension specialists assisted in that development by serving as "advocates" for local communities and arguing for simplicity. The public was also given an opportunity for direct input at several hearings held throughout the state. Since most attendees came to ask questions rather than testify, the hearings provided Extension specialists with "teachable moments."

A Guide

Even with public comment, the administrative codes were necessarily legal in nature. To assist in deciphering both the codes and Chapter 33, *A Guide to Wisconsin's Lake Management Law* was published (Klessig and Winter 1976).

1. The county Extension agent and lakeshore community leaders attend a regional conference organized by a University Extension specialist.
2. Lakeshore community leaders meet with their voluntary lake association and appoint a committee to explore lake district formation.
3. At the request of the organizing committee, the county Extension agent arranges a planning meeting with an Extension specialist. The specialist provides sample petitions and booklets. The committee defines the boundary of a proposed lake district and sets a date for a public educational meeting.
4. At the community meeting, the specialist discusses lake district formation and answers questions. The organizing committee discusses the proposed boundaries and the petition drive.
5. After the committee has collected signatures from a majority of landowners, the petitions are submitted to the county board. The County Agriculture and Extension Committee is given responsibility to send notices to all property owners and hold a hearing. The county Extension agent arranges for a specialist to discuss the law with the county board members holding the hearing. A formal public hearing is held with the county agent acting as secretary and a specialist in attendance to answer questions.
6. After formation, Extension and other local agencies assist the district in applying for state aid to conduct a feasibility study. Data is gathered under contract with a private firm.
7. At the completion of the study, the Department of Natural Resources provides the community with management alternatives. The lake district decides which, if any, alternatives they want to implement and applies for cost-sharing.
8. With federal and state cost-sharing, the district hires a contracting firm to carry out construction work.
9. The Department of Natural Resources monitors the completed project and the district is responsible for continuing management.

Figure 1. The typical sequence of events.

Other brief materials were prepared to aid in understanding lake district creation and the feasibility studies.

In preparing the materials and in discussions with citizens, Extension utilized a general division of labor. The natural scientist concentrated on hydrogeology and limnology while the social scientist emphasized organizational matters. Efficiency in travel demanded, however, that both specialists be able to cover the entire "waterfront."

1976: Amendments and Evolution

Feedback

Even a law that germinated from six years of interdisciplinary research was not perfect. Extension specialists compiled a list of difficulties with the law as they were mentioned by community leaders. Several brainstorming sessions were held with attorneys and lake-related staff of several state agencies in an effort to reach consensus on interpretation of Chapter 33. Some problems were resolved by agreement on a practical working definition. In other cases, only legislative definition could reduce uncertainty. In still other cases, the law was clear, but application was difficult.

After the program was fully operational and most "bugs" in the law were apparent, the informal interagency group began drafting amendments. Extension specialists conveyed the desires of lake communities and assumed the leadership role in developing the amendments.

The Law of the Lakes Revised

The legislature, and especially the natural resources committees, had been regularly updated on the program. They were sent copies of all literature and key legislators were periodically given verbal reports. The chairman of the Assembly Natural Resources Committee agreed to hold any piecemeal amendments submitted by individual legislators until they could be packaged into a single bill.

That bill eventually contained 32 provisions. Community leaders were personally notified of a hearing on the bill. An Extension specialist provided the lead testimony which was supported by the other testimony from citizens. At the request of the chief sponsor of the legislation, an Extension specialist compiled a list of the lake communities in each legislative district that would be impacted by the amendments. A letter noting the communities was then sent by the chief sponsor to each legislator.

Although some provisions, such as combining lake district and sanitary district powers, were expected to be controversial, the bill passed both houses of the legislature unanimously.

Management Plans Explained

While the legislature was "cleaning up" Chapter 33, the first lake districts were selecting their management alternatives from options developed by the Department of Natural Resources. Both the annual meeting of the district and the state must approve the management plan following a hearing.

Selection of a management plan and the construction work associated with an implementation project provide an educational opportunity since citizen interest is stimulated. Department of Natural Resources and Extension personnel attend the official hearing, district annual meetings, and numerous less formal gatherings to discuss the lake project. Extension specialists assist county Extension agents in preparing new releases, press conferences, and TV interviews on the construction.

Changing Educational Needs

By 1976, the major lake communities had become aware of Chapter 33 through conferences, meetings, and literature. Community leaders, county Extension agents, and county boards had acquired a substantive understanding of the procedure for creation of lake districts. The law had been amended to facilitate the process. State policy had been transformed into administrative codes and had been tested.

While continuing educational support was still required in all the areas noted, the central educational need was evolving. Figure 2 illustrates that evolution from creation of lake districts to assistance in the operation of existing districts.

1977: Operations and Maintenance

Workshops

Workshops on "The Operation of a Lake Management District" were first held in 1976. New public officials operating new units of government without traditions or rules of procedure or experience needed assistance. In anticipation of that

	1974	1975	1976	1977	1978	1979	1980
Development of state policy	30	15	15	10	5	5	5
Creation of lake districts	70	50	30	15	15	15	15
Operation of lake districts		15	30	30	30	30	30
Involvement in feasibility studies		20	10	5	5	5	5
Involvement with implementation projects			10	15	20	20	20
General public education on lakes			5	10	10	10	15
Evaluation				15	15	15	10
TOTAL	100%	100%	100%	100%	100%	100%	100%

Figure 2. Allocation of Extension effort.

need, Extension specialists organized five regional workshops in April to prepare the lake district commissioners for their annual meetings in summer. The workshops were co-sponsored by the state Departments of Local Affairs and Development, Natural Resources, Revenue, and University Extension. About 60 percent of the lake district commissioners attended and evaluated the informal "nuts and bolts" sessions very highly.

In 1977, commissioners were polled as to their preference between regional workshops and a statewide convention. The commissioners strongly preferred the more informal and convenient one-day regional workshops. The 1977 sessions will cover the annual meeting and budget hearing, taxes, legal rights and liabilities, cost-sharing, and related programs.

Reference Handbook

At the 1977 workshops, commissioners will be supplied with a three-ring binder designed to serve as both a source of general information and file to organize documents of the specific commission. The handbook is divided into sections with the following tabs: Introduction; State Law and Regulations; Personnel Directory; Agency Partnerships; The Management Plan; District Operations; Annual Meetings; Commission Meetings; Lake Management Publications; and Miscellaneous.

Professional Education

A new program requires "re-treading" of professionals as well as awareness by citizens who might be involved. Special in-service training sessions have been held for Extension and Department of Natural Resources field personnel. However, public agencies do not conduct the feasibility data collection or undertake the construction work. Both of these tasks are contracted by the lake districts to private firms. These firms have looked to the state for technical guidance. Some firms sent representatives to an international conference on lake management held in 1974. Consulting firms sent staff members to a 1975 seminar on conducting feasibility studies. A major national conference for public and private professionals was held in April of 1977.

To meet regular communications needs not satisfied by conferences, workshops, and meetings, a quarterly newsletter was initiated by Extension specialists. An issue of *Lake Tides* typically includes an editorial, an ecological newsnote relating to the season, a guest article from someone familiar with one of the lake restoration projects, suggestions for commissioners, and announcements of awards and educational events.

1978: The Future: Evaluation and Adaptation

Human Impact

Public Law 92–500 provided the nation with water quality goals. Section 314 of the law authorized $300 million for lake restoration. In 1976, the U.S. Environmental Protection Agency began awarding 50 percent cost-sharing grants to lake communities. In order to develop selection criteria for future grants, evaluations of the first "Clean Lakes" grants are being conducted. Limnological evaluation will establish the degree of change in water quality entering the lake and in the lake itself. However, ultimately the projects must be judged in terms of social well-being. Socio-economic evaluation is proposed to determine impact on individuals, participating groups, organizations, and communities.

Reporting to the Lake Communities and the Capitol

By the summer of 1978, results of some of the early implementation projects should be available, the strengths and weaknesses of the lake district concept should be more obvious, the future of financial aids should be clearer, and many districts will have new commissioners. For all of these reasons, four to eight regional conferences should be held involving all related agencies. The sessions should serve to inform, to promote esprit de corps, and to share experiences.

While the legislature will continue to receive regular information on the program, a major effort will be made early in 1979 to provide the legislature with a five-year report.

Everyone Loves Lakes—General Public Education

Lakes are of general interest to citizens whether or not they own property near a lake. Most people use lakes to fish and almost all citizens use lakes aesthetically even if they only drive by them. An intensified effort is planned to reach out to these citizens with media programs and educational materials appropriate to their level of interest.

Not only are citizens interested, they have a right to know about a program that is supported with their tax dollars. It would be politically naive to ignore them.

Preventive Medicine for Lakes

Unfortunately, not much is being done to manage high quality lakes. As in human medicine practice, it is usually easier and cheaper to prevent a problem in a lake than it is to correct it. However, Chapter 33 requires local initiative and sustained commitment before a lake management program can begin. Without a crisis of weeds or fish kills or closed beaches, lake property owners tend toward apathy just as other citizens. Communities with degraded lakes have aggressively sought assistance, while communities with high-quality lakes have tended to ignore the program. Thus, most of the lake districts are being formed around silted-in impoundments and eutrophic lakes. A concentrated community development effort around high-quality lakes should motivate local action for lake protection.

The Energy Crisis

Phosphorus is commonly accepted as the "limiting factor" of aquatic plant growth; lake weeds and algae will grow until they run out of phosphorus. The limiting factor for recreational use of lakes by tourists and second home owners has been "time." However, transporting urban residents to distant rural lakes consumes vast quantities of energy. As gasoline becomes increasingly scarce and expensive, energy rather than time will become the limiting factor determining recreational behavior. In those years of uncertainty, potential lake users will have a special need for information on energy supplies and energy conservation. In cooperation with other units, Extension specialists will attempt to facilitate individual and community adaptation to the realities of a long-term energy crisis.

P/S (Public Service): The Hot and Free Line

No matter how many fancy programs are planned and delivered, the core of Extension's role in managing Wisconsin's inland lakes will be the individual telephone calls and letters to and from courthouses and campuses. Answering specific questions and guiding communities in a competent and personal manner has been the hallmark of Extension. Without such public service follow-through, the "big shows" outlined above are only shows.

Results and Conclusions

The Numbers Game

1. Eighty-five lake management districts have been created.
2. Sixty-eight feasibility studies are in some stage of completion.
3. Seven districts have been funded by the state and/or the U.S. Environmental Protection Agency for project implementation.
4. Three districts have begun their projects.

Generalizations

1. Education for resource users is a long and continuous process which must be systematically planned and executed.
2. A widespread base of informed users and decision makers is essential to launch and maintain a program via the political process.
3. Public participation in resource management requires patience and adaptive public service consultation.
4. Users with a financial and emotional investment in a specific resource can be "tapped" for management responsibility.

5. The education function should receive institutionalized attention in a resource management program just as the technical and financial functions are provided by various structural arrangements.

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Case History:

A Public Education Program of Predator Damage Control

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The development of the present-day program of predator damage control in the State of Kansas has been an evolutionary process. Nearly every type of predator control known has been attempted in Kansas at one time or another. The first organized attempt at predator control in the State was the enactment of a bounty law in 1877, which continued in effect until 1970. Kansas State College personnel became involved in rodent and predator control in an advisory capacity in 1901. In 1914, with the passage of the Smith-Lever Act and the creation of the Extension Division, Extension personnel became involved. At several times between 1940 and 1967, the U.S. Fish and Wildlife Service was involved, to varying degrees, in predator control programs in some areas of the state. Strychnine, sodium monofluoracetate (1080), and sodium cyanide have all been used at one time or another for coyote control within the state. No poisons, aircraft or bounties are used in the present Kansas program. For more detail on the history of predator control in Kansas see Gier (1968) and Henderson (1972).

In 1953, the Kansas Extension Service established a position for a specialist in wildlife management, and the state moved closer to the idea that an extension program was the way to lessen the predator problem. The program goal was similar to that developed in Missouri in 1945 (Sampson and Brohn 1955). In 1968, the Kansas Extension Service hired a specialist in wildlife damage control with the responsibility to develop a statewide educational program on the control of damage caused by predators. At the same time the sole responsibility for wildlife damage control in Kansas was given to the Kansas State University Cooperative Extension Service.

Program Development

Predator control is a controversial issue that often involves as much emotion as fact. Because of this, the development of the educational program was coordinated with a careful identification of the problems, attitudes, and needs of the intended audiences. Inputs and feedback relative to the program were obtained by attending meetings of various livestock and wildlife organizations and discussing the proposed program. Livestock producers primarily wanted a program that was effective in reducing losses, yet low in cost. Other segments of the public, however, required that any program also be selective, safe, and humane.

In order to satisfy these requirements, the program was based on the following objectives:

1. Reduce the damage caused by carnivores to domestic livestock by instructing producers on methods known to be effective in reducing losses.

2. Encourage control methods which are as safe, efficient, economical, humane, and selective as possible.
3. Encourage research on the ecology of native carnivores and on the relationships between livestock management and losses due to predation.
4. Encourage the development and implementation of livestock management programs and systems that prevent or reduce losses.
5. Provide additional educational information on the role of native carnivores in natural ecosystems.

The basic philosophy behind the program is simply this: Carnivores have both positive and negative economic and social values; most damage is caused by relatively few individuals, not by all of them; when this individual or a small group of individuals are removed the damage stops; and the livestock producer is in the best possible position to locate that problem individual and remove it promptly when predation begins. The Kansas program is not a predator control program, it is a predator *damage* control program. The coyote population in Kansas is stable and has been since the early 1970s according to results of 1972-76 coyote scent-post surveys. We estimate a normal early summer coyote population of around 150,000 coyotes in Kansas' 82,000 square miles. No attempt is made to control the coyote population. The program is an educational effort directed at the goal of reducing livestock losses through the removal or exclusion of individual problem animals.

Wherever possible, the *prevention* of damage through improvements in livestock management or facilities is stressed. We believe this to be a realistic and key factor in lessening the predator problem.

Implementation

The program is implemented primarily through individual training of producers wishing to reduce wild animal damage. The problem animals include mainly the coyote, but also starlings, sparrows, pigeons, bats, commensal rodents, small field rodents, prairie dogs, pocket gophers and moles. County Extension agents organize requests for training and announce meetings and demonstrations. The Extension wildlife damage control specialist then meets with the individual or group and explains the program. In the case of a coyote-livestock conflict, the specialist goes through the trapping process step-by-step and shows where to look for predator sign and set traps. Only offset-jaw steel traps are used to reduce injury caused by the trap. The wildlife damage control specialist explains to the producer how he can set the traps to make them more selective and reduce the capture of non-target animals. He may also give instruction on predator calling or make suggestions on livestock management techniqes that could lead to a reduction in losses. In some situations, the solution to a predator problem may require a multi-disciplinary approach. Wildlife specialists then work cooperatively with livestock and agricultural engineering specialists and the producer to develop livestock management systems and facilities to efficiently reduce and prevent predation losses.

In addition to individual, on-the-farm training, public meetings, group demonstrations, and workshops with city and town officials are also held to explain damage control procedures and the role of wild animals in natural ecosystems. A series of support publications and handouts has been developed for distribution to explain more fully the philosophies and procedures involved in controlling wildlife damage. Newsletters on a variety of wildlife-related topics are sent out to agents and cooperators on a regular basis. Wildlife damage control specialists participate in 6 to 12 television programs annually to discuss current problems and topics in wildlife damage control. Video television cassette tapes are produced and distributed to area offices. News releases and radio tapes are used to achieve a broad dissemination of important or timely information. A series of slide sets with accompanying cassette tapes on "The Coyote," "How to Trap a Coyote," and "How to Call a Coyote" are available to anyone in the state through the county Extension offices.

The wildlife damage control section at Kansas State University has developed a two-volume handbook on the control of wildlife damage for reference use by county Extension agents across the state. The handbook is now serving as a model for a Great Plains regional publication on wildlife damage prevention and control. We are coordinating the cooperative development of that handbook by wildlife specialists from throughout the region. When completed, this handbook will serve as a basic reference for agents and specialists throughout the Great Plains.

In March 1973, the Kansas legislative branch approved legislation restating the involvement and the role that the Extension Service was to play in Kansas.

In 1973, the Kansas Extension Service sponsored the first Great Plains Wildlife Damage Control Workshop which was concerned primarily with predator problems. In 1975 we hosted a second workshop which was expanded to include damage caused by all types of wildlife. These workshops provided a forum for a mutual discussion of common problems by specialists from throughout the region.

Whenever problems are identified that appear to be particularly worthy of research, they are pointed out to researchers with an assurance that we will cooperate as much as possible in the research project. As a result, the National Audubon Society is currently helping to fund a Kansas State University research project on the relationships between sheep management and coyote predation. This study is designed to identify statistically those livestock management practices that have some affect on predation losses, either positive or negative. Upon completion, this study will provide a factual basis for making management recommendations to producers suffering predation losses.

In order to provide another means of assistance to livestock producers who need immediate help with a predator problem, a card-carrying coyote hunter program was initiated in 1972. Numbered, billfold-sized cards were issued by county agents to reliable persons who showed an interest in assisting producers with predator problems. Coyote hunters are then notified of damage situations only when the landowner has requested assistance from coyote hunters. Newsletters and meetings provide educational information to coyote hunters on coyotes and their habits. Coyote hunting, control of coyote damage, and the importance of hunting in an ethical manner are discussed.

Not only does this program provide a source of immediate assistance to producers with predator problems, it also creates better understanding and good will between livestock producers and coyote hunters. Coyote hunting has long been a tradition in Kansas. The hunters, by signing the card, pledge to: 1) Pursue the sport in an ethical manner; 2) respect the rights of others; 3) seek prior permission before entering on private land; 4) study information provided by the Extension Service; and 5) use their knowledge to help others. They agree to help livestock producers whenever they can by seeking out and killing problem coyotes while at the same time respecting and studying the coyote and its habits. In cases of serious or persistent losses, or if the landowner does not want the services of a coyote hunter, the Extension wildlife damage control specialist is available to provide assistance. Coyote hunter awards are given each year to hunters who exemplified outstanding efforts to hunt in an ethical manner and were successful in reducing livestock losses. Hunters harvested 34,000 coyotes in the winter of 1974-75. That is the second highest number of coyotes harvested in the United States. Only Texas harvested more.

We maintain a close coordination with state agencies and special interest groups concerned with predatory animals and livestock losses. Our program has received excellent cooperation from many organizations, including the Kansas Livestock Association, Kansas Sheep Association, Kansas State Board of Agriculture, Kansas Farm Bureau, and state Soil Conservation Districts. We have regular meetings with the administrators and staff of the Kansas Forestry, Fish and Game Commission, with whom we have signed a memorandum of understanding.

Another key to the success of the Kansas program is that when personnel are not active with helping people solve problems they can engage in on-the-farm studies to experiment with ways to prevent damage or they can develop programs for youth in the realm of environmental education. So, aside from wildlife damage control activities, we have developed an environmental education series of 4-H and FFA projects for Kansas youth. This series includes projects on: acres for wildlife; ecology; birds; mammals; fish; reptiles and amphibians; animal damage control; fur harvest; and wildlife management. It is hoped that through these projects, young people will become more aware of the environment and its associated wildlife and that this will lead to more knowledgeable decisions concerning natural resources in future years.

Evaluation

In the fiscal year, 1976, a total audience of 5,997 people attended meetings and workshops regarding coyote damage control. A questionnaire survey of producers who received individual training from July 1, 1975 through June 30, 1976 was conducted to evaluate the effectiveness of the training in reducing losses. Nonrespondents were contacted by telephone, if possible. Useable responses were obtained from 62 of the 77 producers receiving training.

A total of 52 percent of those receiving training were able to stop their losses completely. In all cases, reported predation losses after training were substantially lower than those reported prior to training. It was impossible to calculate an exact percentage decrease, however, because of the differential periods of time involved.

Of those receiving training, 42 percent in turn showed someone else how to stop damage, multiplying the effects of the educational program. A total of 93 percent of those responding approved of the educational predator damage control program the way it was conducted.

A total of 61 percent of the producers reported using more than one method in their attempts to reduce losses. Methods most commonly employed were: steel traps (92 percent); firearms (35 percent); livestock management (30 percent); snares (27 percent); predator calls (24 percent); and dogs (8 percent). Nine producers (15 percent) indicated that they would like to be able to use poisons in predator damage control, particularly sodium cyanide in the M-44 device.

Producers receiving training reported capturing a mean of 6.2 coyotes. This figure is probably inflated somewhat by the fact that some producers trapped coyotes for fur in addition to controlling damage. Prime coyote pelts brought $25-$55 during the winter of 1976-77. In many cases trapping coyotes enabled producers to offset losses of livestock to coyotes. Selectivity of the program is demonstrated by the fact that producers reported capturing only 6.7 percent nontarget species. Because offset-jawed traps were used, many of these nontarget animals were released unharmed.

Economically, the Kansas predator damage control program is the least expensive of any western state. This is primarily because it is an educational program rather than a service program. The cost of the Kansas program in 1975-76 was $45,000. Three employees are involved in the program—two specialists and one secretary.

A recent Kansas State University research project found that sheep producers in Kansas in 1975-76 experienced a loss of about 1 percent of all sheep to predation.* This is substantially lower than reports for other western states. All loss of livestock to predatory animals in Kansas is estimated to be less than $150,000 annually. Kansas ranks high among livestock and agricultural producing states, yet reports the lowest livestock losses to predators, spends the least amount for predator damage control and supports one of the highest coyote populations in the nation, and, not by coincidence, experiences the least field rodent damage to range and agricultural crops.

Of course, the effectiveness of any program must be measured at least in part by its acceptability to clientele groups and the public at large. Wildlife interests demonstrated their approval of the program in 1971 when the Kansas Wildlife Federation recognized the Extension program with its "Conservationist of the Year" award. Acceptability to livestock producers was demonstrated by a joint resolution of the Kansas Sheep Association and the Kansas Livestock Association in 1972, recognizing the success of the Extension wildlife damage control program. Similar resolutions have been issued in subsequent years including 1976. As a result of the program's success and the fact that it is environmentally sound, the National Audubon Society and its affiliate, the Kansas Audubon Society, have provided moral support for our program.

Continuing broad support for the program was again demonstrated in 1975 when, in response to support from both livestock and wildlife interests, the state legislature appropriated funds to create a new area Extension specialist position in wildlife damage control. The need for this individual originated in the fact that for seven years (1968-1975), one specialist covered 82,000 square miles of Kansas. Quick response to problem areas is another key to a successful program.

Summary

Coyotes, like most wildlife species, have both positive and negative values. Although some coyotes are detrimental to man's interests by destroying livestock, others are beneficial by helping to suppress irruptions of potentially harmful ro-

*R. L. Meduna 1977: personal communication.

dent species. Sport hunting of coyotes provides many hours of recreation for the people of Kansas as well as other states. In recent years, coyotes have become a very valuable fur resource. The value of the coyote fur in the winter of 1976-77 will bring in more money than any other furbearer in Kansas. To a growing number of people there is an immeasureable aesthetic value in just seeing a coyote.

The Kansas educational program of predator damage control provides livestock producers with an effective and economical solution to their predator problems while, at the same time, preserving and maintaining the integrity and stability of natural ecosystems. Through this program we strive to educate not only the livestock producer, but all citizens of the state. We attempt to dispel the myths and prejudices on all sides of the predator control issue by seeking out and providing objective, unbiased information on the subject.

Increasingly, citizens are being asked to make decisions that affect their environment and its associated wildlife. The tendency is for people to become more urbanized and to lose contact with the land. In the face of increasing human populations and demands for more agricultural production, it is imperative that future decisions affecting the management of native carnivores be made by an intelligent and informed populace. That goal can only be realized through programs of public education.

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Case History:

The $6-million Eel, or From Bait to Delicacy in Four Years

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It all started with a two-line blurb in a magazine and the all-American desire to make a buck. It led to a sophisticated $6-million industry with markets in Europe and the Orient.

Back in 1972, a University of North Carolina Sea Grant advisory agent was reading "National Fisherman." He came across an item which said simply that American eels were being commercially harvested. That set the agent, Walter Jones, thinking. Eels are plentiful throughout the North Carolina coastal plain in both inland rivers and coastal sounds. Jones had caught eels on a hook and line in North Carolina waters. Sports fishermen complained about eels getting in the way. Small quantities of eels were being sold commercially as blue crab bait for 18 cents a pound. Why not, Jones wondered, turn the plentiful nuisance into a big-time, profitable commercial crop?

The University of North Carolina Sea Grant College Program is a federal-state cooperative which seeks the wise development of coastal resources. As an advisory agent, Jones had been asked to come up with an idea for developing an underutilized species in North Carolina since our waters are full of nutritious fish which could be used. Additional fisheries were and are needed to assist small fishing operations with below-average incomes. Since fishing is often done on a part-time or seasonal basis, income can be sporadic.

Jones decided that eels were a promising underutilized species—one that would probably return a high profit and provide additional part-time work for fishermen. Further, since the eels were so widely available, they presented an opportunity for a large number of fishermen. A literature search revealed that the annual demand was then 24,000 tons for Europe and 25,000 tons for Japan. Central Europe, the Soviet Union and China require an estimated 5 to 10 tons. Jones believed that if marketing channels could be opened, North Carolina eels would bring a good price on the world market.

1972: The Groundwork

The project got underway quickly. A student assistant was provided by North Carolina State University to work on the eel project with Jones. The two set to work building and setting the eel traps or pots. Since neither of the two knew much about eel harvesting, everything they did at first came from books and talks with northern fishermen who were already in the eel business.

Jones and the student, Wade Fuller, spent the first year doing exploratory fishing and laying the groundwork for a possible new fishery. They were trying to find out if the stock in North Carolina was large enough for commercial fishing. While the two were out plying the river looking for eels, fishermen—who were also out on the river—began to be intrigued with the idea. They would stop the agents to ask them what they were doing. The two men would show the fishermen the eels.

The fishermen were also invited to the agents' shop to learn more. Back at the shop—something akin to an old fish house near the river in New Bern, which is up river in the central coastal area—the two would work on different pot constructions. While they were working, they would talk to the various fishermen who dropped in to see what on earth these fellows were up to. There, in the rundown shop with its pot-bellied stove and four lightbulbs, they would hold one-to-one workshops for anyone who was interested.

It was a learning process for the advisory agents, too. Each summer, when annual Sea Grant funding review came up, they would evaluate what they had learned. Then they would lay out what had to be done during the next spring's fishing season. This annual review gave them and Sea Grant administration an opportunity to evaluate and plan on a regular basis. It also provided input from outsiders who came in to review the program each year.

Things began to fall in place gradually. While the agents were working out the gear details and spending time on the river, they were also spending an average of two hours a day talking the idea up. When they bought gear at the hardware store, they talked about what they were doing. Over a gas pump, or at the sport shop or fish house, or over lunch at the corner grill, they talked about it. Curiosity was building.

Since the eels were not being sold to local fish houses, arrangements had to be made for storing the live eels until enough could be collected to make an overseas shipment. Three 1000-gallon modified septic tanks were set up to hold the eels until enough could be accumulated for a test shipment.

With a little luck and a phone book, the two located an exporter in Raleigh who was willing to try a test shipment of live-frozen eels. Though they were curious about the eel fishing and the tanks, fishermen remained skeptical because no price had been set.

Then the exporter, a poultry wholesaler, found a buyer for live-frozen eels. Jones and Fuller transferred 800 pounds of eels from the modified septic tanks to the back of their camper-topped pickup where the eels were packed in ice.

There were still unforeseen problems for the fledgling industry. On the way to the processor who had agreed to package and freeze the eels, the two had to cross a high-rise bridge. According to Fuller, "We were starting up the bridge. Walt was driving. All he said was 'Oh, my God.' I turned around and looked out the back window. All you could see were eels, and all of them were piled up against the tail gate where the window and door could open. Walt and I could just envision the door opening and all those live eels spilling out on the Beaufort Bridge." They completed that first trip despite the scare. The live eels were packed in 50-pound wax fish cartons, frozen and shipped overseas.

The answer came back. The European market would accept North Carolina eels. Right away, the agents knew they had to do several things: 1) they had to encourage North Carolina fishermen to fish for eels; 2) they had to provide the fishermen a place to store their live eels; and 3) importantly, they had to come up with a way to transport the eels from the holding areas to the freezing plants.

Getting a few eel fishermen on the river wasn't so difficult. When word went out that the first prices had been set at 18, 23 and 28 cents a pound (depending on size), eels began to sound like an attractive supplemental catch. Fishermen were getting between five and 15 cents a pound for their finfish catch at that time. Naturally, the price made them want to give it a try. The agents provided the technical assistance and materials for those who wanted to get started. Each fisherman was given enough materials for one pot.

The appeal was money and the unusual. The fishermen had no doubt that there were enough eels. At first there were about half a dozen trying the new market. By year's end, there were 15 to 20 new eel fishermen. The agents were certain there was a commercial stock of eels at least in the Neuse River around New Bern. Plenty of eels were being caught and, even at 18 cents a pound, the advisory agents thought a commercial enterprise could make a go of it.

1973: Expansion

The next year, 1973, was a time of expansion based on the solid groundwork done in 1972. Fuller graduated and a full-time agent, Gene (Skipper) Crow was hired to work with Jones on the eel fishery. Together, the two began to expand the effort on several fronts. Workshops continued. There were television appearances and much publicity.

If the agents were going to involve many more people they could not continue holding the catches in their own tanks. Then, too, the fishermen needed a source of ready-made pots. The agents designed and built, with the exporter's support, a long haul tank truck with aerators and water pumps. This would transport large quantities of eels to the processing plant. To hold the live eels after catch until the truck could make a pickup, the agents modified a design being used in the North. The floating holding boxes enable individual fishermen to hold their catches live at their own docks.

Jones and Crow contacted a local evaluation-training center for the handicapped. They taught people at the center to construct eel pots. This provided a supply of ready-made pots for those who chose not to make their own.

Jones and Crow had begun to worry, though, because there was only one buyer in the state. They felt it was their duty to inform fishermen of other eel buyers farther north and vice versa. The agents contacted northern dealers who operated tank trucks and urged them to buy in North Carolina. At the same time, the two compiled lists of buyers and provided those lists to the eel fishermen. The result was a price war that drove the price from 30 to 40 to 50 cents a pound.

At the same time, the North Carolina exporter was ready to move into the eel business in a big way. He, however, did not want to handle the eels before they were ready to be shipped out. So, he contacted East Carolina Industries (ECI), which is affiliated with the federally-funded Migrant and Seasonal Farmworkers Association. ECI had also been building eel pots and now they would store 20,000-pound eel shipments to be delivered to the freezing plant.

The eel fishery was clearly underway. Assistance was needed only in helping fishermen set up. The agents began planning a new direction to their work—aquaculture. Aquaculture, they reasoned, was the next logical step to take. While the price and demand were good, growing eels seemed as attractive as catching them. Many of the techniques for eel culture had already been worked out in Japan, where eels have been grown for many years. Funding was approved in August, 1973.

1974: The Payoffs

In 1974, all the groundwork began to pay off. By the end of the year, there were about 200 North Carolina eel fishermen. Four exporters were buying in the state. And the price per pound had stabilized at 50 cents. As the idea began to catch on regionally—through newspaper articles, interest in the ECI plant which is in the northern part of the state, and word-of-mouth—Jones and Crow found it necessary to "go on the road." The two spent a good deal of time traveling from fish house to technical institute and back explaining what the new fishery was all about. The price remained stable, despite the fact that more eels were being put on the market by all the new fishermen. Eeling continued to attract interest and curiosity.

The agents visited local newspapers and talked to fish dealers and fishermen to advertise their workshops. To attract interest in new areas, they posted signs saying "CASH FOR LIVE EELS, for further information, contact the Sea Grant Program." If they got much response in a given area, they would set up a workshop. In addition, the Coastal Plains Center for Marine Development Services, which is supported by the federally-funded Coastal Plains Regional Commission, sponsored eel harvesting workshops in North and South Carolina and Georgia. These were set up in cooperation with Sea Grant agents in those states. The other states also have developing eel fisheries today.

The eel aquaculture demonstration facility—a laboratory, some small eel holding tanks and an outdoor grow-out pond—was opened in the spring. The initial grant was from the Coastal Plains Regional Commission, which seeks economic development of deprived regions, to get things rolling. The grant was for $9,200. Some of the money was spent on travel expenses for a Japanese eel culturist to visit New Bern and advise the agents.

The first small eels, elvers, to be transferred to the tanks were harvested from North Carolina rivers in March, 1974. This first "crop," however, was lost to diseases introduced in the river water used for the tanks. Well water was substituted and a new crop of elvers was flown in from Maine.

1975: A Money-Making Business

The following year, 1975, Jones became field director of the eel farm. Crow moved to Morehead City in the central coastal area to carry Sea Grant advisory services into a new geographic area. His major responsibility was the harvest of wild eels. He provided direct technical assistance to North Carolina fishermen and carried on a vigorous correspondence with fishermen from Maine to Florida who were interested in getting started in eeling.

The move to Morehead City represented not only an expansion of the eel work but also a larger expansion of UNC Sea Grant Advisory Services in general. From the solid foundation of person-to-person contact for a particular purpose—eel fishing—Advisory Services were able to move naturally into other areas of interest to the coastal community. By being in direct contact with the people, we were able to identify their needs. Today our Advisory Services encompass land use management, recreation and coastal engineering as well as commercial fishing and seafood science and technology.

Agents trained to work with the processing aspects of the seafood industry assisted East Carolina Industries in its effort to further process eels before export.

ECI plans to ship gutted and smoked eels as well as live-frozen eels. In 1974, they received a grant to build a 30-by-40-foot freezer. This enabled them to process eels for direct overseas delivery. ECI has continued its expansion, frequently calling on Sea Grant for technical assistance.

In 1975, 350 part-time and full-time eel fishermen received $600,000 from both in-state and out-of-state buyers. In terms of worldwide dollars connected with those eels for such items as transportation, fuel, investments, profits and road use taxes that figure translates into $6 million. The price of eels at the end of 1975 was 50 cents per pound. That year, Crow handled 170 requests for personal visits and information concerning the harvest of wild eels.

1976: An Established Enterprise

Finally, last year eel harvesting seemed well established. Crow still spent about 50 percent of his time on eels. By early December, he had handled 121 in-state requests for technical assistance on eel harvesting. In addition, he had handled 73 out-of-state requests from East Coast states as well as Arkansas, Texas, California and Denmark. (Most written requests for information are carefully followed up with a telephone call to ascertain that needs have been met. This often leads to valuable contacts.)

But the number of fishermen seemed to have leveled off at about 350, and the price was generally 50 cents a pound. There were seven in- and out-of-state buyers. East Carolina Industries—which now devotes most of its efforts to eels—had 503 members, all of whom are involved in some aspect of the eel business. ECI trained 180 fishermen and provided boats on a pay-back basis to 125 of them. In addition, other businesses have been considering processing and smoking eels for domestic consumption. A new eel fisherman, who is the first to try eel fishing in the southern part of the state, has been getting 85 cents a pound for eels sold directly to local markets.

Crow is no longer trying to drum up much new business for wild eel harvesting, though he still expects to spend about 50 percent of his time responding to inquiries. He does believe that the southern area of the state, around Wilmington, has good eel stocks. This year, Sea Grant has added an additional advisory agent who will be located in the Wilmington area. Developing potential eel markets there will be a good way for the agent to begin to make contacts.

Research

Research connected with the growing industry has been varied. It has developed naturally in response to needs generally raised by the coastal public. When Jones or Crow or others connected with eel aquaculture have found a research need, they have been able to either find researchers on their own or work through the UNC Sea Grant administrative offices to identify those capable of carrying out the research. As the aquaculture project has become increasingly viable, research efforts have begun to focus on questions common to both wild and cultured eels:

1. Discussions are now going on with the state's Wildlife Resources Commission and Division of Marine Fisheries to draw up regulations for the commercial harvest of wild eels. To date, it is felt that the breeding stocks have not been adversely affected. There is concern, however, that recent interest on the part of Oriental buyers in elvers for aquaculture may lead to a run on the stocks.

2. An economic analysis of eel fishing showed that, under the study conditions, a minimum of 30 pots must be fished to make a profit.
3. In addition to the work on eel fishing gear, agents have also worked extensively on processing methods. In 1976, for example, they came up with a way to shock live eels for packaging. This new method saves shipping space and makes the product easier to handle.
4. Fat content and fatty acid composition studies were carried out on both wild and cultured eels. Fat content influences the consumer appeal and the price for eels. The diet used to raise the eels strongly influences both the quantity and type of fats in the product.
5. Just recently, Skip Crow has worked with Sea Grant's new recreation specialist and the aquaculture project in an effort to set up a market for bait eels. These eels, which make good sport fishing bait, are not usually marketable. The undersized eels are culled out in commercial fishing operations.
6. A conference on eel culture and biology is being planned. And, a "traveling road show" on eel culture, to be sponsored in cooperation with the Coastal Plains Center for Marine Development Services, will be presented this year in states from Virginia to Florida.
7. Without going into considerable detail on the aquaculture project, it should be mentioned that the principal investigator and his staff have wrestled with questions ranging from food utilization to feeding trays to disease control.
8. Economic analyses of the aquaculture project are underway.
9. There is a need now for a thorough survey of East Coast eel supplies and foreign demand. Common opinion is that the demand is almost limitless. North Carolina now provides an estimated seven to 15 percent of United States eel exports. The state ships out approximately 750 tons annually.

Communications

The efforts of Advisory Services agents were supplemented in 1974 with the addition of a public information specialist to the UNC Sea Grant staff. Since that time, frequent newspaper and magazine releases, newsletters, radio public service announcements and pamphlets have helped keep inquiries coming in. In addition to promoting direct personal contact with the agents, the public information effort has led to requests for further written information. The Sea Grant administrative offices alone have filled about 350 requests for copies of a booklet entitled "The case of the slippery eel, or how to harvest, handle and market wild eels." Approximately 15 to 20 requests are still filled weekly by this office. Frequently, the requests involve multiple copies and/or later personal follow-up. In one instance, the booklet was used as a textbook by a technical institute. Additional copies are distributed by advisory agents. The booklet is in its fourth printing. A total of 4,500 copies have been printed. The popularized booklet was written by a Sea Grant Public Information Specialist in cooperation with Jones and Crow.

Similar publication efforts are being carried out for the bait eels and for the eel culture project. (Requests for information on eel culture are not included in the above figures.)

Conclusions

In five years, the University of North Carolina Sea Grant College Program has spent less than $75,000 on wild eel harvesting advisory services. What started out as an effort to tap an underutilized species has led to an increasingly sophisticated and expanding industry—one which promises even further development. There is a potential market now for eels of all sizes.

Throughout the process of developing this industry, advisory agents were relatively free to follow their instincts, to follow what they perceived public interest and need to be. There was, of course, major review at yearly intervals. But Crow feels that if they had had to wait for chain-of-command approval for each and every move, the project might never have gotten off the ground.

Of course, the job was made easier because Jones and Crow were helping sellers in a sellers' market. Extensive worldwide demand continues, prices are good, supplies are down elsewhere. To have created a market would have taken a lot longer if, indeed, it could have done at all. North Carolinians are not eating eels to any great extent. In that sense, eels are still an underutilized species. Newspapers occasionally pick up a recipe from "The case of the slippery eel" and run it as a curiosity. The seafood lab, which is operated in cooperation with the North Carolina State University Food Science Department and the Agricultural Extension Service, is experimenting with methods for home smoking of eels. The fisherman near Wilmington is doing a good local trade. But, at this point, Sea Grant has not contemplated a full-scale campaign to develop local markets.

The project has lived up to its goals. It has improved the financial situation of at least 350 fishermen and a number of businesses. It promises to do more. Equally important to the UNC Sea Grant Program itself is the fact that this advisory services project—thanks to the flood of inquiries and public interest—gave our overall Advisory Services Program a strong beginning. The eels have helped us get our collective foot in the door in many cases. Our Advisory Services now include four fisheries agents, a recreation specialist, a land use management specialist, a staff of four at the seafood lab, and a soon-to-be-hired coastal engineer. With a few exceptions, all of these people have worked on at least one aspect of the eel projects. For example, the recreation specialist made some of his first contacts with coastal sports shop owners when he was working on the bait eels. It has been a mutually beneficial process.

Sea Grant has enjoyed credibility which has, in general, given the program a boost. Then too, the experience has taught us to respect the people, to be sensitive to their needs and wishes. Also, though we are a growing organization, we maintain an informality which gives staff an opportunity to come up with and pursue a good idea.

Case History:

The Role of the Louisiana Cooperative Extension Service in the Development of the Louisiana Crawfish Industry

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Introduction

In Louisiana, crawfish required for some of the renowned delicacies are easily obtained today. This, however, has not always been the case.

Commercial sale of crawfish in Louisiana was first reported in a government publication in 1880 (Penn 1941). Through the 1920s, commercial sales were small due to the perishability of crawfish and the poorly developed highway network within the state. Sales tended to be local and were comprised of occasional surpluses of crawfish caught for family subsistence (Security Industrial Insurance Company 1970). The commercial crawfish industry did not come into its own until the 1930s.

During the 1930s, a marked increase of reported commercial catches was made possible by improvements in crawfish preservation, transportation and harvest techniques (Comeaux 1972). These early catches were taken from natural river basins and swamps in Louisiana, with the bulk coming from the Atchafalaya River Basin.

The first commercially managed crawfish pond in Louisiana was developed by a rice farmer, Voorhies Trahan, in 1949. Reflooding of his field between fall rice harvest and spring made possible rotation of rice and crawfish. Soon thereafter, wooded swamps, marshland, and cleared hardwood forests or open lands unsuited for cropland or pasture were devoted to producing commercial crops of crawfish (Viosca 1966).

From 1949 to the mid-1960s, the total acreage of managed ponds was small because crawfish farming was a high-risk endeavor due to insufficient knowledge of the habits and needs of crawfish. Beginning in the mid-1960s, commercial crawfish enterprises increased greatly (LaCaze 1968). This paper outlines the role the Louisiana Cooperative Extension Service played in the development of the crawfish industry after 1963.

Method

The Cooperative Extension Service is a university institution which transmits scientific knowledge to state residents. It was through this organization that a program for the crawfish industry in Louisiana was developed.

The initial Extension effort in crawfish farming was directed toward rice farmers in Louisiana. By rotating their rice fields with crawfish, some rice farmers were able to supplement their income. County agents were instrumental in directing most of the early efforts to culture crawfish in combination with rice.

Publication of pioneer management research results from rice fields in the early 1960s marked the beginning of the Extension program for the crawfish industry. Widespread distribution of free crawfish farming bulletins by the Extension Service and Wildlife and Fisheries Commission, such as Hill and Cancienne (1963), LaCaze (1970), and Viosca (1966), removed many doubts regarding the likelihood of high per-acre yields of crawfish. Thus, in time, potential crawfish farmers from sugarcane and rice producing areas came into the business, and it became necessary for confident government personnel to give positive counsel on a farm-to-farm basis.

The second phase of the Extension program for crawfish farmers began in 1970, and involved two key elements: (1) a program specialist at the state level and (2) professionally trained county agents on a local level working with the farmers.

The key element in the proposed structure was the program specialist at the state level. His function was serving as the link between the knowledge center (university) and the audiences. In addition to transmitting knowledge from the center, he also fed back problems from farmers.

With the assistance of the county agents and their local Extension staff units, a number of activities were envisioned at the area, parish and community level:

1. Agent training meetings concerning crawfish culture techniques and farm management were conducted for agents in the field. Programs involved instruction by the specialist and other authorities from the university, as well as other government agencies such as wildlife and fisheries and the Soil Conservation Service.
2. Mass media information programs on the crawfish industry in general were conducted locally, along with public education programs on crawfish farming. Public education programs include the distribution of literature to local groups, articles in the local press, programs on radio and circular type letters to the county agents and farmers concerning timely management information. These matters were handled by the parish Extension staffs with assistance from the specialist. Other divisions of the university and other organizations having special expertise on specific problems were called upon to join the educational activities conducted.
3. Community and parish meetings were organized and conducted in crawfish producing areas of the state for the purpose of discussing problems and management information. Local farmers were involved in the educational programs to share their experiences with other farmers.
4. Contact was maintained by the specialist with all elements involved in crawfish research and development of the industry. As research results of an applied nature became available, these were translated into forms so that educational work could be started.
5. The specialist and county agents gave assistance, when necessary, through on-farm visits. This type training was beneficial to both the farmer and agent, and developed a very close working relationship between the Extension Service and the farmer.

Results and Discussion

Historically, the bulk of Louisiana's crawfish harvest has been from the Atchafalaya Basin. This semi-wilderness area in south-central Louisiana is a floodway for the Atchafalaya River-Mississippi River complex. Pond crawfish farming was developed to prevent erratic supplies of crawfish and to assure control of water management and predators. Pond farming also takes advantage of high prices restaurants pay before the basin crop is harvested.

There are a number of factors contributing to the increase of pond acreage in the last decade. (Table 1.) With the increase in numbers of cultivated ponds, together with improved transportation to market, crawfish began finding their way to more and more markets over a wide portion of the country. Rapid development of these domestic ponds was hastened by several factors, some of which posed threats to the stability of the crawfish industry. These factors include: (1) the drainage of natural swampy areas in south Louisiana—areas ideal for growing crawfish, (2) inconsistent water levels which affect feeding and reproduction and (3) increased pollution of the crawfish's natural habitat. A plus factor in the rapid development of on-farm ponds was the increased demand by the consumer for this Louisiana delicacy on the dinner table.

Table 1. Estimated total pond acreage for various years.

Year	Acreage	Authority
1949	40	Lovell (1968)
1960	2,000	Viosca (1966)
1966	6,000	LaCaze (1966)
1968	10,000	de la Bretonne, Avault, and Smitherman (1969)
1969	12,000	Perry and LaCaze (1969)
1970	18,000	Perry, Joanen and McNease (1970)
1971	24,000	Walton and LaCaze (1972)
1973	44,000	Gary (1974)
1975	45,000	Field Inventory by James Fowler

After publication of pioneer management research in the early 1960s which revealed that crawfish culture was an economically feasible business, the need for an Extension educational program was evident. County agents as well as other government agencies such as the Wildlife and Fisheries Commission were flooded with requests for information and assistance. Sources of information were scattered and inconsistent, with few qualified individuals available to help new producers.

Biologists with the Wildlife and Fisheries Commission, such as Percy Viosca and Cecil LaCaze, were the first professionals to give assistance to farmers interested in crawfish farming. With the establishment of a wildlife and fisheries specialist within the Cooperative Extension Service, the leading educational effort was soon assigned to the Extension Service. Initial training for county agents and the few farmers in the business was conducted by the specialist, with assistance from LaCaze and other authorities in the field.

Paralleling this educational program was the development of a statewide organization, the Louisiana Crawfish Farmers Association. The purpose of this organization was to provide an exchange of information among farmers and researchers and to aid in the development of a marketing system which would keep the crawfish farmer in a competitive economic position.

The major thrust of the Cooperative Extension program was directed through the county agent to producers. Parish production meetings were conducted on a regular basis to keep farmers informed of the latest recommendations in culture practices. In addition, current research information was presented at the annual meeting of the Crawfish Farmers Association, and printed resource information was developed by the specialist for distribution to the field. Thus, in time, potential crawfish farmers became more inclined to pursue the activity, and involved Extension personnel confidently gave positive counsel more often.

Many problems were encountered by the first farmers involved in crawfish culture. Although cultural technology was adequate to produce crawfish in ponds, water quality was a main consideration. Few farmers knew how to harvest crawfish and had to rely on commercial fishermen to harvest their crop. Once the wild crop became available, the farmer would often lose his fishermen. More mechanized harvesting techniques were developed to help eliminate some of these earlier problems and relieve labor problems. Many of these early problems were solved by the farmers themselves through their own innovations. As improvements were made, these techniques were extended to other producers through the Extension program.

The commercial crawfish processing plants were also improtant in the early development of the crawfish farming industry. During the latter half of the 1960s, processing plants were handling almost 3 million pounds of live crawfish per year, which was a significant increase over quantities handled in previous years. The number of licensed crawfish peeling and packing plants in operation increased from 5 in 1959 to 29 in 1966, and to 34 in 1972 (Gary 1974; Hudson and Fontenot 1970).

Demand for both live crawfish and processed meat continued to increase with increased production, thus adding to the feasibility of crawfish farming. However, as the industry grew and became more complex, so did the problems. Major research efforts from 1965–1973 were in studying the life history of crawfish and production in ponds (Avault, de la Bretonne, and Jaspers, 1970).

Beginning in 1973, the Louisiana Sea Grant Program began to recognize the importance of this new industry, and immediately became involved by supporting research in various universities within the state. A long-range program had also been designed by Cooperative Extension and the Office of Sea Grant to develop a marine advisory program. With the development of this program, the Extension effort for crawfish farmers, and the industry in general, was greatly accelerated.

Educational programs involved many types of Extension activities. Community meetings were organized to present educational programs on such topics as crawfish biology, business management, plant sanitation and storage, legal requirements in processing plants and new fishing techniques. Specialists, key leaders, other agency personnel and area marine agents were utilized in presenting these programs.

Mass media programs were conducted with respect to the crawfish industry. News articles were developed concerning crawfish products for promotional purposes as well as current market information for producers.

Specialists at the state level developed materials in the form of literature, slides, charts and film strips for distribution by area agents and parish Extension staffs concerning the biology, production and utilization of crawfish.

Summary

The Louisiana Cooperative Extension Service has been instrumental in the development of a successful crawfish industry, presently valued at $6 million by the Louisiana Department of Agriculture. An effective Extension educational program was developed for transmitting information from the university and other information sources to practicing farmers and processors within the industry.

Future expansion of Louisiana's crawfish industry will depend in part on solving new and existing problems in management and market expansion. Through a continuous Extension program, backed by university research, this industry should continue to be an important aquaculture resource for people in the state. The success in crawfish culture has suddenly captured the eye of the investing public as the only large scale, economically feasible crustacean aquaculture venture in the U.S.

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Case History:
Information Delivery for Water Quality Management

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Cooperative Extension is the information delivery component of the Land Grant college system. Its mission is to provide pertinent information in a form useful to any clientele group.

A specific instance involved members of the University of California Cooperative Extension staff about four years ago when the State Water Resources Control Board and the nine Regional Water Quality Control Boards—acting under direction of federal and state law—began drawing up water quality control plans for each of the principal hydrologic basins in California.

California's program of basin-wide water quality planning has its roots in state as well as federal laws. The state Porter-Cologne Water Quality Control Act (1969) launched the present intensive control program. Federal laws and the Environmental Protection Agency intensified the process, setting guidelines, standards and deadlines, providing more funds, and requiring plans—particularly under P.L. 92–500. The first phase of the program ended in 1971, when interim quality control plans were adopted for most of the state's water. Under these interim plans, water quality standards for municipalities and industries were tightened, and construction of dozens of additional sewage treatment facilities was begun. But that was not enough, as the State Water Resources Control Board made clear when it stated: "Future attempts to control water quality must be based on factors more comprehensive than just municipal and industrial wastewater treatment." This required a second phase of planning for broader control of water quality.

Under Phase Two, permanent water quality control plans had to deal not just with pollution problems that could be easily pin-pointed (and for which the engineers already have answers) but all water quality problems in the state—including those related to agriculture.[1] Furthermore, these comprehensive control plans had to be formulated and adopted by mid-1974. So many of the basic decisions had to be made during a very short period of time — 18 months or so.

To draw up the proposed plans, the State Water Resources Control Board let contracts totalling nearly $3 million to various private firms and public agencies. Most of the private companies were engineering and planning firms which were water-oriented but generally did not have on their staffs expertise in water quality requirements for agriculture.

The comprehensive water quality control plans were to consider everything, or almost everything, that might influence water quality. For instance: future land use or population trends; other long range needs for water; economic effects of water quality control; possible technological developments to remove pollutants; methods of control; costs of control; and water quality monitoring programs.

[1] While this paper deals specifically with water quality control planning for food, fiber and commercial ornamental crops production, Cooperative Extension recognizes that water quality is important to all Americans: the householder, the fisherman, the forester, etc. We have educational programs in these areas also.

Keep in mind that the production of food and fiber accounts for about 85 percent of the developed water put to use in California. The impact of such a far-reaching, all-encompassing water quality control program obviously became a concern of agriculture—and therefore of Cooperative Extension. What role might, or should, Cooperative Extension play in such a program? How might our role be implemented? Herein lay the challenge.

Cooperative Extension—The Information Delivery System

The University of California's Cooperative Extension, (also known as the Agricultural Extension Service) traces back to the Smith-Lever Act of 1914 which provided federal funds to Land Grant universities and colleges to conduct research and educational programs in agriculture and home economics. In 1915, the State of California adopted the provisions of the Smith-Lever Act, and designated the University of California as its Land Grant institution. Today, Cooperative Extension plays a major educational role throughout the state. It has offices in all but one of the 58 counties of California, including all major cities in the state. Its budget is derived from federal, state and county sources.

There are 350 full time Extension professionals in the field (county) offices. They are supported by an additional 150 professionals on three campuses of the university and a field station. The strength of the Cooperative Extension education program results from its close ties with research programs of the University of California and the United States Department of Agriculture. Extension specialists on the campuses bring to the attention of scientists research needs as gleaned from their association with local Extension staff and the user audiences. Extension specialists and county staff specialize in getting research results out to user audiences in understandable form. Cooperative Extension academic staff members—state or county—also do some applied research. Cooperative Extension is an educational, not a regulatory, agency. But, when appropriate, it does inform its clientele about regulations enforced by other agencies, and of their responsibilities and options in meeting those regulations.

The Procedure

With this background in mind, let us consider the specific problem faced by Cooperative Extension in meeting the challenge of Phase Two of the water quality planning program. Extension's first step was to offer its support and cooperation to the state and local water quality agencies. This expression of concern and interest was apparently well-received by the water quality control people. It was agreed that a series of jointly sponsored conferences would be held in the Central Valley, an area with nearly 7 million acres under irrigation and intensively cultivated. Extension assumed the responsibility for selecting locations and meeting places, and each agency invited the appropriate members of its staff. Responsibility for inviting the consultant firms was left to the state and regional water quality control agencies.

The purpose of these sessions was first, to acquaint Cooperative Extension staff members with the planning program in greater detail; second, to make known to the control agencies the concern and interest of the university community and its willingness to be of service; and third, to develop the working relations and mechanisms for technical input from the university to the planning process. At the end of this series of six meetings, it was apparent that: l) there was obviously a role for Cooperative Extension as well as for our colleagues from the experiment station of the Land Grant college and 2) our offer of assistance in making available technical expertise was accepted.

It was evident that any such effort would require a significant amount of Extension time. Furthermore, one question seemed particularly pertinent: How would our clientele—in this case farmers, good friends of Extension—react to our working with the control agencies? The answer to that question was made clear by posing another one: what might be the reaction of our farmers and related clientele groups if we were not to offer our technical assistance and if we did not make our information delivery system available to "get the word out" that another regulatory mandate of such impact was facing the growers? Farmers, it should be added, recognize the value of good water and are not in disagreement with reasonable efforts to protect its quality.

The Role Defined

Recognizing, therefore, both the need and the responsibility, the vice-president of the university's Division of Agricultural Sciences appointed a Water Quality Task Group whose charge was to advise the administration and to develop the procedure or mechanism for university input into the water quality planning process. This group of eight members, four from the experiment station, and four from Cooperative Extension, developed the concept of a committee of consultants, which was to be the working group. The idea of a committee of consultants was not totally new, although it had some innovative components. The task force approach had already been utilized in the university's response to a request from the Santa Ana Watershed Planning Agency. That project involved the university's doing the entire job—a three-month study of the nitrate problem in a hydrologic basin southeast of Los Angeles.

The committee of consultants' function was defined as follows: 1) to assist the water quality control agencies and the private planning consultants in defining agricultural water quality control problems; 2) to assist in identifying data sources; 3) to consult as requested in interpretation of data; 4) to assist in evaluating the technical accuracy of proposed plans.

Those two phrases "assist in" and "as requested" are particularly noteworthy. The university was *not* to do the planning. The plans were to be those of the state and regional water quality control boards. It is not the purpose of the university to interfere, but to offer its assistance and to be prepared to respond.

In order to facilitate communications with the committee of consultants, three Extension specialists were designated as primary contacts. They were already strategically located in the state and also represented particular fields of knowledge and experience. All communications on technical matters were channelled through one of these three primary consultants. The associate dean research, of the College of Agriculture and Environmental Sciences (Davis) served as chairman during formal meetings while the Extension environmentalist, land and water use performed the duties of executive secretary.

During the course of its work on this project, this committee involved some 18 to 20 university staff members working with the control agencies and their engineering planning contractors on the development of the Basin Water Quality Control Plans.

Consulting

There was another question of concern: Should the university's input be covered by its policy permitting academic staff to do outside consulting? The University of California has a longstanding policy with respect to consulting by academic staff. This policy is interpreted, like those of other similar institutions, as permitting a positive view of outside consulting. Members of the experiment station and Cooperative Extension already had been approached by the water quality planners and water quality control agencies for their services in this capacity. Some availed themselves of the opportunity while others felt strongly this could become a problem, and therefore declined. This, too, seemed an appropriate question to pose to university administration. Its decision was that, because Cooperative Extension is the information delivery component of the system and is already supported by public funds, Extension's input to the water quality planning process would be conducted as a part of our regular duties.

The Result

Among the more tangible results of the university effort through the committee of consultants was a document, "Guidelines for Interpretation of Water Quality for Agriculture." These guidelines included updated water quality data on crop tolerances and leaching requirements for field, vegetable, fruit and forage crops; effects of boron in irrigation waters; tolerances of ornamental shrubs and ground covers to salinity in irrigation waters; maximum allowable concentration of trace elements in irrigation waters; a guide to use of saline waters for livestock and poultry; etc. These guidelines were adopted by the California State Water Resources Control Board and by the California Department of Water Resources, and serve as the official references in water quality planning for agriculture. This document filled a real need, as one regional water quality control official said: "These numbers are not in the engineers' handbook."

Experience with the committee of consultants demonstrated the ability of scientists from both Cooperative Extension and the experiment station to contribute answers to some very difficult questions, questions posed by staff members of the water quality control agencies and the private consultants engaged to produce the basin plans. These answers were based on the current available information. The time pressure to attain environmental conservation goals by legislative mandate doesn't always allow for additional research, desirable as it might be. The university community, therefore, was placed in the position of responding in a maner somewhat different than the traditional academic approach. Scientifically confirmed answers were provided when known. When all the desired research base was not available, a consensus based on best estimate or best judgement of the total committee was provided.

During this period regular Extension activities continued to bring pertinent information regarding the water quality control planning program to the agricultural community. For example, county Extension personnel provided assistance in the design and management of manure holding ponds, return flow systems, use of effluent for irrigation, etc. These on-going educational programs were designed to provide farmers with the facts of water quality requirements, and—equally important—with information on how to modify farm operations not only to comply with regulations but to enhance overall farm management.

Responsibilities Expanded

After the initial effort leading up to adoption of Phase Two basin water quality plans in 1974, the committee of consultants' concept was employed by the university to provide information to the staff and members of the National Commission on Water Quality. Assistance also has been given the California Department of Water Resources in its updating of the California Water Plan. These efforts have included technical evaluations on such topics as "probable impacts of restricting irrigation water for feed grains and forage production" and "reasonable and unreasonable uses of irrigation water." Both of these are public policy issues of vital concern to agriculture.

Largely because of the demonstrated usefulness of the committee of consultants approach, the vice-president of the university's Division of Agricultural Sciences has now reconstituted the Water Quality Task Group under the title of "Division of Agricultural Sciences—Soil and Water Issues Advisory Task Group." The committee of consultants itself is not to be maintained on a continuing basis. The task group will review requests for assistance from other agencies of government, federal, state or local. When appropriate, it will recommend scientists from the experiment station and/or Cooperative Extension to serve on new—and it is hoped—equally useful and effective committees of consultants appointed on an ad hoc basis.

Conclusion

A committee of consultants composed of scientists with appropriate expertise can be of significant help to regulatory agencies. To accomplish this, however, it is necessary to take note of the three Cs of effective interagency relations: cooperation, coordination and communication. None of these can be accomplished solely by legislative mandate nor by administrative directive. Genuine cooperation, effective coordination and good communication result only when individuals representing the various institutions and agencies see the values to be gained and work to achieve them.

In addition, the committee of consultants concept can be effective only if:

1. The scientific institution perceives the opportunity and is willing to exercise its responsibility.
2. Regulatory officials recognize that additional technical expertise exists in the academic community, and take advantage of the scientists' willingness to be helpful.

Toward Expanded Program Support:
Imperatives for Action

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The objective of our panel discussion is to focus the efforts of all who are interested in a truly strong national program in wildlife conservation toward strengthening its weakest link, public education. It is something which should have been accomplished 40 or more years ago, and that it was not is a sad commentary on the vision, determination, and persistence of all of us wildlife conservation professionals, who should not have been so easily thwarted.

A nationally strong wildlife profession, and wildlife conservation program, requires strength equal to the needs in at least three areas: research, management, and education. It is curious that in the wildlife field we have come much nearer to building the needed strength in research and management than we have in education, and it is in public education that we lag the farthest behind. Note that I am speaking of a *national* program. Some states, and some private efforts, have been outstanding, but they have never grown to the national program so urgently needed.

A national wildlife *research* policy and program began with establishment of the U.S. Fish Commission in 1871, and the first appropriation for bird and mammal research in 1885, and there has been progress ever since. In addition to the research by the Federal Government itself, there have been several programs of federal aid to the states which have resulted in wide participation at the state level in fish and wildlife research. The Cooperative Wildlife Research Unit Program initiated in 1935 was quickly followed by the Pittman-Robertson Act of 1937, under which research was one of the eligible types of projects, and was widely used by the states.

Fisheries research at the state level has likewise been stimulated by federal grant-in-aid programs, including the Dingell-Johnson Act of 1950, the Commercial Fisheries Research and Development Act of 1964, and a similar Anadromous Fish Conservation Act in 1965. These federal programs, providing incentives to the states in the form of matching funds, have effectively stimulated widely based fishery research throughout the country, and have helped significantly to improve the profession.

Wildlife *management* has likewise grown tremendously in national policy and programs since the Lacey Act of 1900 first provided regulatory authority to the Federal Government in the wildlife field. Other developments followed rather quickly. The first national wildlife refuge was established in 1903 in Florida to protect colonial seabirds, and a national bison range, to save that species from extinction, in 1908. Other well known developments in the national wildlife conservation program included the Alaska Fur Seal Treaty of 1911, the Migratory Bird Treaty of 1916, and many other international agreements since. In the long list of federal Acts which have established new programs in the wildlife management area I'll mention only three more which are of outstanding long term significance: the Migratory Bird Conservation Act of 1929 which established a system of national wildlife refuges as a national policy; the Fish and Wildlife Coordination Act of 1934, which has been amended and strengthened since, but still needs strengthening; and the Endangered Species Act of 1973.

In *management,* as we have seen in *research,* there have also been several programs of federal aid to the states which have broadened state participation and generally upgraded the management programs and the profession. Chief among them are several Acts already mentioned, because they provided federal aid to management as well as to research.

In contrast with this rather steady progress, from early beginnings, in establishing strong national programs in wildlife research and management, we have, instead, one of starts and stops, inaction and frustrations, as far as a national program of public education in the wildlife field is concerned.

Certainly there is no lack of highly successful examples in closely related resource areas from which we could have learned and been inspired. As early as 1930, Aldo Leopold, in reporting on the American Game Policy, spoke of the desirability of using the enormous resources of agricultural extension, and then again, in 1932, in a report to the American Game Conference, he urged extension work in game management. In 1936 the Bureau of Biological Survey, immediately after establishing the first Cooperative Wildlife Research Units in land grant colleges, took a logical step toward a national program in wildlife extension by establishing a position of federal wildlife extension specialist, and appointed I. T. Bode to the position.

The prospects looked good. The Biological Survey was in the Department of Agriculture (USDA), where Cooperative Extension was administered. A sister agency, the Forest Service, had been deeply involved in cooperative extension with the Land Grant universities since 1924, when the Clark-McNary Act had authorized it, and I. T. Bode was thoroughly familiar with agricultural extension in his home state of Iowa. He immediately began a vigorous schedule of visiting the state universities and state wildlife agencies to stimulate interest in extension programs for wildlife to parallel those in so many other fields. It is sad that this program did not continue once it had started, because if it had, our session today could be reviewing four decades of progress in a national program of wildlife extension, instead of trying to initiate one.

Why did it not continue? The immediate reason was that I. T. Bode resigned to take up important duties as the first director of the newly established Department of Conservation in Missouri, and the Biological Survey did not replace him. Why? The most important reason was doubtless the very tight budget in that period of economic crisis, but in any event he was not replaced, and in 1939 the Biological Survey was transferred, during one of the government reorganizations, to the Department of the Interior, which made resumption, or initiation, of a cooperative wildlife extension program much harder. This simple fact, that the government's wildlife agency is not in the Department of Agriculture, where Cooperative Extension is administered, has been a much greater handicap than it should be to developing a viable national program of wildlife extension.

But enough of raking over old coals. Is it still important, after all these years, that we start a national program in wildlife extension? You have heard from other speakers about fine work that has been and is being done already in various wildlife extension programs. Is there still any cause for concern? Unequivocally, I say yes, because under the type of national program that we visualize, and urge, every existing state extension program could be strengthened, and the 20 states which have none, could initiate one.

Why is it so important to have a strong, national, wildlife extension program? Most important is to become a part of an exceptionally successful system of public education, making use of its organization, its techniques, its experience. One university administrator described cooperative extension as "having influenced more adult people and changed more practices than any similar educational movement in history." The Land Grant university concept was established in 1862 by the Morrill Act. In 1887 the Hatch Act added agricultural experiment stations and a national program of agricultural research to the Land Grant universities. And then in 1914 there was added, under the Smith-Lever Act, a program of cooperative extension in agriculture and home economics. This teamwork between university education, research, and extension to the public, has made American agriculture the most successful anywhere. We simply want to tie wildlife into an existing program of proven worth.

Liberty Hyde Bailey, a great educator and one of America's pioneer leaders in plant science and horticulture, described, when dean of the College of Agriculture at Cornell, the goal of cooperative extension: "To teach those who have a desire for information, and to create a desire for information in those who do not yet have the desire."

It is natural to wonder if public support for public education is really needed in the wildlife field, which is so popular that it is treated frequently and at great length in the mass media, in magazines, newspapers, television. The mass media treatment can, of course, be helpful, and often is. Cooperative extension employs it to some extent. But often the mass media dispense misinformation and prejudices which complicate the public education job instead of aiding it. It can be no substitute for a good national wildlife extension program.

Jack Berryman will provide the flesh, but here, to help us visualize the kind of program we are urging, are the bare bones of a successful national wildlife extension system:

1. A federal wildlife extension specialist located in the *USDA*, where Cooperative Extension is administered; his function would be coordinating, stimulating, and advising, rather than administering; he would provide a pipeline for information and teaching material, from experts in the Fish and Wildlife Service to the states; the program would involve close cooperation between these two agencies;
2. federal funds in modest amounts which could be offered on a matching basis to induce and assist the states to establish permanent wildlife extension programs in their Land Grant universities;
3. state wildlife extension specialists in the land grant universities, their number and specializations according to needs in the states;
4. a series of cooperative agreements outlining goals, procedures, and responsibilities; in Washington these would be between the Department of Interior (Fish and Wildlife Service) and the Department of Agriculture (Cooperative Extension Service); in the states, between the land grant university and the state wildlife agency; and still others between the USDA and the land grant universities, and between the land grant universities and the county governments.

Here are a few specific reasons why I feel it important that such a national wildlife extension program be established.

1. Public decisions on wildlife policies and programs should be informed decisions; extension could help make them so.
2. Fish and wildlife are the focus of much of our environmental concern; learning about wildlife paves the way for better understanding of ecology, of environmental quality, and of the impacts on the environment of many kinds of developments.
3. The extension system draws on current research; and helps put it to work quickly. It also feeds research needs from the customer to the researcher.
4. The extension system draws directly on the expertise of the teaching faculty, as well as the researchers, in the land grant university, and for communication, on the techniques that have been developed for teaching.
5. The extension approach to public education in wildlife is so important that it has sprung up spontaneously in many states. A good example is from New York State. The far-reaching State Fish and Wildlife Management Act passed in 1958 opened new opportunities, and called for involvement of landowners, sportsmen, and county administrators, as well as state wildlife staffs. The state wildlife division immediately recognized that the public education task was tremendous, and that it urgently needed the kind of assistance that cooperative extension could offer, so they contracted with Cornell University, and paid for the cost of establishing a wildlife extension specialist position to concentrate on this newly created public education problem.
6. Public involvement is characteristic of cooperative extension, and is needed in wildlife education.
7. Numerous public inquiries come naturally to the land grant university on wildlife problems, as on others, because the public has come to expect help from the university. Wildlife questions often require highly specialized knowledge. It is better for the public that they be answered by wildlife specialists than by staff to whom such inquiries are incidental to their regular job and competence.
8. At the youth level, through extension's 4-H programs, fishery and wildlife projects are among the most attractive.
9. The credibility of the state university through the extension system, is generally high. A state or federal wildlife agency is often looked upon as a self-serving interest group whose educational efforts must be suspect. An important policy or program may be accepted by the public sooner if it is explained by a representative of the university, than by the regulatory agency which must administer it.
10. The model is available; let's use it in the wildlife field, as it has been useful in so many other fields.
11. The need for wildlife extension has been so widely recognized that in quite a few states such programs have been established through contracts or grants, on soft money. This is not enough. In the long term greater stability, higher quality, and greater effectiveness will be achieved if the program is strongly based on hard money, in the regular budgets.
12. A wildlife extension program can be of direct value to the existing cooperative extension system, which has traditionally dealt mostly with rural populations, and with agricultural production. Any program which depends upon public

support must be attractive to the public, preferably to a majority of the public. When Cooperative Extension was established in 1914 our American population was largely rural. Now it is urban. The universal appeal of wildlife, to urban as well as rural audiences, can help make the whole extension system more attractive to the American public.

I hope you agree with me that in public wildlife education, as in so many other natural resource areas, "Why not the best?"

Toward Expanded Program Support:

A National Approach to Fish and Wildlife Extension Education

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Introduction

Objectives of this panel have been to develop an understanding and an interest in what extension education is, including the role of Sea Grant, and to examine what fish and wildlife extension has done and could do. In other words, the panel seeks to stimulate interest—hopefully leading to a national effort. It is my purpose to carry the strategy one step farther: to propose a cooperative national approach to fish and wildlife extension education.

Two questions are at once apparent. First, since there are already successful fish and wildlife extension efforts in over half the states, what is the problem? And second, why is the U.S. Fish and Wildlife Service so interested in a system administered by another agency in another department?

The problem is that fish and wildlife subject matter has not been accorded full program recognition at the Federal Extension Service level in spite of the successful programs that have developed in some states. And, for reasons that will be developed, policy recognition is essential if fish and wildlife are ever to become a part of a fully funded, national extension education program.

Second, the Fish and Wildlife Service is interested because extension affects fish and wildlife resources, and because the service has a leadership responsibility in stimulating and supporting programs for these resources. *And, we are interested because it is our conviction that extension education is one of the most effective means of influencing land and water policy and use.*

In a thought-provoking article on "Practical Science Literacy," Benjamin Shen (1975) estimates that more than half the legislation considered by Congress relates to scientific technology. This is also true of the major controversial issues which confront the voting public—problems of environmental protection, production and export of food and fiber, production and utilization of energy, development of transportation systems and other issues. All require decisions by the public, at a time of maximum public participation in decision making. The question is whether or not the public is adequately informed to make intelligent decisions concerning fish and wildlife and related resources.

The emotional assault of "environmentalism" on the public has made it difficult to sort out fact from fancy, and extremist positions from reasonable ones. Clearly, improved decision making requires objective, factual information so that citizens can make intelligent choices. This is among the highest of conservation priorities. One step toward achieving it would be a partnership arrangement between the Federal Extension educational system—the most far-reaching educational system in America—and the Fish and Wildlife Service—the national repository of knowledge on fish and wildlife resources. The idea is not new. Various efforts to achieve a partnership have been under way since 1936. The present attempt may be the most extensive, and it comes at an opportune time.

While the U.S. Fish and Wildlife Service has been interested and active in working with the Federal Extension Service and the Land Grant universities for many years, there has never been a full commitment by either federal agency. In 1976, the Fish and Wildlife Service began to reanalyze the entire situation and identify its role. This paper incorporates the findings of that analysis and exploration, examines Sea Grant, and identifies the responsibilities of various agencies, organizations and institutions. It also suggests a plan of action, and reports on actions already taken.

Extension education in this paper refers to the cooperative extension education system administered by the U.S. Department of Agriculture (USDA) through the Federal Extension Service in cooperation with the Land Grant universities and the counties. The conclusions and suggestions relate to cooperative participation in the federal extension education system, not to other educational activities, information transfer systems or public affairs activities of the Fish and Wildlife Service, or of other federal and state agencies—a very important distinction.

The Federal Extension Education System

The word "extension" means many things to many people. Such ambiguity leads to confusion in communications, responsibilities, and budget proposals. *Extension education is not:* a visual aid, which is a technique; public relations; a news service; information transfer; or technical assistance. Nor is it a substitute for any of the aforementioned. *The Federal Extension education system is precisely that*—a *system* of education—and it is the most extensive in the United States.

The Federal Extension Service was created by the Smith-Lever Act of 1914. It is a cooperative education service with offices and professional staff at the federal, state, and county levels. The concept arose from the needs of rural people in the early 1900s to utilize scientific agricultural knowledge and methods. Extension now aims to serve all people, with services in the 50 states, Puerto Rico, Guam, the Virgin Islands, and the District of Columbia.

The Smith-Lever Act provided for matching federal-state financing, and initiated federal-state-county cooperation. As a result, extension education became an important foundation of the agriculture industry, and has played a major role in the success of modern agriculture in the United States—success that is unparaleled elsewhere in the world.

Extension is the off-campus arm of Land Grant universities. Extension, resident instruction, and research are the three basic elements of a university system, but it is through extension that knowledge from many sources is made immediately available to the user-public.

In the *Federal Extension Service,* there are four program areas: (1) agriculture, forestry, and natural resources; (2) community resource development; (3) home economics; and (4) 4-H youth. Each has a number of subject matter specialists in disciplines such as agronomy, economics, forestry, sociology, farm planning, etc.

In the *state extension service,* which is a part of the Land Grant university, there usually are specialists in the major fields. Each state extension service is associated with the state agricultural experiment station and with university research and resident teaching. Each has a press-radio-television facility staffed with communication professionals.

Finally, *at the county level,* the resources of this entire complex are made available to the public through more than 12,000 county agents and workers, who are among the most respected and influential citizens in their communities.

Administration and Organization

The Federal Extension Service is headed by an administrator. The state extension services are headed by state directors. Organization, policies and priorities are determined by the Extension Committee on Organization and Policy (ECOP), which is composed of state extension directors.

In 1976, cooperative extension work was financed in the amount of $499 million. Of this total, $193 million was received from federal sources, and $306 million from state and local sources. There were approximately 200 positions with the Federal Extension Service, and 4,500 extension employees at universities including 4,100 specialists, and 12,100 agents and workers at the county level.

The Federal Extension education system is a cooperative educational force of tremendous consequence. Although fish and wildlife extension programs have been developed in 28 states,there has not been sufficient policy acceptance at the federal level. This is needed to permit adequate support through the federal-state matching funds arrangement.

There has been criticism of the Federal Extension Service in recent years (U.S. Congress, House 1976). Critics claim that it is too narrow, a tool of agriculture, old fashioned and so forth. Whether or not these criticisms have merit, the fact remains that the extension education concept and organization are sound. There may be changes or improvements, but the extension education system is here to stay, and it should include fish and wildlife in its coverage.

Comparison With Sea Grant

There is an obvious parallel between the Land Grant universities and extension education begun in 1914 and the Sea Grant universities and advisory services program initiated in 1966. The intent of Congress was to build on over one-half century of experience in extension education and bring to the users of marine resources the same kind of educational program that the Land Grant-Extension program brought to users of agricultural resources, while taking advantage, to some extent, of the same administrative machinery and delivery system.

Sea Grant's educational advisory services are administered through the Office of Sea Grant of the National Oceanic and Atmospheric Administration's Marine Advisory Program. This is in the Department of Commerce. The Marine Advisory Service has its own specialists at the federal level and it funds specialists, or Sea Grant advisors, on Sea Grant university campuses. To date, 256 Sea Grant advisors and agents have been employed.

In accordance with a 1974 Memorandum of Agreement, there is a working relationship between the Marine Advisory Service and the Federal Extension Service, both in Washington and at the Sea Grant and Land Grant universities, which enables Sea Grant to use the delivery system and administrative machinery of the Extension-Land Grant university systems. In many states, the programs have a single administration. But Sea Grant's participation involves more than a cooperative relationship. Congressional intent is expressed in a separate Act, with a new name, new and related programs, and *separate funding*. Recognition and funding by the Congress have stimulated the development of state programs and the recruitment of competent, full-time marine advisors. So, these new strengths, plus the cooperative relationship with the time-tested Land Grant-Extension system enable Sea Grant to have the best of both worlds.

There is a feeling among some professional fish and wildlife administrators that a program like Sea Grant is necessary to enhance fish and wildlife extension. That possibility is discussed in more detail in a subsequent section.

Historical Perspective and Current Status

Efforts to stimulate a national program of fish and wildlife extension date back to at least 1936, but to date none have been wholly successful. It is significant that even without adequate federal recognition or support, strong wildlife extension programs have developed in a number of states. These efforts are described in published papers (see References) and need not be detailed here.

In 1970, a new Memorandum of Understanding was signed between the Federal Extension Service and the Bureau of Sport Fisheries and Wildlife (now the U.S. Fish and Wildlife Service). Supplemental agreements were also signed between the regional offices of the Bureau and many state extension services. And, the Federal Extension Service employed a wildlife specialist for about two years. However, there was no consistent follow up by either federal agency and the agreement was never fully implemented.

As Benson has already stated, there are full- or part-time fish and/or wildlife specialists employed by the state extension services of Land Grant universities in over half the states. They carry out a variety of programs and are funded by a number of different methods. In addition to the fish and wildlife extension specialists of the Land Grant universities, the U.S. Fish and Wildlife Service also presently has six offices on university campuses, working with state extension services, principally on animal damage control work. In addition, the Fish and Wildlife Service has 25 Cooperative Fish Units and 20 Cooperative Wildlife Units on university campuses. Although not directly related to the extension education system, these units are involved informally with extension efforts. The Fish and Wildlife Service and some state fish and wildlife agencies have personnel called "extension" biologists. These are not a part of the extension system.

The state extension services and the Fish and Wildlife Service *both* have a scattering of offices and personnel directly or indirectly involved in fish and wildlife extension education. However, the important point is that there has been no one in the Fish and Wildlife Service or the Federal Extension Service assigned full responsibility for fish and wildlife extension education.

Through all these years and efforts, there has been a patient, persistent, but frustrated interest by the specialists, individually and collectively, for recognition by, support from, and a point of contact with the Federal Extension Service in Washington.

Related Developments

Before discussing a national approach to wildlife extension, there are two related developments that have influenced Fish and Wildlife Service thinking that are important to a consideration of a national approach. First is the effort to expand extension forestry, which has been under way for several years. This carefully coordinated effort has been recognized by the Extension Committee on Organization and Policy and is receiving encouraging consideration by the Congress. That proposal includes wildlife, and if adopted, it would have benefits for wildlife extension. The expansion proposal, however, is limited to forested lands. The same is true of the more recent "Hatfield Bill." While adoption would be beneficial, it may also be too narrow to accommodate all fish and wildlife interests, many of which go beyond forested lands. The proposal to expand extension forestry and the present effort to expand fish and wildlife extension education are not in competition. If the two efforts continue to be coordinated carefully, they would be complementary, not duplicative. In this regard, it is important to emphasize that the total resource educational offering must ultimately include forestry, fish, wildlife, range and related disciplines.

Second, Congress is considering an Aquaculture Act (H.R. 14095), that would have major implications for the Fish and Wildlife Service and for the state fish and wildlife agencies. That bill requires the appropriate cabinet secretary (Agriculture, Interior, or Commerce) to provide for educational services, and the secretary of commerce to establish an aquaculture information center.

The precise roles of the Federal Extension Service (USDA) for transfer of "inland water aquaculture" information and Sea Grant (Department of Commerce) for transfer of "marine aquaculture" information are not clear at this time. However, it is clear that the Fish and Wildlife Service will have to develop, in cooperation with the states, an extension capability to transfer educational information through the delivery systems of one or both of those programs.

Clearly, the federal departments, Commerce, Agriculture and Interior—and the state agencies and institutions must be prepared to implement the extension education requirements of this Act or a similar one. The proposal in this paper considers that need.

The Impasse

The question must be asked: why has fish and wildlife subject matter never become a full part of an extensive educational program that has been so effective for over half a century? The answer to that question may well lead to the solution.

Most of the previous, sporadic efforts to include fish and wildlife subject matter in the Federal Extension Service program were unsuccessful for a number of reasons, including personnel and money ceilings, and higher priorities within the Federal Extension Service.

There have always been strong demands from industry, the public, state extension services and others to expand other specialties—agronomy, poultry science, etc. In contrast, while there was support for fish and wildlife from the conservation organizations, there has never been unified action by the state fish and wildlife agencies. While some states developed strong wildlife extension programs and enjoyed enthusiastic support, others were apathetic, and a few were antagonistic. In spite of its interest and active programs on some campuses, the Fish and Wildlife Service has given only incidental support to a national system. It is unfortunate, but not surprising that wildlife has had a low priority within the Federal Extension Service.

Additionally, other agencies have recognized the value of extension education and have been aggressive in their efforts to use the extension delivery system. For example, the Environmental Protection Agency, the Energy Research and Development Administration, and the Office of Safety and Health Administration have arrangements with the Federal Extension Service. And the Environmental Protection Agency provided funds to defray costs.

If the federal extension education system is to be expanded to include fish and wildlife on a national, cooperative basis, more will be needed than a unilateral action by the Fish and Wildlife Service, the employment of a wildlife specialist by the Federal Extension Service, or the continued urgings of national conservation organizations. Clearly, the successful establishment of a permanent program will depend upon the interest, support and involvement of a broad spectrum of interests: the Federal Extension Service and the Extension Committee on Organization and Policy; the universities, including their extension services, wildlife departments and colleges of natural resources; the state wildlife agencies; the major conservation organizations; other federal agencies; and finally, the Congress to provide funds to support activities at the state levels. This was the rationale and the strategy of the Fish and Wildlife Service exploration: to determine the interest and thinking of as a broad a range of interests as practical.

Summary Results of Consultations and Discussions

The Fish and Wildlife Service review of the possibility of a national cooperative system of fish and wildlife extension education included: (1) a review of literature, legislation and hearings; (2) discussions and consultations; (3) meetings with policy forming groups; (4) contacts with specialists; and (5) a review of preliminary conclusions and solicitation of comments.

The Fish and Wildlife Service held exploratory consultations and discussions with officials of the Federal Extension Service, state extension services, university department heads, deans, fish and wildlife extension specialists, state fish and wildlife agency directors, and major conservation organizations (Appendix I and II). These discussions covered the need for and interest in a national approach, the role of the Fish and Wildlife Service, and the circumstances under which a program should be conducted. Meetings were also held with policy-forming groups or individuals, both to inform and to seek a reaction and guidance, and for the obviously important purposes of liaison and coordination.

The major conclusions and suggestions which resulted from these explorations and which lead to a rationale for, and some of the requirements of a coordinated program are:

1. There is a strong belief in every quarter that the need to increase educational efforts is among the most urgent of the conservation priorities and that this need could be partially satisfied by expansion of the existing fish and wildlife extension education efforts.

2. Fish and wildlife subject matter coverage should be included in the educational programs and offering of the Federal Extension Service, as a precursor to similar recognition within the state extension services.
   a. Inclusion of fish and wildlife material is needed to complete and balance the federal extension educational offering. Recognizing that fish and wildlife are products of land and water resources, landowners and users need to be better informed on how to manage and use those resources. This inclusion would provide increased training and educational opportunities for resource agency personnel.
   b. Inclusion of fish and wildlife subject matter coverage would broaden extension's support base by increasing its appeal to youngsters and natural resource constituencies, thus alleviating criticisms that extension at the federal level is too narrow.
   c. In the states having fish and wildlife extension programs, these and associated youth programs have demonstrated their value by becoming a strong element of state and county extension education programs, and should be recognized by the Federal Extension Service.
   d. Fish and wildlife resources are closely associated with other resource concerns of the Federal Extension Service. Nevertheless, until fish and wildlife are recognized in Extension policy and included in accepted priorities, they will not be accorded appropriate and necessary attention, especially at the county level.
   e. There are several new, and some old laws that require interpretation and public explanation to assure understanding and compliance by federally supported agencies. The Federal Environmental Pesticide Control Act, the Endangered Species Act, the Marine Mammal Act and the 200-mile Fisheries jurisdiction are examples.
3. The fish and wildlife extension specialists in 28 states need a contact within the Federal Extension Service in Washington, who can serve as liaison with other federal agencies, especially the Fish and Wildlife Service and private conservation organizations.
4. There is a strong interest in having the Fish and Wildlife Service become involved in the program. The U.S. Fish and Wildlife Service role should be supportive of the existing educational system of the Federal Extension Service. The Fish and Wildlife Service should work with and through that system, assuming there is a point of contact in the Federal Extension Service to make this possible. Arrangements are needed: (1) to make the support and specialized capability of the Fish and Wildlife Service available to state specialists on a continuing formal basis; and (2) to make the wealth of printed material including news releases, fact sheets, publications, films, etc., routinely available to state fish and wildlife specialists and, where appropriate, to the county agents.
5. A dependable source of funding for state extension activities is needed as well as an increase in current funds, for the following reasons, among others.
   a. Wildlife has had a low priority in the Federal Extension Service and unless an increase in funds is made available by Congress, any funds or positions allocated to wildlife must be taken from other existing federal extension education activities.

b. Available federal funds are insufficient to stimulate wildlife extension in states that do not have these programs. And the funds are spread too thinly in the states that do have programs.
c. A continuing and dependable source of funding through the Federal Extension Service and the state extension services is needed to give specialists independence, career status and eligibility for tenure, and to give priority recognition to wildlife subject matter in the planning process. University administrators welcome cooperative funds from various sources, and these dollars support a number of extension programs. However, cooperative funds are often considered as "soft money." There is always the risk that these funds may be reduced or withdrawn. Consequently, universities are reluctant to grant tenure and full professorial rank and privileges to faculty members whose salaries are derived solely from cooperative sources. These risks are reduced in programs afforded federal recognition and matching funds from the Congress.

6. The state fish and wildlife departments should have a means of effective involvement in fish and wildlife extension but great care must be exercised to accomplish this in a manner that does not limit the educational objectivity of the extension effort.
7. Responsibilities of various federal, state and county agencies need to be clarified to avoid conflicting interests or duplication of effort. For example, one of the Soil Conservation Service's missions is providing direct technical assistance to landowners. In most states, this is done in concert with the state fish and wildlife agency. This should not be confused with the educational role of the state university and state extension services.
8. To avoid public confusion, educational activities should be coordinated with the dissemination of technical information on fish and wildlife resources within each state.

A Proposal for a National Program

Based on the preceding review, there is obvious need and broad support for a national, cooperative fish and wildlife extension education system. Its development and implementation will require coordinated action by several agencies and Congress. There are several alternative approaches, but to initiate such a system would, among other things, require: (1) policy and program recognition of fish and wildlife subject matter in the federal extension education program; (2) cooperative arrangements between the Fish and Wildlife Service and the Federal Extension Service, and with the state universities and state fish and wildlife agencies; (3) mutual strategy and support for obtaining Congressional recognition and increased funding for the Federal Extension Service to support fish and wildlife extension education programs at the state level; (4) a timetable for (a) employing a fish and wildlife specialist at the Washington level of the Federal Extension Service and (b) assigning extension education responsibilities in the Fish and Wildlife Service; and (5) cooperative arrangements between the Fish and Wildlife Service, the Federal Extension Service, and Sea Grant.

Several alternatives to a national approach are apparent. The first is new federal legislation similar to the Sea Grant Act. This would recognize the importance of fish and wildlife resources, mandate cooperation of the Federal Extension Service, identify the role of the Department of the Interior and the Fish and Wildlife Service, and authorize funding for state programs through the Land Grant universities.

A national push for new legislation would focus Congressional attention on the need for fish and wildlife extension education. However, a Congressionally mandated new program, while possibly having the vigorous energy that often accompanies new programs, would increase federal and state administrative costs, and may create competing organizational structures. In the present cooperative climate, new legislation does not seem necessary. In fact, it could disrupt cooperative relationships and delay accomplishment.

Second, cooperative arrangements could be initiated between the Fish and Wildlife Service and the Federal Extension Service to (1) make fish and wildlife educational material available through the Federal Extension Service and state extension delivery system, and (2) encourage local support for fish and wildlife extension programs in states not having programs. Although this would be an appropriate measure, capable of immediate accomplishment, it would be an expedient half-measure which would not recognize fish and wildlife subject matter at the budget, policy and program levels. Its continuation would be tenuous, dependent upon personalities and interests. With these liabilities, it is recommended only as a stopgap, leading to a more comprehensive solution.

The recommended alternative is a series of federal and state executive actions, made under existing legislation, to form a federal-state-university partnership. This partnership would recognize fish and wildlife in federal extension education, utilize existing organizational channels, and be able to seek funding from Congress for programs in all states through the budget process.

There is a willingness—in fact, a very positive interest—to enter into these cooperative arrangements. The advantages of this course are that no new authority or additional Congressional funds are needed to form the partnership, and the inter-agency cooperative arrangements would strengthen the subsequent request to Congress for the necessary funding for state programs.

However, the success of this approach depends upon cooperation that has not materialized in 40 years. Also, Congressional recognition would be lacking at the outset, and funding and priority for fish and wildlife subject matter coverage would be determined by existing formulae and in competition with other elements of the Federal Extension Service.

Actions Needed to Implement the Preferred Alternative

The following actions would be appropriate and necessary to the success of this course:

By the Extension Committee on Organization and Policy. The ECOP must recognize fish and wildlife subject matter at the policy and budget levels and authorize and direct the Federal Extension Service to initiate implementing steps and enter into negotiations with the Fish and Wildlife Service.

By the Federal Extension Service. Organization is necessary to place forestry and wildlife in a working association with related disciplines, such as range, forestry, water resources, and others, in order to present an ecologically balanced offering. Plans are needed to establish a fish and wildlife specialist position.

By the Fish and Wildlife Service. The Service must establish an office of Extension Education, assign personnel, identify Regional responsibility, and include these activities in the 1978 program and budget cycles.

Jointly by the Federal Extension Service and the Fish and Wildlife Service. The two federal agencies should negotiate an update of the Memorandum of Understanding, and develop the details and mechanics of working arrangements between them and the state extension services' fish and wildlife specialists.

Jointly by the Fish and Wildlife Service and the Marine Advisory Service. These agencies must negotiate a Memorandum of Understanding for purposes of liaison and coordination on Sea Grant, 200-mile fisheries jurisdictions and in anticipation of an "aquaculture act."

By state extension services. Following the adoption of a national policy by the ECOP and the Federal Extension Service, state extension services that have not already done so need to recognize fish and wildlife subject matter and identify a contact or specialist in this area. The state extension services should take the initiative in contacting and actively involving the state fish and wildlife agencies.

By state fish and wildlife agencies. It is important that the state agencies responsible for fish and wildlife resource management be involved in any educational program dealing with those resources. In some cases, there are strong ties and mutual support, but, regrettably, this is not always the case. Positive efforts should be made to work more closely with existing extension education programs and to stimulate interest in states not having programs. Besides liaison, coordination, planning assistance and moral support, there are other advantages to the state fish and wildlife agency having a financial stake in extension education. Again, such arrangements must not compromise educational objectivity.

By the conservation organizations. Several of the major organizations[1] have been supportive of the concept for many years and endorse this proposal. Continuing, active support of the conservation sector is imperative for several reasons: (1) as evidence of strong interest; (2) to obtain Congressional funding; and (3) to assure that fish and wildlife resources are considered in any new legislation.

A Timetable for Implementation

The implementation of a national, cooperative system will require time and an orderly sequence of events.

The first phase is to initiate negotiations and complete Memoranda of Understanding between federal agencies; then to complete organizational and mechanical arrangements. Because there already is informal interest, this phase has been initiated.

The second phase involves developing, in consultation with the major conservation organizations, a strategy for obtaining Congressional funding to support state extension education programs.

Finally, existing state extension education programs must be expanded and new programs stimulated. While these actions must be accomplished in the general order outlined, preliminary work can be undertaken concurrently on all three.

[1]The Wildlife Management Institute, National Wildlife Federation, American Forestry Association, and International Association of Fish and Wildlife Agencies.

The Fish and Wildlife Service Role in More Detail

As previously suggested, the role of the Fish and Wildlife Service should support federal and state extension services. In fact, this proposal's strengths are that it would benefit fish and wildlife resources, develop a stronger, more balanced extension education program at the federal and state levels, and expand outlets for Fish and Wildlife Service educational material, all while using the existing organizational machinery.

Fish and Wildlife Service support must be active support. In addition to making its expertise available, the Fish and Wildlife Service can and should assume a leadership role by working with its counterpart state agencies and encouraging their support of fish and wildlife extension. Through its recognition and support, the Fish and Wildlife Service can add to the stature and effectiveness of fish and wildlife extension education within the Federal Extension Service and state fish and wildlife agencies and on university campuses.

Progress to Date

Happily, some of the needed cooperation and support began to develop as this review and plan was being developed. As a result, progress has already been made. The ECOP and the Fish and Wildlife Service have the subject under consideration. Interim personnel have been assigned; a cooperative agreement has been authorized and is currently being negotiated; and implementing arrangements will be discussed at a workshop in Texas in April, 1977. The International Association of Fish and Wildlife Agencies, representing the state agencies, is involved and the major conservation organizations have pledged support. Obviously, this panel is not only evidence of interest and support, but a further step in strategy and progress.

These necessary first steps are encouraging and give reason for optimism, but not complacence. Fish and wildlife extension education will not become a reality at the county level until Congress appropriates funds for educational activities in each state. This will require completion of the partnership, active state involvement, and the overt support of the conservation sector. The outlook is good if the idea is actively tended, nourished and supported.

A partnership to expand fish and wildlife education through the federal extension education system is an idea whose time has finally come—after 40 years of effort. Clearly, the partnership cannot be achieved singly or jointly by the Federal Extension Service and the Fish and Wildlife Service. Rather, it will take concerted, positive actions by all concerned.

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Federal Extension Service
Extension Committee on Organization and Policy
Soil Conservation Service
Marine Advisory Service

Wildlife Management Institute
National Wildlife Federation
American Forestry Association
Natural Resources Council of America
International Association of Fish and Wildlife Agencies
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Toxicological Aspects of Toxaphene in Fish: A Summary

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Introduction

Toxaphene is an organochlorine insecticide (chlorinated camphene containing 67–69 percent chlorine) used extensively in the southeastern United States for pests on cotton, and residues as high as 51 μ g/g have been reported in fish analyzed from that area (National Pesticide Monitoring Program, unpublished data). Although its primary use is as an insecticide on cotton, it is also registered for use on certain grains, alfalfa, fruit, and vegetables. Since DDT was restricted in 1969, toxaphene has been used as a replacement, both alone and in combination with other insecticides (Courtenay and Roberts 1973). As much as 30 to 40 million pounds have been applied annually on crops and livestock in the United States (Hercules Incorporated 1970).

Because of the heavy use of toxaphene in the southeastern United States (Parr, Carrol, and Smith 1971) and its presence in indigenous fish, we undertook these studies to determine the effects of toxaphene on selected fish species. For the past several years, the U. S. Environmental Protection Agency has partially funded our research on toxaphene, which has assisted them in developing criteria for water quality standards on this insecticide. The work, however, was also directed toward: (1) toxicological interpretation of toxaphene residues in fish and their significance to fishery resources, and (2) the development of techniques that may yield sensitive biochemical indicators of pollution-induced stress in the field. This paper summarizes studies reported by Mayer, Mehrle, and Dwyer (1975, in press) and Mehrle and Mayer (1975a, 1975b).

Materials and Methods

Brook trout (*Salvelinus fontinalis*), fathead minnows (*Pimephales promelas*), and channel catfish (*Ictalurus punctatus*) were continuously exposed to toxaphene in water (Table 1). The proportional diluter systems used were modeled after Mount and Brungs (1967) and modified as recommended by McAllister, Mauck, and Mayer (1972). Artificial daylight was provided by the method of Drummond and Dawson (1970), and water temperatures were maintained within ± 0.2°C. These systems delivered five concentrations of toxaphene, with a dilution factor of 0.5 between each concentration, and a control. Acetone was used as the carrier solvent. Its concentration in water did not exceed 0.28, 0.23, or 0.11 ml/l in the brook trout, fathead minnow, and channel catfish studies, respectively. Flow-splitting chambers as designed by Benoit and Puglisi (1973) were used to thoroughly mix and divide each toxaphene concentration for delivery to duplicate exposure tanks. An experimental use sample of toxaphene (X–16189–49) furnished by Hercules Inc., was used throughout the study. Toxaphene concentrations in water were monitored once every two weeks. Methodology for the determination of toxaphene residues in water and fish was described by Stalling and Huckins (1976).

Bone development was assessed through the determination of collagen, calcium, and phosphorous concentrations in the backbone of experimental animals (Mayer, Mehrle, and Dwyer 1975, in press; Mehrle and Mayer 1975a, 1975b). The backbone was removed from each fish, dried at 110° C for 2 hours in a forced air oven, and split into two fractions. Collagen was isolated and quantitatively analyzed in one fraction and calcium and phosphorous were measured in the other. Hydroxyproline was determined in eggs of channel catfish, whole fry too small for backbone analysis, and in backbone collagen of all fish from which the vertebrae could be dissected free (Woessner 1961). In addition, fathead minnows were subjected to sublethal electrical shock (three 1–s, 60–v pulses at 20–s

Table 1. Summary of experimental conditions and sampling periods used during continuous exposure of brook trout, fathead minnows, and channel catfish to toxaphene.

Species, toxaphene concentration (ng/l), and life stage	Water temperature (°C)	Age at initiation of exposure	Duration of exposure (days)	Periods (days) after initial exposure when determinations were made: Growth	Biochemistry
Brook trout					
39–502					
Adults	9–15	1 yr	160	90, 160	
Eggs	9	Eyed eggs	22[b]		
Fry	9		90	30, 60, 90	7, 15, 30, 60, 90
Fathead minnow[a]					
13–173					
Adults	25	40 days	295	30, 98, 295	98, 295
Eggs	25	0	5	—	—
Fry	25	0	30	30	30
Channel catfish[a]					
49–630					
Adults	16–26	2.5 yr	100	50, 100	100
Eggs	26	0	7	—	1
Fry	26	0	90	5, 30, 60, 90	15, 90

[a]Eggs and fry of fathead minnows and channel catfish were produced and remained in the exposure units.
[b]Exposed 22 days before hatching.

intervals) and then x-rayed after being exposed to toxaphene (94 to 727 ng/l) for 150 days (Mehrle and Mayer 1975a). Channel catfish fry were x-rayed before and after the electrical shock. Resulting radiographs were examined for alterations in vertebral structure.

Randomized block designs were used and the data were analyzed by analysis of variance (Snedecor 1965). A multiple means comparison test (least significant difference) was used to compare significant differences among toxaphene concentrations; the level of significance used was $P < 0.05$.

Results and Discussion

Growth and Mortality of Adult Fish

Growth of adult brook trout was significantly reduced in the 502 ng/l concentration after 3 months exposure, and in both the 288 and 502 ng/l concentrations after 6 months (Fig. 1). At this point, the fish were thinned and spawning chambers were added in preparation for the reproductive phase. Upon initiation of spawning in mid-November, all of the fish in the 502 ng/l concentration died and only one spawn was collected. Mortality was 50 percent among the fish exposed to 288 ng/l. We believe that mortalities in these two concentrations were a result of the fish being unable to tolerate the additional stress of spawning. Growth of adult fathead minnows was significantly decreased in the 97 and 173 ng/l toxaphene concentrations, but that of adult channel catfish was not affected (Fig. 1). No adult fathead minnows or channel catfish died during the study.

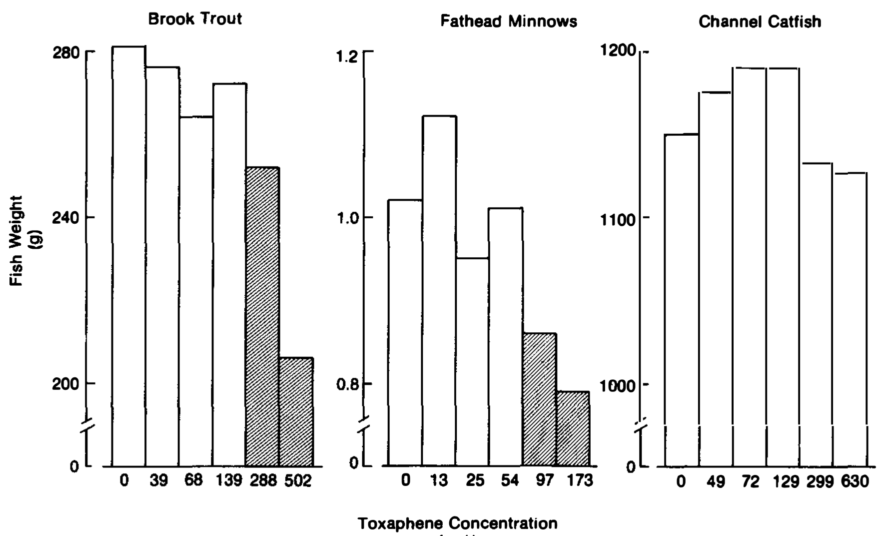

Figure 1. Effect of different concentrations of toxaphene on growth in weight of adult fish. The fish were exposed for 160, 98, and 100 days for brook trout, fathead minnows, and channel catfish, respectively. Shaded areas indicate values significantly different ($P < 0.05$) from the controls.

Reproduction

The numbers of eggs spawned by brook trout and egg viability (presence of neural keel 10 days after fertilization) were inversely related to toxaphene concentrations. The eggs later died at the eyed stage due to a bacterial growth, and additional eyed eggs were exposed to toxaphene for 22 days before hatching, no effect on hatching was observed. Effects on reproduction were not observed in fathead minnows, but in channel catfish the time between pairing and spawning was increased and the amount of gelatinous matrix surrounding the eggs was reduced. In addition, the hatchability of eggs from adult channel catfish exposed to 630 ng/l of toxaphene was not significantly reduced from that of the controls.

Growth and Mortality of Fry

Growth and survival of brook trout fry were reduced by toxaphene concentrations down to 39 ng/l (Fig. 2, 3). Survival of fathead minnow fry was reduced only in the 97 ng/l exposure, but the no-effect concentration for growth was below 54/ng/l. Channel catfish fry survival and growth were reduced in the 299 and 630 ng/l concentrations.

Backbone Development

In general, the effects of toxaphene on the backbone of fish were reduced collagen synthesis and increased mineralization (Table 2). Analyses of whole brook trout fry showed that the concentration of hydroxyproline, one of the major amino acids of collagen, decreased during the first few weeks of exposure to

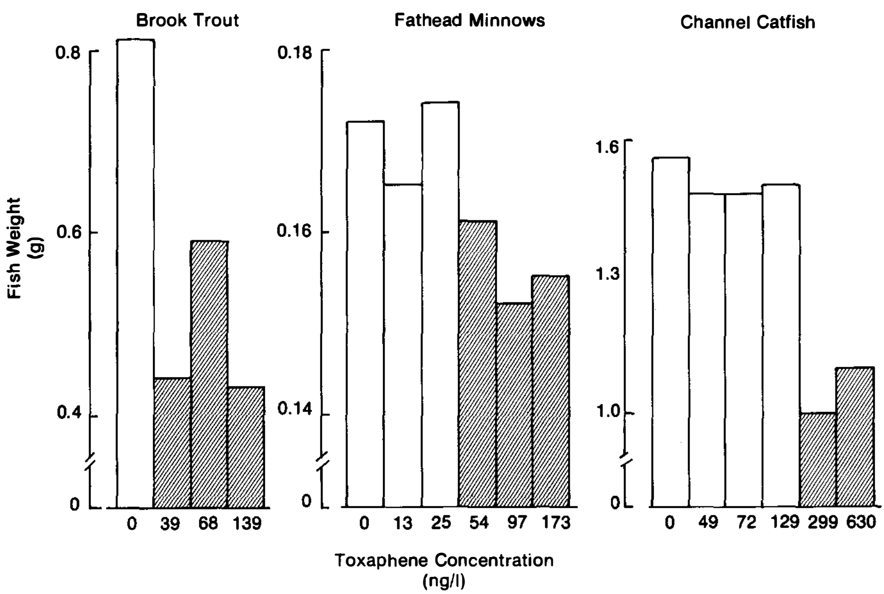

Figure 2. Effect of different concentrations of toxaphene on growth in weight of fry. Brook trout and channel catfish were exposed for 90 days and fathead minnows for 30 days. Shaded areas indicate values significantly different ($P < 0.05$) from the controls.

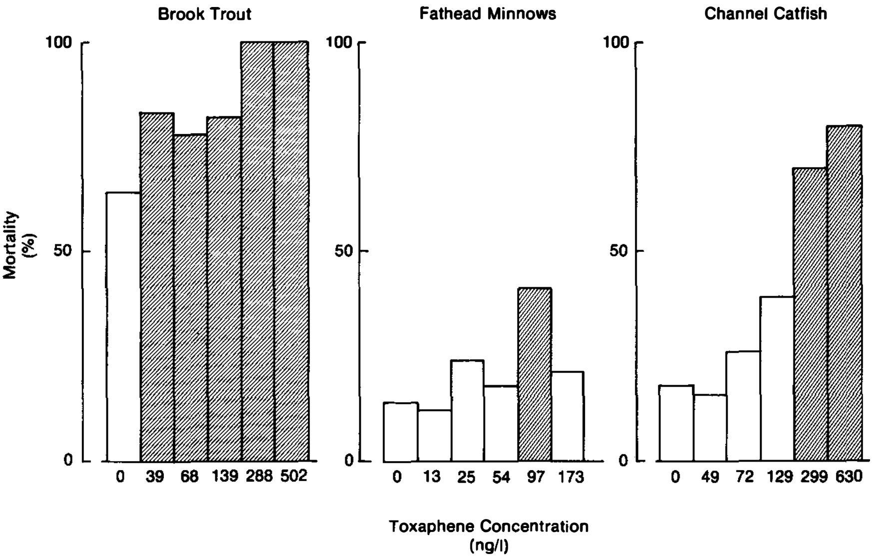

Figure 3. Effect of different concentrations of toxaphene on fry mortality. Brook trout and channel catfish were exposed for 90 days and fathead minnows for 30 days. Shaded areas indicate values significantly different ($P < 0.05$) from the controls.

Table 2. Backbone composition (mg/g of dried bone) of fish fry continuously exposed to toxaphene for 90 days.

Species and toxaphene concentration (ng/l)	Bone composition (mg/g dried bone)			
	Collagen	Calcium (Ca)	Phosphorus (P)	$\frac{Ca + P}{Collagen}$
Brook trout				
0	300	100	110	0.70
39	250*	150	160	1.24
68	250*	210*	200*	1.64
139	250*	210*	200*	1.64
Fathead minnows[a]				
0	190	76	41	0.62
13	220	83	41	0.56
25	200	76	40	0.58
54	180	85	41	0.70
97	140*	81	39	0.86
173	150*	79	39	0.79
Channel catfish				
0	270	65	64	0.48
49	260	81*	66	0.57
72	240*	110*	63	0.72
129	240*	95*	60*	0.65
299	240*	85*	57*	0.59
630	230*	81*	54*	0.59

[a]40-day-old fry exposed for 98 days.
*Significantly different from controls ($P<0.05$).

toxaphene at concentrations of 68 ng/l or more. Hydroxyproline in the collagen molecule is derived from the hydroxylation of proline after the incorporation of proline into the polypeptide protocollegen. The hydroxyproline content of whole fry too small for backbone removal can be used as an indication of collagen formation. In brook trout fry 30–90 days old, the collagen concentrations were reduced and calcium and phosphorus concentrations were increased in the vertebrae of all fish exposed to toxaphene. The collagen content in backbones of adult fathead minnows and the hydroxyproline content of whole fry were reduced at toxaphene concentrations of 97 and 173 ng/l, and hydroxyproline in the collagen of adults was reduced at 54 ng/l and higher. Toxaphene concentrations of 72–630 ng/l significantly decreased collagen, and concentrations of 49–630 ng/l increased calcium in the backbones of catfish fry after 90 days of exposure. However, phosphorus was increased only in fish held in the three highest concentrations of toxaphene. The ratio of minerals to organic content, i.e. calcium + phosphorus to collagen, in the backbone tended to be greater in fish exposed to toxaphene than in the controls (Table 2).

Collagen is the major fibrous protein of all vertebrates and serves as the major component in the organic matrix of connective tissue and bone (Piez and Likins 1958). The proper ratio of collagen, calcium, and phosphorus is necessary to insure normal development and rigidity of bone. We postulated that the increase in the ratio of minerals to organic content of the backbone might cause the backbone of fish to become brittle and therefore more subject to breakage. X-ray analysis revealed poorly developed vertebrae and broken backs in exposed fathead minnows and channel catfish fry. This condition, known as "broken-back syndrome," has been reported by other investigators in pond-reared fish, as well as in natural populations (Sneed 1970). The cause of this condition was not established, but among the possibilities considered were that it was induced by a nutritional deficiency or by a pesticide. The condition can be caused by a vitamin C deficiency (Halver, Ashley, and Smith 1969, Wilson and Poe 1973), toxaphene, and probably other factors that interfere with collagen synthesis.

Growth of fish is usually evaluated by measuring weight and length; however, biochemical mechanisms that are altered by toxic materials should logically be evident before a response is expressed as a reduction in growth. In accordance, we found hydroxyproline and backbone collagen to be sensitive biochemical indicators of growth in brook trout, fathead minnows, and channel catfish exposed to toxaphene which could be used to predict later effects on growth. The earliest effect observed was inhibition of collagen synthesis in the higher toxaphene concentrations, which was then followed by reductions in growth. Decreases in collagen and hydroxyproline concentrations occurred at least 30 days before changes in weight or length were evident.

Residue Dynamics

Whole-body residues of toxaphene in adult brook trout, immediately before spawning were as high as 8 μ g/g (Fig. 4). The more chlorinated congeners were stored to a greater extent than were the less chlorinated ones—probably because the more chlorinated ones were the more lipophilic and the less easily degraded. Residues of toxaphene in the eggs immediately after spawning of the parents exposed to concentrations of 0, 39, 68, 139, 288, and 502 ng/l were 0, 0.4, 0.9, 1.8,

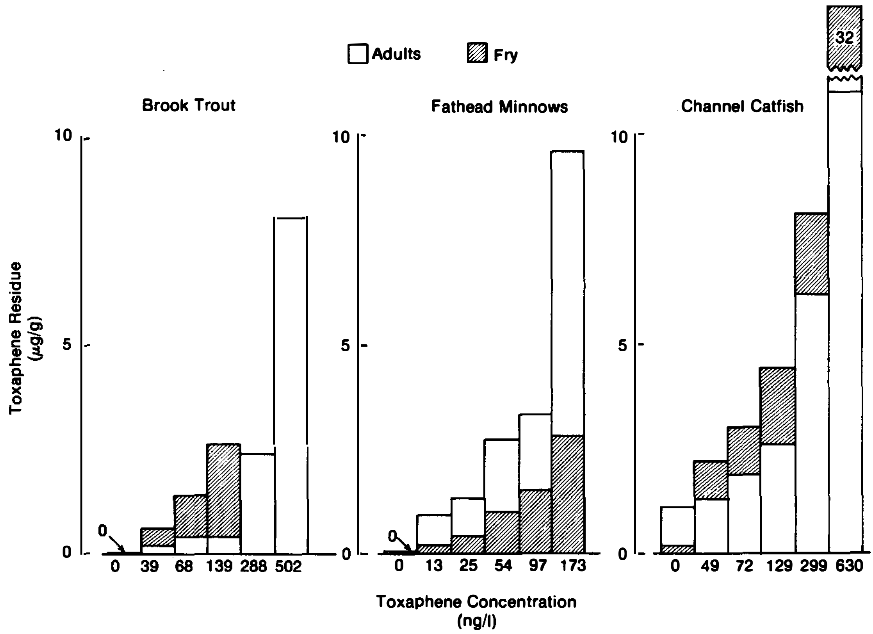

Figure 4. Whole-body residues of toxaphene in brook trout, fathead minnows, and channel catfish continuously exposed to toxaphene for 160, 98, and 100 days (adults) or 90, 30, and 90 days (fry), respectively.

2.9, and 5.2 μ g/g, respectively. Brook trout fry concentrated toxaphene up to 76,000 times (concentration in fish on a wet weight basis/concentration in water) that in the exposure water in only 15 days. Uptake of toxaphene by the fry was highest after 15 days, declined through 60 days, and then tended to increase again between 60 and 90 days of exposure. Accumulation factors of toxaphene in the fry exposed for 90 days were similar to that in the adults. Fathead minnows concentrated toxaphene from 69,000 times in the low concentration to 55,000 times in the high concentration after 98 days of exposure; toxaphene residues ranged from 0.1 to 1.0 μ g/g in eggs and from 0.2 to 2.8 μ g/g in fry. Adult channel catfish concentrated toxaphene from water by factors of 17,000 to 26,000 after 100 days of exposure; for channel catfish fry these values ranged from 27,000 to 50,000. Toxaphene residues in catfish eggs ranged from 0.24 μ g/g in the controls to 4.4 μ g/g in the highest exposure concentration.

Toxaphene was excreted very slowly in the adults of all three fish species. Toxaphene residues decreased if at all, to 54 and 36 percent in brook trout and fathead minnows respectively, after 56 days in fresh water and 4 to 54 percent in channel catfish after 33 days.

Conclusion

The whole-body residues of toxaphene in brook trout, fathead minnows, and channel catfish were within the range of those reported in fish by the National Pesticide Monitoring Program. The effects observed are probably realistic indications of the adverse influence of toxaphene on essential biological processes in wild fish. Tissue residues exceeding 0.4 μ g/g were associated with reduced growth, bone development,and reproductive success in brook trout and reduced growth in fathead minnows (Table 3). In channel catfish fry, toxaphene residues of 3.4 μ g/g and greater decreased growth, and residues of 0.6 μ g/g adversely altered bone development. The effect of toxaphene on growth was relatively less in channel catfish than in the other two species; yet bone composition was altered in all three species when they were exposed to similar concentrations of toxaphene. Although brook trout accumulated less toxaphene than the other two species when exposed to similar concentrations, they had a higher incidence of mortality than did fathead minnows or channel catfish.

Toxaphene concentrations in water of 39 to 72 ng/l were detrimental to the productivity of the fish we studied. Unfortunately, concentrations of toxaphene in water are difficult to measure; however, our data indicate that biologically available toxaphene concentrations in natural waters should be less than 39, 54, and 72 ng/l to protect brook trout, fathead minnows, and channel catfish, respectively.

Table 3. Concentrations of toxaphene in water and tissue causing chronic toxicity to fish.

Species, factor measured, and life stage	Toxaphene concentration Water (ng/l)	Fish tissue (μ g/g)
Brook trout		
Growth		
Adult	139–288	0.4–2.4
Fry	< 39	< 0.4
Bone development		
Fry	< 39	< 0.4
Egg viability	39–68	0.4–0.9[a]
Fathead minnows		
Growth		
Adult	54–97	1.0–3.3
Fry	25–54	0.4–1.0
Bone development		
Adult	25–54	1.3–2.7
Fry	54–97	1.0–1.5
Egg hatch	> 173	> 1.0[a]
Channel catfish		
Growth		
Adult	> 630	> 11
Fry	129–299	1.9–3.4
Bone development		
Adult	> 630	> 11
Fry	49–72	0.2–0.6
Egg hatch	> 630	> 4.4[a]

[a]Toxaphene concentration in eggs.

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Effects of Petroleum on Birds

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Introduction

Oil pollution is in the forefront of public attention because of the recent series of oil spills from tankers such as the *Argo Merchant*. Oil spillage frequently destroys the marine flora and fauna; the most striking single effect is the oiling of large numbers of marine birds. For example, as many as 30,000 birds died after the grounding of the *Torrey Canyon* at Seven Stones Reef, Great Britain in 1967 (Bourne, Parrack and Potts 1967). Moreover, between 1967 and 1971 at least 250,000 seabirds died worldwide as a direct result of oil spillage (Clark 1973). More recent oil spills have had equally devastating effects on marine birds.

Oil spillage resulting from the transportation of oil accounts for only 35 percent of the 6.1 million metric tons of petroleum hydrocarbons introduced into the oceans each year (Wilson and Hunt 1975). Most of the oil in the environment results from the countless discharges of petroleum occurring during normal usage. Most of these discharges are small enough to go uncataloged, but their global impact may in the long run be determined by the total amount of oil rather than by the size of the individual spills (Storrs 1973). Thus, the overall effect of oil pollution on aquatic bird populations must be examined from two points of view: (1) the disastrous effects of oil spills and (2) the sublethal and indirect effects of chronic exposure to low levels of petroleum hydrocarbons in the environment.

Bird Oiling

Seabird mortality resulting from oil spillage has been reviewed by Bourne (1968), Clark (1973), and Vermeer and Vermeer (1975). These reviews emphasize the high susceptibility of certain species of birds to oil pollution. Of all aquatic birds, alcids, diving ducks, and penguins appear to be the chief victims of oil pollution (Vermeer and Anweiler 1975; Vermeer and Vermeer 1975, Frost, Siegfried and Cooper 1976). The reasons why these birds constitute the most frequent and largest numbers of casualties is related to their presence in heavily trafficked sea lanes, their large numbers, the high proportion of time spent on the water, and their behavior. These birds dive while feeding so they become covered with oil when they break the surface in an oil slick. In contrast, gulls are much less vulnerable to oil slicks than diving birds because of their habit of flying over surface pollution and therefore avoiding contact (Bourne 1968). In an oil spill area in Nova Scotia, purple sandpipers (*Erolia maritima*) accumulated a thin coating of oil, but no sandpipers were observed flightless or dead (Smith and Bleakney 1968). Typically, wading birds are merely stained and not coated with oil (Vermeer and Vermeer 1975).

The main physical effects of oiling are loss of buoyancy and insulation. These effects result from the matting of the feathers, which destroys the waterproofing and insulating properties of the plumage (Hartung 1967). When the feather barbules are oiled, they adhere to each other and allow water both to saturate the outer contour feathers and to penetrate down feathers (McEwan and Koelink 1973). Heavily oiled and watersoaked birds frequently stop feeding and go to shore, where they are isolated from their food supply (Erickson 1963). Many of the birds never make it to shore, but drown on the open ocean because they lose buoyancy (Vermeer and Vermeer 1975). Heavily oiled mallards (*Anas platyrhynchos*) and scaup (*Aythya affinis*) lost almost twice as much heat as did control birds (Hartung 1967, McEwan and Koelink 1973). Thus a heavily oiled duck would need to almost double its dietary intake in order to make up for heat losses, but intake is usually reduced rather than increased and oiled ducks die rapidly.

Chemical Analysis

The analysis of animal tissues for oil is difficult because of the complex nature of oil and the presence of naturally occurring hydrocarbons in animal tissues. Petroleum has been identified by gas chromatography in a composite sample of liver, kidney, fat, heart and brain of an oil-exposed common murre (*Uria aalge*) in the liver and kidney of an oil-soaked surf scoter (*Melanitta perspicillata*) and in the liver of a Western grebe (*Aechemophorous occidentalis*) (Snyder, Fox, and Soave 1973). However, the analytical methodology for detecting and quantitating petroleum hydrocarbons in avian tissues is in the early developmental stages and standardization of techniques has not been accomplished. Petroleum hydrocarbons have been detected in various organs of oil-dosed mallards.* The quantitation of specific hydrocarbons in liver and muscle tissue has been achieved but the analysis of complex hydrocarbon mixtures such as crude oil and refined petroleum products is still in the qualitative stages.**

Systemic Effects of Oil Ingestion

Oil ingestion has been implicated in the high mortality of seabirds (Hartung and Hunt 1966; Snyder, Fox, and Soave 1973; Vermeer and Vermeer 1975). Hartung (1963) demonstrated that oiled ducks ingest oil from their feathers. He oiled the breast feathers with a suspension of lampblack in mineral oil, and after 6 hours of preening, the duck's bill, tongue, and throat were black, and the lining of its intestinal tract showed traces of carbon particles. He found the same result by another method in which the breast feathers of three black ducks (*Anas rubripes*) were contaminated with oil containing radiolabeled iodine (Hartung 1963). Within 24–36 hours the feces exhibited high levels of radiation, up to 12 times normal background levels. About 50 percent of the oil was preened off within eight days; the amount ingested decreased logrithmically from the first day.

Under natural conditions ducks can readily acquire 7 g or more of oil on their plumage (Hartung 1964). A coating of 7 g should result in the ingestion of approximately 1.5 g of oil during the first day (Hartung and Hunt 1966).

A single dose of 1.2 ml of No. 2 fuel oil did not harm canvasbacks (*Aythya valisineria*) (Hunt 1961). At a higher dosage of 2.4 ml, the body weights of the control and treated ducks did not differ significantly after a period of 31 days, but reaction time to stimuli slowed and muscular coordination deteriorated. Hartung

*Laseter 1976: personal communication.
**Gay and Belisle 1976: personal communication.

and Hunt (1966) tested a number of industrial oils for their toxic effects on waterfowl. All the oils (including No. 1 fuel oil, diesel oil, motor oil, and cutting oil) caused lipid pneumonia, gastrointestinal irritation, fatty livers and enlargement of the adrenal glands when fed to ducks in single doses as low as 1 ml/kg; effects were more common at dose levels about 2 ml/kg. The pancreas degenerated in those ducks fed cutting oil and diesel oil. Diesel oil and fuel oil produced toxic nephrosis of the kidneys.

Coastal and pelagic species of birds compensate for osmotic water loss when they are exposed to salt water by an increase in the rate of water uptake by the small intestine and by an increase of the excretions from the paired nasal glands (Bradley and Holmes 1972; Crocker and Holmes 1971a). The absorption of water and ions at an increased rate is essential to trigger the development of the nasal gland (Crocker and Holmes 1971b). If the absorption of ingested seawater is impaired, the nasal glands will also be impaired and the bird will become dehydrated.

Pekin ducklings (*Anas platyrhynchos*) given a single oral dose of 0.2 ml of crude oil at the same time that their drinking water was replaced by 60 percent seawater did not develop the characteristic increases in the uptake of water and sodium ions observed in control ducklings (Crocker, Cronshaw, and Holmes 1974). In addition, the increase in water uptake by the intestine that developed during prolonged exposure to salt water was eliminated after a single dose of Santa Barbara crude oil. The water soluble extracts of crude oils from San Joaquin Valley, California and Paradox Basin, Utah also inhibited water and ion uptake by the intestine (Crocker, Cronshaw, and Holmes 1975). It seems probable that dehydration may cause the death of many oil contaminated birds.

The effects of oil on aquatic birds is the subject of current research at the U. S. Fish and Wildlife Service's Patuxent Wildlife Research Center, Laurel, Maryland. Much of the previous work on this subject has dealt with the rehabilitation of oiled birds with very little attention given to the effects of chronic low level oil pollution or to the less easily observed effects of oil spills. Birds may be affected by oil directly, through feather oiling, by exposure of eggs to oiled feathers, and by ingestion of oil. They may be affected indirectly through changes in habitat and food supply and by exposure to oil through the food chain.

The overall objective of our work is to evaluate the effect of sublethal levels of oil to birds through correlated physiological, toxicological, and ecological investigations. Specific objectives include the evaluation of the effects of ingested oil on survival and reproduction, the effects of oil films on viability of eggs, the assessment of the prevalence and degree of oil ingestion by wild birds, the joint effects of oil and toxic chemicals on survival and reproduction, and the relationship between tissue levels of oil products and physiological and ecological damage. Without this knowledge it would not only be impossible to predict the impact of oil pollution on aquatic bird populations but would leave us without a firm footing on which to base future recommendations.

Oil ingestion should have its most dramatic effects during the critical period when ducklings are growing rapidly. Mallard ducklings that were reared for 8 weeks on a diet containing up to 50,000 ppm of South Louisiana crude oil (SLC) survived as well as controls (Szaro, unpublished data). The ducklings that received this high dosage, however, weighed an average of 200 g less than the controls (Table 1). Their livers were double normal size whereas their spleens

Table 1. Body and organ weights of ducklings reared for 8 weeks on a diet containing South Louisiana crude oil.

Treatment	Mean body[a] weight (g)	Liver[b] Mean weight (g)	Liver[b] Mean percentage of body weight	Spleen[b] Mean weight (g)	Spleen[b] Mean percentage of body weight
Control	1118.5	34.5	3.2	0.87	.074
250 ppm	1126.5	33.0	3.0	0.74	.067
2500 ppm	1108.5	31.5	2.9	0.64	.058
25,000 ppm	1069.1	51.4[c]	4.8	0.39[c]	.037
50,000 ppm	913.4[c]	69.7[c]	7.4	0.30[c]	.032

[a] $n = 50$.
[b] $n = 10$.
[c] $P < 0.05$

were less than half normal size. The enlargement of the liver indicates increased liver function since the liver is the site of removal of the toxic compounds present in oil. Moreover, feather development was retarded in the birds given high dosage levels.

A study has been initiated to examine the sublethal effects of the chronic ingestion of petroleum hydrocarbons in liver function in the mallard duck. These ducks are being fed a reconstituted aromatic mixture containing representative aromatic hydrocarbons found in South Louisiana crude oil at 400 and 4000 ppm. Liver function is being determined by the indocyanine green clearance technique. This technique is an accurate reproducible method of measuring removal of the dye by the liver. After 3 months and 5 months on the diet, the 4000 ppm group showed significant changes in liver function as evidenced by an increase in the disappearance rate of the dye. No changes were seen in plasma enzymes, hemoglobin, or total blood protein. The data suggest that the ingestion of high levels of aromatic hydrocarbons results in increased liver function due, probably, to cell enlargement. No cellular damage has yet been demonstrated (Patton, unpublished data).

Food chain studies are also being conducted to study the possible effects of natural uptake of petroleum hydrocarbons on aquatic birds. The presence of petroleum hydrocarbons has been demonstrated in several marine organisms ranging from sedentary diatoms and phytoplankton to zooplankton and oysters (Thompson and Eglinton 1976, Blumer, Gillard, and Chase 1971; Corner et al. 1976; Anderson 1975). However, investigations on the passage of petroleum hydrocarbons to the higher trophic levels are virtually nonexistent. Crayfish (*Procambrus* spp.) have proven a suitable food item for waterfowl and are currently being exposed to a water soluble fraction of oil. This mixture will be radioactively labeled to trace its bioaccumulation. These labeled crayfish will then be fed to adult mallards.*

Crude oils also contain high concentrations of metals. The Committee on Biologic Effects of Atmospheric Pollutants (1974) has reported that different types of crude oils contain as high as 1400 ppm vanadium. This crude oil component was found to significantly alter lipid metabolism in mallard hens (White and Dieter, unpublished data). Normal cholesterol concentrations in blood of nonlaying hens averaged 11.9 mg/l compared to 3.8 mg/l in laying hens. However, in laying hens

*Tarshis 1976: personal communication.

fed 100 ppm vanadyl sulfate, the average cholesterol concentration was not different than that in nonlaying hens, averaging 9.1 mg/l. Similar alterations in lipid metabolism occurred in a pilot study of mallard hens fed 10,000 ppm crude oil.

Reproductive Effects of Oil

Oil may affect aquatic birds by decreasing their reproductive potential. Mallard and pekin ducks fed 2 g/kg body weight of a relatively nontoxic lubricating oil stopped laying eggs for 2 weeks (Hartung 1965). Mallards fed a diet containing 25,000 ppm SLC laid significantly ($P \leq 0.05$) fewer eggs than controls. The ducks fed diets containing oil laid an average of 11.0 eggs whereas the control birds laid an average of 24.6 eggs during a 30-day period. Mallards fed diets containing 10,000 ppm paraffins and a 2500 ppm oil diet did not lay significantly fewer eggs than the controls (Coon, unpublished data).

Nesting seabirds would be particularly vulnerable to petroleum pollution because many of the species, particularly the alcids, have a low reproductive potential and are heavily concentrated on the nesting grounds (Vermeer and Vermeer 1975; Vermeer 1976). Oil could present a serious hazard to these birds through egg contamination. Female Sandwich terns (*Sterna sandvicensis*) and other shorebirds contaminated with oil that had been washed ashore have been observed returning to their nests and transferring oil to their eggs (Rittinghaus 1956). These eggs failed to hatch even after 50 days of incubation. Gull and cormorant populations have been successfully controlled by spraying an oil and formalin mixture on their eggs (Gross 1950). Diesel fuel sprayed on 57 pheasant (*Phasianus colchicus*) eggs decreased their hatchability to zero; 44 percent of the 57 control eggs hatched (Kopischke 1972). Very small quantities of oil coated on mallard eggs was sufficient to reduce their hatchability by 68 percent (Hartung 1965). These experimental studies however, failed to account for possible deaths due to the toxic nature of the oil rather than to the blockage of air transfer through the shell.

Small drops of either crude or refined oil applied to artificially incubated mallard eggs produced significant mortality (Table 2) (Szaro, Albers, and Coon, unpublished data). The hatchability of common eider eggs was reduced from 96 percent to 69 percent with the application of 20 μ 1 of No. 2 fuel oil (Szaro and Albers, in press). It was evident that embryonic mortality was caused by the toxic nature of the oil rather than by the blockage of normal gas exchange, because eggs treated

Table 2. Hatching success of mallard eggs treated with oil.

Treatment	South Louisiana crude oil (% hatch)	Kuwait crude oil (% hatch)	No. 2 fuel oil (% hatch)
Control[a]	92	92	88
1 μ 1	62[b]	72[b]	64[b]
5 μ 1	2[b]	24[b]	18[b]
10 μ 1	2[b]	16[b]	10[b]
20 μ 1	0[b]	6[b]	0[b]

[a] $n = 50$.
[b] $P < 0.05$.

Table 3. Hatching success of mallard eggs treated with 5 microliters of Southern Louisiana crude oil or No. 2 fuel oil at different stages of development.

Age of embryo at treatment (days)	South Louisiana crude oil (% hatch)	No. 2 fuel oil (% hatch)
Control[a]	100	80
2	0[b]	13[b]
6	3[b]	33[b]
10	8[b]	68[b]
14	78[b]	83
18	88[b]	80
22	95	93

[a] $n = 50$.
[b] $P < 0.05$.

with propylene glycol in even greater amounts exhibited normal hatching success. Albers (in press) showed that 50 μ 1 of propylene glycol covered approximately the same surface area of a mallard egg as 10 μ 1 of No. 2 fuel oil. The hatchability of those mallard eggs treated with propylene glycol was 80 percent as compared to 88 percent for the control. In later studies, propylene glycol had no effect on the hatchability of either mallard or common eider eggs (Szaro, Albers, and Coon, unpublished data; Szaro and Albers, in press). The hatching weights of the ducklings from oiled and control eggs were not significantly different ($P \leq 0.05$) in any of these studies.

The survival of oil treated eider embryos depends on age at treatment (Szaro and Albers, in press). Embryos that died after treatment, with 20 μ 1 of No. 2 fuel oil averaged 4.3 days of age at treatment, whereas surviving embryos were treated at an average age of 16.1 days. Albers (unpublished data) found that the hatchability of mallard eggs treated with petroleum increased as the age of the embryo at treatment increased (Table 3).

Conclusions

The chronic effects of oil pollution on aquatic birds are not well known. Our preliminary studies indicate that oil ingestion is probably not a major cause of seabird mortality. Oil ingestion may affect the physiological and reproductive condition of seabirds. Moreover, a substantial number of seabird eggs may be destroyed each year by oil contamination. Such laboratory studies now need to be extended to the field. Further laboratory studies are needed to measure the accumulation and persistence of oil in tissues and to interpret the significance of oil residues in tissues.

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Environmental Contaminants in Relation to Canadian Wildlife

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Introduction

This paper attempts an overview of some of the projects that the Canadian Wildlife Service (CWS) has conducted or assisted in the past decade. Although I mention research conducted by other federal agencies, I made no attempt to report on toxic chemical research being conducted by universities or the provincial wildlife or enivronment agencies. With one exception, I have also chosen not to discuss mercury. Although the CWS pioneered mercury-wildlife research in North America through its sponsorship of Fimreite's research, and investigations on the prairies and aquatic ecosystems downstream from chlor alkali plants and pulp mills revealed high levels of mercury in some birds (Fimreite, Fyfe, and Keith 1970, Fimreite et. al 1971), Canadian field evidence of adverse effects proved elusive until recently.

Throughout this paper, I have reported all residues as parts per million (ppm) on a wet- or fresh-weight basis. Unless noted otherwise, organochlorine residues are reported as geometric means. Mercury refers to total mercury and unless otherwise indicated, mercury residues are reported as arithmetic means.

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Forest Spraying in Canada

Programs to control forest insects have been carried out in Canada intermittently since 1927 and regularly in the last 25 years (Nigam 1975). Calcium arsenate was used in the late twenties in several provinces to control spruce budworm (*Choristoneura fumiferana*) and hemlock looper (*Lambdina fiscellaria*). DDT was first used in Ontario in 1944 and its use expanded to Quebec in 1945 and to British Columbia in 1946. The acreages involved in these early operations in no way match the acreages that have been sprayed in recent years in Quebec and New Brunswick (up to 9 million acres (3.64 million ha) annually in each province).

Since its inception in 1952, the New Brusnwick spray operation has been monitored for side effects on some non-target organisms, especially fish and birds. Pearce (1971, 1975) reviewed the history of the New Brunswick spruce budworm program and its effect on wildlife, notably migratory birds. During the years 1952 to 1968, 12.64 million pounds (5.73 million kg) of DDT were sprayed over the forest in that province. Some of that DDT was aerially transported and deposited via rainfall to the Gulf of St. Lawrence (Pearce, Reynolds and Peakall in prep.) and Pearce, Gruchy, and Keith (1973) attributed failures in reproductive success of gannets (*Sula bassanus*) on Bonaventure Island to high levels of DDE in the Gulf ecosystem. The hunting season for American woodcock (*Philohela minor*) was closed in New Brunswick in the early 1970s because levels of DDT in muscle tissue were considered too high for human consumption (Pearce and Baird 1971).

Although acute effects on birds appeared to be minimal, the effects of DDT on fish were severe and obvious (reviewed by Kingsbury 1975). Immediate mortalities of up to 92 percent and delayed mortalities of salmon parr (*Salmo salar*) in watersheds treated with ½ lb/ac (0.56 kg/ha) DDT earlier in the year were observed. Logie (1975), in his analysis of the salmon-DDT data from the Miramichi River watershed, concluded that "spraying . . . with DDT at ½ lb/acre [0.56 kg/ha] caused reductions in the normal return of grilse and salmon to these rivers of about 50–60 percent."

Buckner and McLeod (1975) reviewed the effects on mammals of the New Brunswick forest spray programs using DDT, and the newer organophosphate and carbamate compounds and concluded "The few studies that have been conducted indicate that mammals in general are relatively invulnerable to the aerial application of insecticides."

Phosphamidon and fenitrothion were introduced to the spray campaign in New Brunswick in 1963 and 1967 respectively. Phosphamidon, introduced for the purpose of protecting the salmon and trout resource, proved inordinately toxic to birds when applied at 7 oz/ac (0.49 kg/ha) (Fowle 1965). Further research showed that even 4 oz/ac (0.28 kg/ha) phosphamidon caused some bird mortality (Fowle 1972). Fenitrothion also caused songbird mortalities at 4 oz/ac (0.28 kg/ha) (Pearce 1975), although it was generally considered less toxic to birds than phosphamidon.

The 1975 New Brunswick spray campaign was characterized by a variety of spray regimes and chemicals used over 6.68 million acres (2.7 million ha). Fenitrothion and phosphamidon were each used alone, in combination[1] with each other, or in combination with aminocarb or trichlorfon. Pearce, Peakall, and Erskine (1976) estimated that at least 2–3 million songbirds, largely canopy feeders, died during the spray program. Ground-feeding birds did not appear to be significantly affected. Much of the mortality was attributed to phosphamidon, sprayed at various dosages and in regimes which usually included fenitrothion. For instance, ruby-crowned kinglets (*Regulus calendula*), Cape May warblers (*Dendroica tigrina*) and Tennessee warblers (*Vermivora peregrina*) were severely affected, showing 80, 91 and 58 percent declines respectively in mean numbers of singing males recorded on transects sprayed with 2.5 oz/ac (0.175 kg/ha) fenitrothion followed by 2.5 oz/ac (0.175 kg/ha) phosphamidon.

The 1976 spray program in New Brunswick was the largest ever conducted there: 9.6 million acres (3.88 million ha) were treated two or more times (Varty 1976). About 3.80 million lb (1.72 million kg) of insecticide were used; approximately 3.23 million lb (0.15 million kg) being fenitrothion, the balance made up by phosphamidon, aminocarb, and trichlorfon. There were 23 different spray regimes, nine of which were used in areas exceeding 100,000 acres (40,470 ha). Spray regimes were altered to reduce the impact on birds noted in 1975, and to some extent, that was successful. Nevertheless, some mortalities, notably among the canopy dwellers, were noted. Detailed analyses of the songbird monitoring data are now in progress.* Comparisons between recent budworm spray operations in Quebec and in New Brunswick* suggest that the type of aircraft and the delivery (including guidance) systems may be factors critical to the hazard to birds. Application of fenitrothion from TBM aircraft caused a significantly greater

[1] A combination means one spray followed, a few days later, by another application of the same or another chemical.

*Pearce 1977; personal communication.

effect on songbirds, especially canopy species such as kinglets, than the same insecticide applied at the same dosage from DC-6 aircraft. Phosphamidon applied by TBM aircraft at dosages as low as 2 oz/acre (0.14 kg/ha) caused substantial reductions of warblers and kinglets. Neither fenitrothion nor phosphamidon alone, or in combination, had any adverse effect on the fertility of voles and deermice. The effect of fenitrothion on stream organisms was minimal except at the heaviest treatment (4 oz/ac (0.28 kg/ha)). Trichlorfon and aminocarb had no adverse effects, and phosphamidon effects on stream organisms were not monitored (Varty 1976).

The Quebec spray operations, which also began in 1952, have been scattered in locale. Blais, Benoit, and Martineau (1975) summarized the histories of the various control programs carried out between the years 1952 to 1973. During that time, 1.99 million lb (0.9 million kg) of DDT, 0.49 million lb (0.22 million kg) phosphamidon, and 3.08 million lb (1.40 million kg) of fenitrothion were applied to Quebec forests in five different locations. In 1974, 6.3 million acres (2.55 million ha) were sprayed, mostly with fenitrothion alone but also with fenitrothion plus mexacarbate and aminocarb. The chemicals were applied from DC-6 aircraft using ULV nozzles. Although some limited studies of side effects had been conducted in the Temiscouta and Gatineau regions,* a comprehensive monitoring program which examined the effect of the spray on a variety of non-target organisms was not initiated until 1974. Overall, bird losses were minimal and there was no discernible effect on small mammal populations (Buckner and Sarrazin 1975).

The 1975 and 1976 operations in Quebec encompassed 7.1 and 7.3 million acres (2.87 and 2.93 million ha) respectively, and again fenitrothion alone and in combination with mexacarbate, aminocarb, phosphamidon, and dimethoate (1976 only) was used. As in previous years, no significant mortality of birds and no adverse effects on mammals were noted.**

An excellent and comprehensive review of all aspects of forest spraying in Canada from its beginnings to 1973 has now appeared under the title *Aerial Control of Forest Insects in Canada* edited by Dr. Malcolm Prebble (1975).

Agricultural Chemicals

Large-scale direct mortalities of wildlife due to exposure to agricultural chemicals have been rarely recorded in Canada. The only major recent incidents have been reported from the lower mainland of British Columbia. Carbofuran granules applied in the spring have persisted long enough to kill ducks feeding on the treated field the following fall and winter in each of 1973, 1974, and 1975. Between 40 and 1000 ducks have died in each incident. The granules persist in the soils of the Fraser River Delta (Williams, Brown, and Whitehead 1976). Each winter the land floods and granules at or near the surface become available to waterfowl. In 1975, many dead green-winged teal (*Anas carolinensis*) with from 6 to 100 granules in their crops were found. On the basis of the known LD_{50} to mallard (*A. platyrhynchos*), Forsyth*** calculated that a green-winged teal would need to ingest only two to three granules to acquire a lethal dose. Even if one-half of the carbofuran had leached from each granule, a lethal dose could still be acquired in five or six granules.

*Pearce 1977; personal communication.
**Buckner 1977; personal communication.
***Forsyth 1977; personal communication.

The manufacturer has withdrawn that particular carbofuran formulation from use in British Columbia. Its registration status has not been altered because no similar problems associated with its use have arisen elsewhere.

The contamination of prairie seed-eating birds and mammals and their predators by cyclodienes and mercury reported in the 1960s (Fyfe et al. 1969, Fimreite, Fyfe and Keith 1970) dropped off rapidly in response to restrictions in use of these compounds for treating cereal seeds (Fyfe, unpublished data).

Community and Genetic Effects of Herbicides

Concern about continual applications of herbicides to rights of way along roadsides, power transmission lines and prairie ecosystems etc. led the CWS to sponsor programs of research into the subtle ecological and genetic changes in plant communities exposed to herbicides. Changes in number of seeds produced, changes in plant size, and changes in life form due to genetic alteration, as well as changes in frequency of occurrence due to community alteration, could have serious implications for mammals and birds dependent upon those plants for food and cover and winter survival.

Community Effects

In Alberta, Dwernychuk and Boag (1973) demonstrated that the elimination of preferred plant species led to a decline in the number of ducks nesting in areas treated with 2, 4-D. Patterson (unpublished) investigated changes in prairie pothole productivity associated with the uses of herbicides. Although the data are still being analysed, a few trends have emerged. Invertebrate species diversity and invertebrate biomass appear to be lowered and changes in the amounts and kinds of emergent vegetation occurred.

When one considers that by far the greatest amounts of herbicides used in Canada are applied to the grain-growing prairies, and that this area produces the majority of the continent's ducks, then any changes in habitat and pothole productivity which lead to a decline in waterfowl production should be viewed with interest.

In Quebec, Tomkins and Grant (1974) sprayed pioneer and mature perennial pastures with seven different herbicide treatments. In general, mature communities proved to be as susceptible as pioneer communities to herbicide applications. Life-form proved to be important in determining response to some herbicides, notably paraquat, simazine and diuron. However, monocots differed markedly from dicots in their response to the auxin herbicides, being less susceptible due to their internal physiological and structural differences.

Genetic Effects

Tomkins and Grant (1976) examined somatic cells of flower buds from the Quebec study area to determine the frequency and nature of chromosomal aberrations. The spontaneous mitotic chromosome aberration rate in 12 species growing under natural conditions was 0.4 percent. All herbicides produced chromosomal aberrations; the highest numbers of aberrations were noted with simazine (14.2 percent) and diuron (7.6 percent). However, the aberrations did not persist throughout the growing season and were not transmitted through the pollen to the next generation. The chromosomal aberration rate in meiotic cells of herbicide-treated plants was not different from that in untreated plants, although the herbicide treatments appeared to inhibit gametogenesis in some of the species examined.

Genetic shifts or changes did not appear to present as much of a problem as did community alterations. However, a reexamination of the treated area in 1977 (five years following the original application of the herbicides) is planned so see if these conclusions are valid.

The Great Lakes

In 1972, the Canadian Wildlife Service began the first of its surveys on reproductive success of several fish-eating bird species breeding on the Great Lakes. It became apparent very soon that herring gull (*Larus argentatus*) and black-crowned night heron (*Nycticorax nycticorax*) reproductive success in colonies located on Lake Ontario was well below normal (Gilbertson 1974, Price in prep.). Additionally, double-crested cormorants (*Phalacrocorax auritus*) experienced total reproductive failure on the Canadian side of Lake Ontario in 1972 (Postupalsky, unpublished data). Associated with the declines in reproductive success were high contaminant levels in eggs, thin, cracked and flaking eggshells, and some indications of aberrant parental behaviour.

One unusual aspect of the Great Lakes fish-eating birds study was the discovery of a number of abnormal or deformed young birds in all the species under study (Gilbertson, Morris, and Hunter 1976). Approximately 7,500 night heron, gull and tern chicks from colonies on Lakes Erie and Ontario were examined and some 44 of these were abnormal in some way. The abnormalities included crossed bills, supernumary toes, and slipped tendons. The incidence was higher on Lake Ontario than on Lake Erie. Hays and Risebrough (1972) had previously reported 40 abnormal young among 3,122 roseate terns (*Sterna dougallii*) and common terns (*Sterna hirundo*) on Long Island. In both reports, the incidence of abnormalities was much higher than that reported previously.

Herring Gulls

In 1972, reproductive success in Lake Ontario herring gull colonies was well below normal (Gilbertson 1974) with estimates at the eastern end of the lake of 0.10 to 0.21 young fledged per breeding pair. These estimates were even lower than the 0.3 to 0.4 fledged young per breeding pair described by Keith (1966) almost a decade earlier on Lake Michigan, and much lower than the usual 0.8 to 1.2 young per breeding pair on the Atlantic Coast (Kadlec and Drury 1968). Shell thinning from 9 to 16 percent on eastern Lake Ontario and from 1.3 to 5.6 percent on Lake Erie together with egg breakage and shell flaking were also noted. Reproductive success on Lake Erie was better than on Lake Ontario, with 0.35 to 0.52 fledged young per breeding pair (Gilbertson 1974). In 1973, Gilbertson and Hale (1974) determined that 20 percent of the eggs laid on one Lake Ontario colony died within the first week, regardless of the date of laying.

The CWS assessed herring gull reproduction on the Canadian Great Lakes again in 1975. The reproductive success figures reported by Gilman et al. (in preparation) are shown in Table 1. Hatching success was highest on Lake Superior (79.6 percent) and lowest on Lake Ontario (18.6 percent). On Lakes Ontario and Erie,

Table 1. Reproductive success of herring gulls on the Great Lakes, 1975[a] and organochlorine and mercury levels in their eggs, in 1974 and 1975[a b].

	Reproduction				Egg residues[d]					
	No. active pairs	Observed no. eggs laid	Hatching success (%)	Fledging success[c]	*N*	DDE	Dieldrin	Mirex	PCB[e]	Hg
L. Ontario	42	129	18.6	0.15	39	22.6	0.37	5.06	142	0.51
L. Erie	55	168	63.1	1.41	42	7.04	0.30	0.31	65.8	0.22
L. Huron	126	406	72.1	1.48	40	13.8	0.41	0.56	51.5	0.23
L. Superior	100	302	79.6	1.38	39	18.6	0.39	0.66	60	0.39
L. Michigan	—	—	—	—	10	31.8	0.48	trace	91.3	n.d.

[a]From Gilman et al. (in prep)

[b]Eggs collected from two colonies on each lake in both 1974 and 1975 except from Lake Michigan where they were from a single colony in 1975.

[c]Mean number of chicks surviving to 21 days per pair of active adults.

[d]Median ppm wet weight.

[e]PCB values based on a 1:1 mixture of Aroclor 1254:1260

n.d. Not determined.

egg disappearance, and embryonic failure were the major cause of egg failure. Survival of herring gull chicks on Lake Ontario was approximately one-tenth that of any of the other Canadian Great Lakes colonies studied. In spite of an embryo failure rate of 16.7 percent on the Lake Erie colony, chick survival was proportionately higher and Lakes Erie, Huron and Superior herring gulls produced numbers of young per breeding pair similar to those of colonies on the Atlantic Coast (Kadlec and Drury 1968; Haycock and Threlfall 1975).

The median levels of DDE, dieldrin, mirex, PCB and mercury in herring gull eggs from the Great Lakes are also shown in Table 1. Twelve other chlorinated compounds are present together with a number of polynuclear aromatic hydrocarbons (Fox et al. 1975). Mirex levels were 10 times higher in Lake Ontario eggs than in eggs from any other lake. Dieldrin levels were relatively constant from lake to lake. Lake Michigan recorded the highest median DDE level (31.8 ppm) while the highest median PCB value occurred on Lake Ontario (142 ppm). Gilman et al. (in prep) do not consider mercury to be of toxicological significance to Great Lakes herring gulls. Vermeer, Armstrong, and Hatch (1973) found normal reproductive success in a herring gull colony in northwestern Ontario in which some eggs contained up to 16 ppm mercury.

Artificial incubation of herring gull eggs from the Great Lakes and elsewhere, and egg transfers between Lake Ontario colonies and other locations, implicated both an intrinsic factor or factors within the egg leading to hatching failure (Gilman et al. in prep) and an extrinsic factor (Fox et al. in preparation) leading to both egg disappearance and hatching failure.

Fox et al. (in preparation) produced good evidence that changes in adult behavior constituted the extrinsic factor(s) responsible for egg loss and some of the embryonic mortality on Lake Ontario herring gull colonies. They monitored nest defense behavior, nest attentiveness and nest air temperatures on three colonies, two on Lake Ontario with contaminated eggs, the other on the Atlantic Coast with relatively uncontaminated eggs. Lake Ontario gulls, especially those from Scotch Bonnet Island, showed a lessened degree of nest defense, leaving their nests and sometimes the colonies when observers approached. The reduction in nest attentiveness exposed Lake Ontario gull eggs to predation and the danger of excessive temperature changes.

Black-crowned Night Herons

Reproductive success in a colony of black-crowned night herons on eastern Lake Ontario has also been affected by high toxic chemical residues (Price, in preparation). Embryonic failure, egg disappearance, egg tossing and predation upon the eggs (probably by the herons themselves) characterized the hatching failures

DDE and PCB levels in night heron eggs were high (Table 2) in comparison to levels reported from colonies located elsewhere (Ohlendorf, Klaas, and Kaiser 1977, Tremblay and Ellison, in preparation). However, dieldrin levels in eggs from Wisconsin and Long Island, N. Y. exceeded those in eastern Lake Ontario (Faber and Hickey 1973, Ohlendorf, Klaas, and Kaiser 1977).

Between 1972 and 1976, dieldrin levels remained essentially constant. DDE levels, although appearing to fall, did not change significantly, but PCB levels definitely declined ($P < .05$).

Table 2. Black-crowned night heron reproduction, egg residues and shell thickness on eastern Lake Ontario.

	Reproduction				Egg residues[a]				Eggshells	
Year	No. active pairs	Observed no. eggs laid	Hatching success (%)	No. fledged per active pair	*N*	DDE	Dieldrin	PCB[b]	*N*	% Change in thickness index[c]
1972	20	99	36	0.7–1.1	7	12.4	0.33	63	23	−13.8
1973	17	102	39	0.9–1.1	6	11.0	0.52	35	6	−16.7
1975					5	4.5	0.18	9.8	12	−16.0
1976	65	301	54	0.5–1.4	18	6.8	0.38	28	23	−16.7

[a]Geometric means in wet weight ppm.

[b]PCB values based on a 1:1 mixture of Aroclor 1254:1260.

[c]Change from pre-1947 value of 1.44 given in Anderson and Hickey 1972

Although egg hatchability rose from 36 percent in 1972 to 54 percent in 1976 (Table 2), it is still considerably below the 93 percent reported in Palmer (1962). Tremblay and Ellison (in prep.) recorded egg hatchability of 56 percent in each of 1975 and 1976 on one of the two islands they studied in the estuary of the St. Lawrence River. On the other island, hatchability in 1975 was 66 percent, falling to 33 percent in 1976 due to observer influence.

The number of young fledged was probably not greater than 1 per active pair in 1972–1976 on eastern Lake Ontario. Henny (1972) considered 2.00 to 2.10 fledged young per breeding pair to be the minimum required for population maintenance.

Shell-thickness index (Ratcliffe 1967) of Lake Ontario night herons was 17 percent below the value reported by Anderson and Hickey (1972) for eggs collected in the Great Lakes area before 1947. The less-organochlorine-contaminated eggs from the estuary of the St. Lawrence River show only a 2 percent decline in thickness index (Tremblay and Ellison in prep.). Keith and Gruchy (1972) diagrammed the differences between species in the shell-thinning response to DDE and used 20 percent shell thinning as the level usually required before a reduction in reproductive success could be shown. For night herons, the relationship between DDE in egg contents and shell thickness is essentially linear over the range 2–12 ppm DDE and by extrapolation, 20 percent shell thinning would be associated with 19–20 ppm wet weight DDE (Faber and Hickey 1973, Ohlendorf, Klaas, and Kaiser 1977, Price in prep., Tremblay and Ellison in prep.). Black-crowned night herons may therefore be termed a DDE-sensitive species, along with the falcons and pelicans.

Although reproductive effects are obvious at a level of 13 percent shell thinning in night herons from eastern Lake Ontario, contaminants other than DDE, such as PCB, dieldrin and mirex, are also present and may be contributing to the reproductive failures in this colony. Just as differences in sensitivity to DDE occur, differences in sensitivity to PCB occur (Heath et al. 1972). In the same way that night herons appear to be more sensitive to DDE than herring gulls in shell thinning, night herons are also probably more sensitive to PCB and other organochlorines. For instance comparison of Tables 1 and 2 show that PCB levels in gull eggs from Lakes Superior, Huron and Erie, whose hatchability is at normal or near normal levels, are in the same range as those PCB levels found in Lake Ontario night herons experiencing hatching failure.

Spatial and Temporal Relationships of Organochlorine Compounds

Spatial Relationships

Comparisons between organochlorine levels in fish-eating bird eggs collected from North American coastal areas and levels in eggs collected from colonies farther offshore invariably show that coastal areas are more contaminated (Keith and Gruchy 1972, Pearce, Gruchy, and Keith 1973). The same kind of comparison between the Great Lakes area and the River and Gulf of St. Lawrence shows that eggs from the Great Lakes (especially Lake Ontario) are more highly contaminated. For example, Table 3 shows that herring gull eggs collected from Lake Ontario contained a mean of 26.1 ppm DDE while eggs from Quebec (the Gulf and Estuary of the St. Lawrence) contained 6.4 ppm DDE (Gilbertson and Reynolds 1974). PCB levels showed a similar decline with distance from the Great Lakes.

Table 3. DDE and PCB levels[a] in eggs of herring gulls and double-crested cormorants: spatial and temporal relationships.

Location	Year	Herring gull			Double-crested cormorant		
		N	DDE	PCB	*N*	DDE	PCB
Lake Ontario		16	26.1	113	7	12.2	22.8
St. Lawrence Estuary & Gulf		16	6.4	13.0	15	7.3	13.7
Bay of Fundy[b]	1971	13	2.5	2.12	11[c]	9.7	14.3
	1972	15	1.3	2.54	9	6.7	9.1
	1973	15	2.1	1.81	9	2.9	5.6
	1974				9	1.9	5.3
	1975				10	2.0	5.2

[a]Geometric means, ppm wet weight, converted from Gilbertson and Reynolds 1974.
[b]Arithmetic means, from Zitko 1974, 1976.
[c]Two to three eggs analysed combined.

In the same manner, double-crested cormorant eggs from Lake Ontario were more contaminated with DDE and PCB than those from Quebec (the Gulf and Estuary of the St. Lawrence) (Gilbertson and Reynolds 1974).

Temporal Relationships

Examination of temporal changes in residue levels shows that in many instances, DDE levels have declined over the period 1971 to 1976. The best example of this is the Zitko (1976) cormorant data (Table 3). DDE levels have fallen from 9.7 ppm in 1971 to 2.0 ppm in 1975. The major input of DDT into the eastern Canadian environment was the spruce budworm program. DDT was last used for forest insect control in 1968, and following the major reduction of other uses of DDT in Canada in 1969, DDE residues were expected to decline in Canada in the 1970s. Declines in levels of DDE in songbirds are now evident in the US (Johnston 1974, Nickerson and Barbehenn 1975).

For PCB, temporal declines have occurred in Bay of Fundy cormorants and possibly in herring gulls (Zitko 1974, 1976) (Table 3) but in other locations, declines over time are not evident up to 1975. The Canadian Task Force on PCB (1976) reached this same conclusion following its examination of PCB levels in eggs of herring gulls from the Great Lakes and eastern Canada.

A comparison of the temporal trends of DDE and PCB shows that in Bay of Fundy cormorants, the levels of DDE in the eggs are falling faster than the PCB levels. These differences in rates of change should be expected since PCB use in Canada has continued into the 1970s, whereas large-scale DDT uses ended in 1969.

Inland Fish-eating Bird Studies

Loons

Concern that common loon (*Gavia immer*) populations might be affected by organochlorine compounds and mercury led the CWS to initiate a survey of the reproductive success of this species in Ontario. This study was designed to complement a previous research project in Algonquin Park (Barr, unpublished) and to investigate Fimreite's (1974) hypothesis that the extremely high levels of mercury carried by adult loons (51.9 ppm in liver) in the Wabigoon River system of northwestern Ontario were responsible for the absence of young loons on both Clay and Ball Lakes and that part of the Wabigoon River joining them.

Barr (in preparation) began his survey of loon reproduction in 1974. Mercury and organochlorine levels were determined in loon eggs, in selected adult tissues, and in representative fish of sizes utilized by loons as food for chicks. Although analysis of the data is still in progress, a few general conclusions are possible. For the first 100 miles (161 km) of the Wabigoon River, common loon reproduction has come to a halt. For the 28 mile (44 km) section of the river between Clay and Ball Lakes, it is possible, by comparing it to similar areas elsewhere, to eliminate changing water levels, high turbidity and human interference as factors affecting the reproductive success of loons. The levels of mercury in the fish eaten by loons and mercury levels in the loons themselves, suggest that mercury adversely affects loon reproduction*.

At the same time, the CWS began a survey of loon reproductive success on two lakes in eastern Ontario. The lakes differed in trophic state, level of recreational use and geology.

Reproductive success on the heavily-utilized and somewhat eutrophic Big Rideau Lake was 0.7 and 0.5 fledged young per territorial pair in 1974 and 1975 respectively. On the oligotrophic and less-utilized Crotch Lake, reproductive success was 0.8 fledged young per pair in both years. These data compare favourably with Olson and Marshall's (1952) 0.5 young per pair in Minnesota and Vermeer's (1973) 0.4 young per pair in Alberta.

Only addled eggs were collected. Four eggs from Big Rideau Lake contained a mean 5.2 ppm DDE, 9.1 ppm PCB, and 0.28 ppm mercury. The two eggs from Crotch Lake contained a mean of 4.4 ppm DDE, 17.9 ppm PCB and 0.46 ppm mercury.

The mean contaminant levels in eight eggs collected in 1974 and 1975 from lakes with normal loon productivity near, but not on, the Wabigoon River system were 8.6 ppm DDE, 8.6 ppm PCB and 0.69 ppm mercury. These levels are not very different from those of eastern Ontario. Vermeer's (1973) 15 eggs from Alberta contained 1.7 ppm DDE and 1.2 ppm PCB (arithmetic means).

Considering the data from northwestern and eastern Ontario together with that from Alberta, it appears that loon reproduction is being influenced by mercury on part of the Wabigoon River, but that elsewhere, loon reproduction does not seem to be influenced by present levels of organochlorines and mercury.

Loon egg shells from eastern Ontario are 8 percent thinner than egg shells collected in Ontario and Quebec before 1947 (Anderson and Hickey 1972). I have plotted percent change in shell thickness against DDE content in loon eggs using data from Vermeer (1973), Lumsden (unpublished) and the CWS study in eastern Ontario. By linear extrapolation (Keith and Gruchy 1972), I determined that 20 percent shell thinning would occur at 14 ppm DDE. This places loons in the DDE-sensitive catogory along with the falcons, pelicans and black-crowned night

*Barr 1977; personal communication.

heron. However, on average, no Canadian loon populations contain mean DDE levels as high as 14 ppm in their eggs.

Studies on Falcons

Peregrines

The recent continent-wide survey of peregrine falcon (*Falco peregrinus*) populations (Fyfe, Temple, and Cade 1976) has not given cause for optimism about the fate in the wild of these birds. Although the Peale's falcon (*F. p. pealei*) population has remained stable, the tundrius population (*F. p. tundrius*) has begun to decline all over its range from Alaska to the eastern part of northern Canada. No recoveries of the anatum race (*F. p. anatum*), which breeds south of the tree line, were evident.

Nevertheless, the Canadian falcon-captive breeding program at Wainright, Alberta is now producing young peregrines in quantity and in the summer of 1976, 38 young Peregrines were released at various sites across Canada. These sites ranged from true falcon eyries in the north and west where, in some instances birds were put out under foster parents, to artificially constructed ledges on the sides of buildings. It is too early to know how many of the birds survived the winter but immature peregrines have been seen recently in the Montreal area and at least one is believed to be from the group released there.*

Paririe Falcons and Richardson's Merlins

The CWS began its studies of the prairie falcon (*Falco mexicanus*) in 1966. Fyfe et al. (1969) reported a decline in territory occupancy and an inverse relationship between DDE content in eggs and production of young. Eggshells were also 11 percent thinner than those collected before 1947. Studies on the merlin (*Falco columbarius*) began in 1969. Fyfe, Risebrough and Walker (1976) reported studies on the relationship between levels in eggs of five contaminants[2] and embryonic mortality, reproductive success, shell-thickness index, and territory defence in prairie falcons and merlins.

Productivity in both species varied as the shell thickness index, and unpublished data (Fyfe, Risebrough and Walker) indicated that shell thickness index was closely dependent upon DDE. In both species, the most productive nests were those in which the eggs were less contaminated with DDE. PCB, although not related to prairie falcon productivity, was related to merlin productivity. Territorial defense was weakest in merlin pairs with high DDE levels in eggs (and also possibly PCB) and lowered shell thickness index.

In general, DDE concentrations were four times as high in merlin eggs as in prairie falcon eggs. The productivity and other data suggest that prairie falcons are more sensitive to DDE than are merlins.

Summary

In Canada, as elsewhere, the widespread occurrence of DDE, the major metabolite of DDT, has been implicated in reproductive failures in several species and populations of birds. Widespread contamination of ecosystems, notably PCB, dieldrin, heptachlor epoxide and in some instances mirex has also been shown.

[2]DDE, PCB, dieldrin, heptachlor epoxide, mercury.
*Bird 1977; personal communication.

Eggshell thinning, hatching failures, and changes in adult behaviour have been demonstrated in several of the falcons and in fish-eating birds, notably those from the Great Lakes. All of the above-mentioned compounds are present in elevated levels in the Great Lakes ecosystem, together with a number of other chlorine-containing compounds, some of which are not yet identified. The precise mechanisms through which all of these compounds exert their influence on bird populations are now being probed. Loons, although probably DDE-sensitive, do not carry levels of DDE high enough to be of reproductive significance. Mercury in northwestern Ontario seems to be affecting loon reproduction.

The large-scale uses of chemicals to control forest insects continue to occupy our attention because large numbers of small songbirds have been killed in recent years in New Brunswick.

The use of DDT in forest-spray operations ceased in 1968 and most other uses of DDT were eliminated in 1969. Since then, DDE residues have appeared to decline in some wildlife species. Restrictions on the use of mercurial fungicides on the prairies occurred in the early 1970s, resulting in a steady decline in mercury levels in prairie falcon eggs there. The import and use of PCB continued in Canada through the mid 1970s and, with one exception, PCB levels have not yet begun to decline in bird populations.

Peregrine falcons, with the exception of those on the Pacific Coast, still seem to be severely affected by organochlorine contaminants. Prairie falcon and Richardson's merlin reproductive success has also been adversely affected by organochlorine contaminants.

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Birds of Prey, DDT, and Tussock Moths in Pacific Northwest

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Outbreaks of the Douglas-fir tussock moth *(Orgyia pseudotsugata)* in the Pacific Northwest have occurred several times in the past, notably 1947, 1956, and 1965. Although DDT usage was banned by the Environmental Protection Agency (EPA) in 1972, its emergency use for Douglas-fir tussock moth control was cleared by EPA in 1974, but intensive monitoring was required. During June and July 1974, 426,159 acres of forest in northeastern Oregon, southeastern Washington, and adjacent Idaho were sprayed with DDT. DDT (0.75 lb) mixed with 0.94 quart of auxiliary solvent and enough No. 2 fuel oil to make 1 gallon was sprayed from helicopters at approximately 0.75 lb DDT per acre. Our field studies of raptors were conducted in northeastern Oregon (La Grande - Enterprise) and northern Idaho (near Potlatch).

Detrimental effects of DDT on raptors have been documented in numerous field and laboratory studies. DDT and DDE have been associated with eggshell thinning and reduced production (Anderson and Hickey 1972, Cooke 1973). The present study was designed to provide further data on residue accumulation and population characteristics of the American kestrel *(Falco sparverius)*, goshawk *(Accipiter gentilis)*, Cooper's hawk *(A. cooperii)*, and sharp-shinned hawk *(A. striatus)* following DDT application. Special attention was focused on the kestrel because it was the most abundant raptor in the study area. Furthermore, laboratory experiments with the kestrel have shown that DDT and dieldrin in combination, and DDE induced eggshell thinning and lowered reproductive success (Porter and Wiemeyer 1969, Wiemeyer and Porter 1970, Lincer 1975). Although DDT may induce deleterious effects on the species in captivity, we wanted to measure the effects of one operational spraying (at 0.75 lb/acre) on forested lands.

Kestrel populations in the U. S. have not drastically declined during the DDT era, although some reduction in productivity was noted (Henny 1972). The Cooper's hawk and the sharp-shinned hawk have shown population decreases, thin-shelled eggs, and reduced productivity (Hackman and Henny 1971, Henny and Wight 1972, Snyder et al. 1973). The goshawk population in the East has shown, if anything, a recent slight increase (Snyder et al. 1973).

The emergency DDT spray program provided a unique opportunity to evaluate possible adverse effects of one spray program on wild raptor populations. To evaluate the effects of the spray, I: (1) determined residue buildup of DDT and its metabolites in the blood plasma and eggs of adult raptors, (2) determined the relationship between residues in the blood plasma and egg of the same female, (3) measured eggshell thickness, and (4) monitored productivity rates.

One-year postspray findings were reported for kestrels by Henny, Nelson, and Gray (in press). Residues in mountain bluebird (*Sialia currucoides*) and common flicker (*Colaptes auratus)* eggs one year postspray were reported by Henny, Olson, and Meeker (1977). The present report updates the kestrel findings to include

1976 (2 years postspray) and includes new information on residues in the blood plasma of accipiters. Data are also being compiled on residues in accipiter eggs but are not yet complete.

Methods

The method for study was described by Henny, Nelson, and Gray (in press). Briefly, prespray and postspray information was collected from the sprayed area, from adjacent areas, and from unsprayed areas. Samples from kestrels were grouped for analysis based on the size of their home range during the nesting period, whereas the accipiter samples were grouped for analysis based on natural voids in the data. The nearest distance to the spray area (in 0.1-mile increments) was recorded for each sample collected.

Three hundred nest boxes were placed in the study area to attract nesting kestrels. Approximately 50 percent of the boxes were placed in the spray area, 20 percent in the adjacent area, and 30 percent in the unsprayed area. One egg was collected from each clutch and analyzed for DDT and its metabolites; eggshell thickness (including membrane) was measured at the equator with a Starrett 1010M micrometer. Four measurements were made of each egg to obtain a mean value. The remainder of the eggs were monitored for hatchability and fledging rates. Many raptors were trapped and bled. A minimum of 1 cc of blood was collected from 200 adult kestrels and 60 accipiters. The blood was taken from the brachial (wing) vein or the jugular vein, placed in a heparinized tube, and stored on ice. On the day that samples were collected, the whole blood was centrifuged and the plasma drawn off and frozen for later analysis. The analytical methods used for the blood plasma and eggs followed Peterson, Stahl, and Meeker (1976). Slight modifications to improve the speed of plasma analysis were made (Henny, Nelson, and Gray, in press). The lower detectable limit for blood plasma was 0.01 ppm for DDT and its metabolites; for eggs it was 0.03 ppm for DDT and its metabolites and other organochlorine pesticides, but for polychlorinated biphenyls (PCB) it was 0.20 ppm.

Results

The American Kestrel

The kestrel apparently obtains most of its pesticide load through ingestion of contaminated food. Kestrels nesting within the study area are migratory and primarily winter in Mexico (Henny, Nelson, and Gray, in press). Food habits were not investigated during the present study, but were summarized by Fisher (1893). He indicated that grasshoppers, crickets, and other insects are the kestrel's principal food during the warm months (period spent in the spray area); mice predominate during the rest of the year. Terrestrial caterpillars, beetles, spiders, and some birds also are eaten.

Understanding the home range of the kestrel is also important in evaluating pesticide burdens in the spray area and at various distances from the spray area. The greatest movement recorded for an adult kestrel during the nesting season in this study was 1.5 miles. Craighead and Craighead (1956) reported the average maximum diameter of kestrel home ranges during the nesting season as 1.35 miles (range 0.6 to 2.3); Enderson (1960) reported a 1.4-mile average maximum diameter.

Based on the home range information, the kestrel blood samples collected during this study were partitioned at 1.5 miles from the spray area for analysis purposes; kestrels captured within 1.5 miles of the spray area may have lived within the spray area part of that year. Assuming that the nest site was in the center of the home range, information on residues in eggs, productivity, and eggshell thickness was partitioned at 0.8 mile from the spray area. The blood samples from adjacent and unsprayed areas were partitioned at 6 miles in 1974 (the year when no eggs were collected), but the two categories were combined in 1975 and 1976 because of nearly identical residue values in each group. Kestrel egg samples for the adjacent and unsprayed area in 1975 and 1976 were partitioned at 10 miles; the greater distance may represent more meaningful "controls". For evaluating nesting success, the adjacent and unsprayed areas were pooled and called the nonspray area. The distances used for partitioning the data in this report are compatible with those in previous reports.

Dispersal of kestrels from 1 year to the next is less understood than movements during a given nesting season. Adults return in subsequent years to the immediate vicinity (6 of 8 recoveries were within the same 10′ block were banded [an area of approximately 13 by 7 miles in northern latitudes]). Young birds are more dispersed (Table 1).

Residue levels in blood plasma. Blood samples were collected from adult kestrels in 1974 (prespray and postspray), 1975, and 1976 (Fig. 1). The data from both sexes were pooled because residues were not significantly different by sex. The prespray samples showed that DDE (a metabolite of DDT) was present in all blood samples analyzed; the residues were generally low with an arithmetic mean of 0.11 ppm. The 1974 afterspray samples were collected from 2–40 days postspray; the mean sampling date was 19 days postspray. DDT was detected in the plasma of two kestrels only 4 days postspray indicating that kestrels rapidly accumulated DDT.

Because plasma residue data were not normally distributed, sampling periods, locations, and years were compared by a test based on an exponential distribution (Epstein and Tsao 1953, Henny, Nelson, and Gray, in press). Residues of DDT and its metabolites in the sprayed area showed a highly significant increase during the postspray period in 1974 ($P = 0.006$). Postspray residue levels at increasing

Table 1. Recoveries of adult and young American kestrels banded during the nesting season and recovered in subsequent nesting seasons in the northern latitudes of the U. S. and Canada.

Distance from banding site (miles		Adults	Young
0–20		8	7
21–40		0	2
41–60		0	1
61–80		0	1
81–100		0	0
101–120		0	0
121–140		0	0
141–160		0	1
	Total	8	12

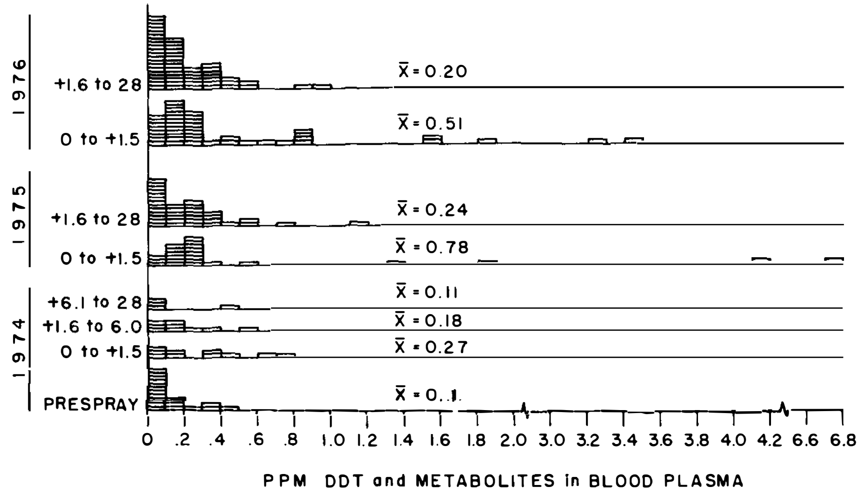

Figure 1. Residues of DDT and its metabolites in blood plasma of 200 adult American kestrels sampled during the 3-year study. The numbers on the ordinate refer to distance from the spray area boundary in miles and each rectangle represents a bird sampled.

distances from the spray area approached prespray background levels. In 1975, residue levels in the spray area (0.78 ppm) showed a significant increase over postspray residues in 1974 (0.27 ppm) (P = 0.023). Furthermore, residue levels farther away from the spray area also increased suggesting a possible dispersal of DDT throughout the region. The data from outside the spray area (1.6 to 6.0 miles and 6.1 to 28 miles) were combined in 1975 because the mean residue values were nearly identical (0.23 and 0.24 ppm). The buildup outside the spray area may have resulted from drift of the DDT when applied, by movement of the kestrel's prey (insects, birds, or mammals), or possibly by dispersal of young kestrels.

Blood plasma residue levels in 1976 decreased in the spray area from levels in 1975 (0.78 vs. 0.51 ppm) (P = 0.074). Similarly, residue levels decreased outside the spray area from 0.24 to 0.20 ppm, but the difference was not significant (P = 0.392).

Residue levels in eggs (DDT and metabolites). One egg from each of 21 clutches was collected in 1975 for pesticide residue analysis and eggshell thickness measurements. The residue levels in the eggs were adjusted for moisture loss by the procedure of Stickel, Wiemeyer, and Blus (1973). Mean levels of DDT and its metabolites (wet weight) in the spray area were five times those in eggs collected more than 10 miles from the spray area, with no overlap (Fig. 2).

One egg was collected from each of 51 clutches in 1976. Additional kestrel boxes were placed in the field in 1976 and many boxes were moved to better sites, which accounts for the larger numbers of nesting kestrels in the boxes in 1976. Residues of DDT and its metabolites in eggs from the spray area decreased significantly from 1975 to 1976 (6.42 to 2.24 ppm) (P = 0.002). Again, as with the plasma residue data, statistical tests were based on the exponential distribution. In addition, there was an apparent decrease in residues in the adjacent and unsprayed areas from 1975 to 1976, (1.61 to 1.19, and 1.33 to 0.73) although the 1975 sample

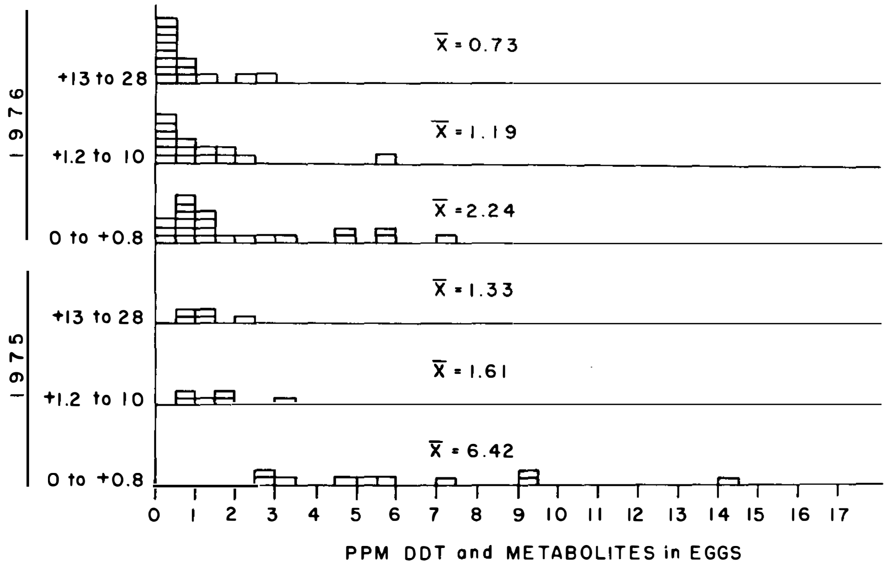

Figure 2. Residues of DDT and its metabolites in eggs from 72 American kestrels collected in 1975 and 1976. The numbers on the ordinate refer to distance from the spray area boundary in miles and each rectangle represents a bird sampled.

sizes were too small to permit a statistical test. However, residues in the spray area in 1976 were still significantly higher than in the unsprayed area in 1976 (2.24 vs. 0.73 ppm) (P = 0.007).

Residue levels in eggs (other pollutants). Of the 51 kestrel eggs collected in 1976, no other pollutants were detected in 38 (75 percent) of the eggs. Eleven eggs contained dieldrin, one egg contained dieldrin plus PCB (< 0.3 ppm), and one egg contained PCB (0.2 ppm). The residues in 12 eggs containing dieldrin averaged 0.08 ppm wet weight (range 0.03 to 0.22). The mean for dieldrin in the 51 eggs was 0.02 ppm. With the exception of DDT and its metabolites, the kestrels in the study contained relatively low levels of pollutants.

Residues in plasma and egg (same female). Although the relationship between pesticide residues in blood and fat has been established in studies with mammals and with poultry, it was tested again in the laboratory with mallards (*Anas platyrhynchos;* Friend et al. in press). The correlation with fat biopsy samples was good, and I began testing the technique with wild birds during my study in 1974. As a part of the field evaluation, residues in plasma were compared with residues found in eggs because eggs are considered suitable for monitoring purposes. To conduct this aspect of the study, a blood sample and an egg were needed from female birds. Only 12 paired sets of blood samples and eggs were collected during the 1975 season and levels in the plasma ranged from only 0.05 to 0.35 ppm; however, an additional 35 paired sets of data were collected in 1976. Contrary to my initial suggestion that the relationship fits a log distribution (Henny, Nelson, and Gray in press), the data now available appear to better fit a log-log distribution (Fig. 3). The positive relationship is highly significant; however, only one sample contained more than 1 ppm residue in the blood plasma. More investigation of

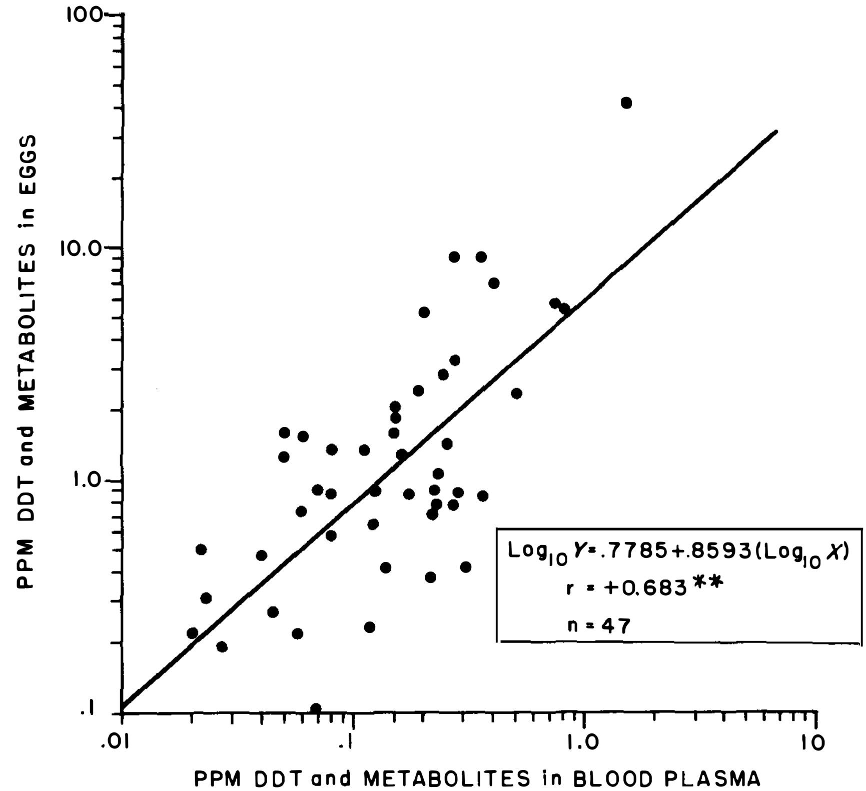

Figure 3. Log-log relationship between residue levels of DDT and its metabolites in eggs and blood plasma collected from the same female American kestrel (includes one egg near spray project heliport with 42.7 ppm).

blood samples and eggs in kestrels and other species will improve our understanding of the relationship.

Eggshell thickness. Data for eggshells were divided into the same distance categories as previously used for egg residues (Table 2). Furthermore, the eggshell thickness data appeared to be normally distributed.

In 1975 eggshells were 10.4 percent thinner (0.1867 mm) in the spray area 0–0.8 mile) than in the 13–28-mile category (0.2084 mm) (P = 0.005) and 11.5 percent thinner than the pre-1947 eggshell thickness of 0.211 mm in interior and northern North America (Anderson and Hickey 1972). The pre-1947 thickness was nearly identical to that found in the 1975 unsprayed area. The thinnest egg in the spray area was 21.8 percent thinner than the mean thickness from the unsprayed area.

The 10.4-percent thinning in the spray area was associated with an increase from 1.33 to 6.42 ppm of DDT and its metabolites in the eggs. A highly significant negative correlation exists between shell thickness and the log of DDT and its metabolites in kestrel eggs collected in 1975 and 1976 (Fig. 4). Furthermore, the regression line indicates that with 0.1 ppm DDT and metabolites in the eggs, the projected eggshell thickness is 0.212 mm which compares to 0.211 mm for pre-1947 shell thickness. Lincer (1975) reported a logarithmic relationship between

Table 2. Eggshell thickness of American kestrels on and near the DDT spray area, 1975 and 1976.

Category	Location (from spray area in miles) 0 to +0.8	+1.2 to 10	+13 to 28
1975			
Mean eggshell thickness (mm)	.1867	.2030	.2084
S. D.	.0150	.0116	.0110
S. E.	.0047	.0047	.0049
Range	.163–.205	.190–.220	.190–.217
n	10	6	5
1976			
Mean eggshell thickness (mm)	.1968	.2012	.2012
S. D.	.0157	.0151	.0138
S. E.	.0033	.0036	.0037
Range	.170–.224	.173–.225	.172–.218
n	23	18	14

DDE and eggshell thinning for kestrels in New York; Cade et al. (1971) and Blus et al. (1972) reported similar logarithmic relationships for other species.

An initial inspection of the scatter of points in Figure 4 showed that the eggs with smaller volumes were nearly all below the regression line, i. e., smaller eggs had thinner shells. However, a further analysis of egg volume revealed that it was independent of laying data, elevation, or concentration of DDT and its metabolites in the egg (correlation, r, of Log_{10} (DDT) and volume = − 0.041, NS). Therefore,

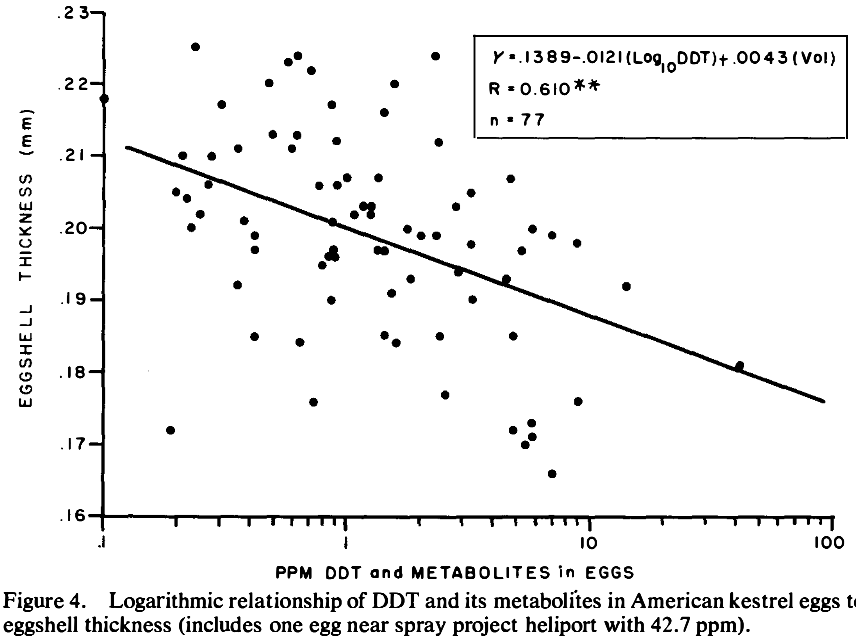

Figure 4. Logarithmic relationship of DDT and its metabolites in American kestrel eggs to eggshell thickness (includes one egg near spray project heliport with 42.7 ppm).

Table 3. Analysis of variance of eggshell thickness on egg volume and $\log_{10}$ (DDT). The partial regression coefficients are b_1 (Log_{10}DDT) = – 0.01212, and b_2 (volume) = + 0.00429, with a coefficient of determination (R^2) of 0.37. Therefore, 37 percent of the total variation in eggshell thickness is accounted for by regression on Log_{10} (DDT) and egg volume.

Source	d.f.	SS	MS	F
Regression on vol.	1	.00267	.00267	20.54**
Regression on Log_{10} (DDT) given vol.	1	.00306	.00306	23.54**
Residual	74	.00969	.00013	

some birds lay smaller eggs than others, possibly due to age or a number of other factors. Proper analysis of the effect of DDT therefore requires, in general, that multiple regression be used with Log_{10} (DDT) and volume as the two independent variables in evaluating the effect of DDT on eggshell thickness. The simple correlation (r) for Log_{10} (DDT) on shell thickness was $-$ 0.463 ($P < 0.01$); the simple r for volume on shell thickness was +0.416 ($P < 0.01$). The analysis of variance of eggshell thickness on egg volume and Log_{10} (DDT) is shown in Table 3.

Eggshell thickness increased in the spray area in 1976 over 1975 ($P < 0.05$), but with no significant change in the unsprayed area. Eggshells in the spray area in 1975 were 11.5 percent thinner than pre-1947 eggshells, but were only 6.7 percent below normal in 1976.

Productivity. Although data were collected from unsprayed and sprayed areas, they are observational rather than experimental (controlled). The major difference between observational and experimental data is that a number of factors other than the DDT treatment might influence the results, particularly when evaluating nesting success. Factors such as elevation, laying date, and weather may be important. A range in elevation of 2300 feet was found in the study area and laying date and elevation were correlated.

The late spring in 1975 in the Northwest resulted in delayed nesting and reduced nesting success throughout the region. Only 52 percent of all kestrel nests were successful and only 1.38 young were fledged per nest. Based on a sample of 21 nests observed from the "egg stage" (nests with eggs recorded), Henny, Nelson, and Gray (in press) found there was no detectable difference in productivity between the sprayed and nonsprayed (adjacent and unsprayed combined) areas in 1975. However, the authors suggested that some of the females with high residues in their blood may not have nested in 1975. They based their suggestion on the fact that residues in blood plasma from nesting females ranged from 0.05 to 0.35 ppm, but some females trapped away from nest sites (but may have been nesting) contained residues in excess of 1.0 ppm.

Fifty-one pairs were observed from the "egg stage" to completion of the nesting cycle in 1976. Initially the nesting data were divided into four time categories (similar to treatment of data from 1975). Fourteen nests were assigned to each of the first three time periods, and the remaining nests to the last category. Each time period was then divided into high elevation (the seven nests at the higher elevations) and low elevation. Then, the two elevation groupings were divided into spray area and nonspray area. Thus, 16 sets of information on clutch size and fledging rates were available (Table 4). The following tendencies were observed: (1) smaller clutches in the later nests, (2) larger clutches at higher elevations, (3)

Table 4. American kestrel productivity in 1976 in relation to timing of nest initiation, elevation, and spray vs. nonspray area.

Date and elevation	Factor and treatment					
	No. nests		Clutch size		Young per nest	
	Spray	Nonspray	Spray	Nonspray	Spray	Nonspray
May 4–29						
High	6	1	4.67	5.00	2.33	2.00
Low	-	7	-	4.71	-	2.43
June 1–9						
High	2	5	4.50	4.80	3.00	3.60
Low	1	6	4.00	4.33	0	2.33
June 9–20						
High	4	3	4.75	5.00	2.25	4.00
Low	3	4	3.67	4.25	1.67	2.50
June 21–July 3						
High	1	3	3.00	3.67	0	2.33
Low	4	1	3.25	4.00	0.50	0

smaller clutches in the spray area, (4) lower fledging rates in late nests, (5) higher fledging rates at higher elevations, and (6) lower fledging rates in the spray area.

Nesting data were also tabulated on May nests, early June nests, and late June and July nests (taking advantage of a 9-day data void between June 11 and June 20) (Table 5). Elevation was not incorporated into Table 4; however, the second part of the table includes information on the amount of DDT and its metabolites in the eggs. Unfortunately comparisons with DDT concentrations were based on only 12 clutches with greater than 2 ppm in the eggs. All productivity data are too sparse to be conclusive.

The Accipiters

All three North American accipiters were found in the study area in northeastern Oregon. Very little is known about the migratory characteristics of the species in the study area, although Gabrielson and Jewett (1940:183–185) consider the goshawk a permanent resident of the Cascades and Blue Mountains of northeastern Oregon, the Cooper's hawk a regular permanent resident throughout Oregon, and the sharp-shinned hawk a common permanent resident in Oregon. Ralph Anderson of the U. S. Forest Service indicated the sharp-shinned hawk in the Blue and Wallowa Mountains of northeastern Oregon is migratory, the Cooper's hawk is partially migratory (moves to lower elevations during severe winters), and the goshawk is a permanent resident.*

Few accipiters have been banded in the Northwest to further elucidate migration; however, a number of Cooper's hawks and sharp-shinned hawks banded in California during the winter (November-February) have been recovered. Of the 10 reported recoveries of banded Cooper's hawks, all were from California. In contrast, of the 12 reported recoveries of sharp-shinned hawks, 10 were from Califor-

*Ralph Anderson 1976: personal communication.

Table 5. American kestrel productivity in 1976 in relationship to DDT concentrations and timing of nest initiation.

	Date eggs in nest[a]			
	May 4–29	June 1–11	June 20–July 3	Totals
Spray area				
Clutch size	4.67	4.40	3.33	4.18
Young per nest	2.33	2.10	0.83	1.82
% nests successful[b]	67	70	33	59
n	6	10	6	22
Nonspray area				
Clutch size	4.75	4.53	(3.75)[b]	4.48
Young per nest	2.38	2.94	(1.75)	2.62
% nests successful[b]	63	88	(75)	79
n	8	17	4	29
Greater than 2 ppm DDT in eggs				
Clutch size	(5.67)	4.33	(3.66)	4.50
Young per nest	(3.00)	2.00	(0)	1.75
% nests successful	(67)	67	(0)	50
n	3	6	3	12
Less than 2 ppm DDT in eggs				
Clutch size	4.40	4.52	3.43	4.29
Young per nest	2.00	2.81	1.71	2.39
% nests successful	60	86	71	76
n	10	21	7	38

[a]Does not refer to exact date clutch was completed, it probably *averages* a week to 10 days after clutch completion.
[b]A successful nest has at least one young fledged.
[c]Statistics based on samples of less than 5 are enclosed in parentheses.

nia, 1 from western Oregon, and 1 from eastern Washington. The winter bandings lend further support to the contention that sharp-shinned hawks from the Northwest are migratory, whereas the Cooper's hawks probably are not. Storer (1966:431) stated, "the sharp-shinned hawk depends almost entirely on birds as prey, and its existence in the northern forests is contingent upon its ability to move south when the bulk of the small birds leave." Storer further stated that in contrast to the two smaller species, the goshawk is nonmigratory, although in some years there are extensive southward movements, presumably corresponding with low points in the cycles of abundance of their prey species.

Food habits of the North American accipiters were studied by Fisher (1893), Storer (1966), and Wattel (1973). Storer (1966:432) summarized the proportions of birds to mammals (occasionally a few insects and lizards are recorded) eaten by accipiters as follows: sharp-shinned hawk (birds 97.0 percent, mammals 3.0 percent); Cooper's hawk (birds 82.3 percent, mammals 17.7 percent); and goshawk (birds 44.8 percent, mammals 55.2 percent). Most of these data were collected in the fall, winter, and early spring with little information recorded during the nesting season.

Some home range information on the accipiters is available from studies of Craighead and Craighead (1956) in Michigan and Wyoming. The average maximum diameter of the home range during the nesting season was 1.2 miles for sharp-shinned hawks in Wyoming; 1.5 miles for Cooper's hawks in Michigan and 1.4 miles in Wyoming; and 1.7 miles for goshawks in Wyoming. The larger species tended to have larger home ranges. To my knowledge nothing is known about the dispersal of accipiters.

Residue levels in blood plasma. The number of blood samples collected from accipiters is too small for statistical analysis; however, some trends are apparent (Fig. 5). The accipiters contained higher levels of DDT and its metabolites after spraying than the kestrels. DDT residues in kestrels peaked at 0.78 ppm in the

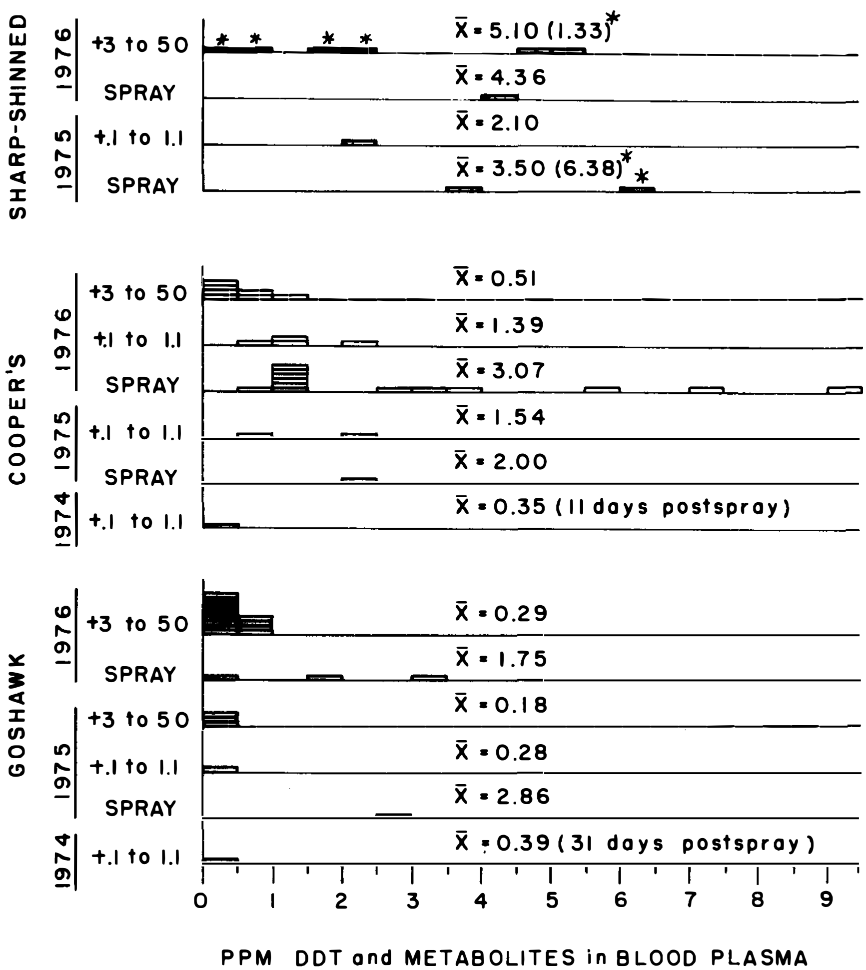

Figure 5. Residues of DDT and its metabolites in blood plasma of adult goshawks, Cooper's hawks, and sharp-shinned hawks. The (*) for sharp-shinned hawks indicates the yearling age class. The numbers on the ordinate refer to distance from the spray area boundary in miles and each rectangle represents a bird sampled.

spray area in 1975; goshawks in the spray area in 1975–76 contained 2.03 ppm; Cooper's hawks in the spray area in 1975–76 contained 2.99 ppm (the mean for the four Cooper's hawks 0.8 mile or more into the spray area was 5.88 ppm); and sharp-shinned hawks in the spray area in 1975–76 contained 4.75 ppm. Furthermore, only one pair of sharp-shinned hawks could be found in the spray area in 1976. I combined the accipiter data from the spray area in 1975–76 because few data were collected in 1975, therefore, no trend in residues could be traced for the 2-year period.

Discussion and Conclusions

In 1965 Peterson (1969:529) discussed the effects of contamination of food chains and made some predictions of the fate of populations of raptors. He noted that "the most likely food chains to be contaminated and to affect the top predators would be chains involving birds and fishes. In other words, the bird-eating birds and fish-eating birds would be most vulnerable. Mammal-eating birds would be less affected." Moore (1966) and Keith (1969) verified these predictions when they examined species of birds with differing food habits and compared levels of insecticide residues.

The findings from the present study based on one aerial application of DDT agree with Peterson's predictions. A comparison of DDT residues in the blood plasma of the four species shows that the primarily insectivorous kestrel showed the least buildup of residues. Residues in kestrels peaked one year (1975) after spray, possibly due to the relatively short insect food chain and faster population turnover (i. e., higher natural mortality rates). Even though the residue buildup was lowest in kestrels, the 1975 eggshells were 11.5 percent thinner than normal, residues in plasma averaged 0.78 ppm, and residues in eggs averaged 6.42 ppm. In 1976, eggshells were 6.7 percent thinner than normal, residues in plasma dropped to 0.51 ppm, and residues in eggs dropped to 2.24 ppm. Furthermore, the eggshell thinning was a log function of the amount of DDT and its metabolites (90 percent DDE, 1 percent DDD, and 9 percent DDT) in the eggs. Levels of other pollutants were judged to be low. Limited evidence in 1975 suggested that birds with higher DDT burdens may not have nested; data from 1976 indicated a tendency for birds from the sprayed area to fledge fewer young per nesting attempt.

Lincer (1975) reported that eggshell breakage in kestrels began when eggshells became more than 22 percent thinner than pre-1947 eggshells. He further pointed out that not one North American raptor population exhibiting 18 percent or more eggshell thinning has been able to maintain a stable self-perpetuating population. Although eggshell thinning of kestrels did occur during the present study, it rarely approached the 18–22 percent level. The unsuccessful nests in the spray area were generally deserted; the birds did not seem to have the tenacity to incubate the clutches to full term.

Behaviorial changes that could affect breeding birds have been noted by various authors. These take the form of increased aggression, reduced discriminatory behavior and alertness, and reduced territorial activity (Jefferies 1973). Biologists visiting the nests during the present study may have accounted for some desertion; however, nests in both the spray and nonspray areas were visited in a similar manner.

The goshawk (primarily mammal-eating) in the spray area in 1975–76, showed a 2.6–fold increase in plasma residues over the 1975 peak for kestrels, the mammal and bird-eating Cooper's hawk showed a 3.8–fold increase, and the bird-eating sharp-shinned hawk showed a 6.1–fold increase. In view of the higher residue levels in comparison with those noted for the kestrel, concern must be voiced for all three accipiters in the spray area.

Unfortunately, the accipiter eggs have not been analyzed at this date but, if the relationship for kestrels in Figure 3 is even a close approximation for the higher residue levels, the pesticide load in some of the accipiter eggs must indeed be large. In 1976, a cracked Cooper's hawk egg that contained virtually no shell was found in the spray area. Another concern is the relatively high residue levels found in adult sharp-shinned hawks many miles from the spray area, coupled with the fact that only one pair could be found in the spray area in 1976 after considerable searching.

The sharp-shinned hawk may be contaminated over a much larger region than just the spray area due to their more mobile prey (other birds). Unfortunately, no sharp-shinned hawks were sampled in the spray area in 1974. Although the pattern of residue accumulation (peak and beginning of decline) is understood for the kestrel, the accipiter patterns are not yet fully understood. However, we do know the relative contamination of the three species in the spray area in 1975–76, and this agrees with the general prediction made by Peterson 10 years ago.

The blood plasma technique, as a by-product of this study, was field tested and proven to be reliable for monitoring pesticide trends in raptors. More information is needed, however, for the higher plasma residue levels, and this will be available when the accipiters eggs are analyzed. The value of the blood plasma technique for pesticide monitoring if a strong predictive relationship exists is obvious. Major advantages to the blood plasma technique include: (1) the bird does not have to be killed to obtain the sample, therefore, large scale sampling is possible even with endangered or threatened species, (2) multiple samples are possible over time from some individuals, (3) freezer storage space for specimens is greatly reduced, (4) laboratory costs per sample are reduced due to less time needed for sample preparation and cleanup, and (5) discrete populations can be sampled periodically in sufficient numbers to establish pesticide exposure patterns and changes in residues levels.

Future Research

Our research in the 1974 DDT spray area will continue for at least two more nesting seasons, primarily to establish patterns for the accipiters and to improve our understanding of the relationship between blood plasma and egg residues. In addition, the U. S. Fish and Wildlife Service is taking part in the Department of Agriculture's Tussock Moth Research and Development Program in which alternative approaches (to DDT) for tussock moth control are being field tested.

Acknowledgments

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Oregon Department of Fish and Wildlife and the U. S. Forest Service provided living quarters. Jack Thomas, Director of the Range and Wildlife Habitat Laboratory of the U. S. Forest Service, provided office space for our summer employees. Ralph Anderson of the Wallowa Ranger District of the U. S. Forest Service assisted in providing information on raptors in the study area. George M. Jonkel kindly provided banding records from the Bird Banding Laboratory. W. Scott Overton (Oregon State University) and Kenneth P. Burnham (U.S. Fish and Wildlife Service) provided analytical advice, and Lucille F. Stickel, Lawrence J. Blus, Stanley N. Wiemeyer, and Stana Federighi (Patuxent Wildlife Research Center) kindly reviewed the manuscript. The project is partially funded by the U. S. Forest Service in Portland, Oregon.

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Relationships Between Insect Control and Human Health

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In approaching a subject like insect control and human health, one must first ask: What form of insect control? Are we to discuss the need to control agricultural insect pests for the sake of human health, or forest insect pests, or biting insect pests? We need only recall that food, clothing, shelter, and freedom from vector-borne disease are all health factors in order to realize that the control of any bona fide insect pest can be rationalized as a contribution to human health. It would be pointless to argue that contention. However, the methodology of insect control as affecting human health is certainly something we can discuss profitably. My title should have read "Relationships between insect control practices and human health." We will not, then, argue whether or not we should control corn earworms, boll weevils, gypsy moths or mosquitoes.

Insect Control Practices

It is hard to believe that DDT was released for public use only 31 years ago. Yet that is half a lifetime for many people, and surely the great majority of people cannot remember when the insecticide DDT did not exist. What this means is that to most people, insect control is synonymous with DDT and the many other organic compounds that followed it into our armamentarium against pests. Older people, however, remember when insect control included resistant plants, crop rotation, fly-free planting dates, sanitation and a host of other practices which involved no chemicals. And what does insect control mean to younger people? They are bound to hear, read or see on TV that the environment matters, that pollution must be fought, and that insect control must consequently ease up on chemicals and turn to other methods, pre-DDT if need be. If these young people are in college learning applied entomology, this is exactly what they will hear. Even the most obstinately insecticide-oriented entomology departments of 25 years ago are now placing great emphasis, if not the major emphasis, on pest management rather than just eliminative insect control.

Entomologists, behaving like legendary medieval philosophers, have spent a lot of time arguing over the fine distinctions between pest management, integrated control, biological control, genetical control, environmental control, and other such "alternatives," so called, to chemical insect control. Many, including myself, have maintained that insect control has always been a combination of methods and that even during the heyday of all-out chemical control many non-chemical methods remained in widespread use. I am not denying that for two decades or so all-out reliance on chemicals was popular. This unfortunate interlude in the history of applied entomology was brought to an end not so much by man as by nature. It was pest resistance to insecticides, more than anything else, that exploded the balloon and brought entomologists back to a more sensible course. Man failed and nature won. This is why I like Dr. Beirne's definition of pest management: ". . . the intelligent management of pests and of their surroundings and the management of the people who devise or do that managing" (Beirne 1966:11).

I doubt that it would be appropriate, on this occasion, to discuss the many nonchemical forms of insect control which are part of the fast-improving science of pest management. None relate to human health except in far-fetched ways. I will therefore limit my remarks to insecticides as they impinge on human health. Insecticides obviously play a dual role in public health, a hazard as poisons and cytopathogens, and a boon, as versatile disease vector control agents. My treatment will be correspondingly dualistic.

Insecticides in Man and Route of Entry

Human intoxication with insecticides can be conveniently examined as (1) acute poisoning, (2) chronic poisoning, and (3) occupational poisoning. The first of these is largely concerned with the highly toxic members of the organophosphate (OP) insecticide group, while the second is more an involvement of residues arising from the long-lasting and slowly degradable organochlorine (OC) compounds. The third involves mostly the OP compounds, especially as they act in the matter of reentry of laborers into treated areas.

Acute Poisoning: Deaths

National statistics on pesticide poisoning mortality are difficult to obtain (Lisella, Johson, and Lewis 1975). For many years it has been assumed that nationwide there are in the neighborhood of 150 deaths per year ascribable to pesticide poisonings, mostly insecticide-caused. Yet there is evidence that the rate has been dropping in recent years. One authority (Hayes 1976) states that between 1956 and 1969 the percentage of pesticide deaths ascribable to organochlorine compounds increased from 13 to 25. Although the national rates given by Hayes may be disputed as underestimates, more recent data from California and Florida (Table 1) verify that overall deaths from insecticides, as well as overall pesticides, are indeed decreasing quite dramatically.

In 1972 the Environmental Protection Agency prohibited nearly all uses of DDT and since then has prohibited or severely restricted the use of aldrin, dieldrin, heptachlor and chlordane. This has resulted in increased use of the more toxic

Table 1. Accidental deaths from insecticides in California and Florida, 1966–1975. Data from respective health departments.

	Year										
	66	67	68	69	70	71	72	73	74	75	Average
California	5	13	2	6	2		4		1		3.3
Florida	8	13	16	9	6	4	2	3	2	3	6.6

Reduction by 5-year periods

	1966–1970 total	1971–1975 total	% reduction
California	28	5	82%
Florida	52	14	73%

organophosphates. It needs greatly to be emphasized, however, that the major switch to these and away from organochlorine compounds had started many years before because of rapidly mounting resistance to the latter both in agricultural and public health insect pests. In Florida, OP compounds, until four years ago, accounted for the great majority of pesticide poisonings. Among these, parathion ranked so high that I have analysed it separately (Table 2). It is clear that accidental deaths from parathion poisoning have been diminishing constantly since the early sixties. California and other states report the same, so whatever the OC bans are doing, they are not causing more deaths from OP poisoning.

A form of acute poisoning which may be nonlethal and yet neither chronic nor occupational results from exposure to space treatment of domestic and public health pests. The homeowner involvement cannot be evaluated but is generally assumed to be great. Aerosols and sprays discharged in homes against biting and nuisance insects expose more humans to insecticides than public insect control programs, as the volume of sales will attest. The small effects of outdoor OP sprayings were made assessable only lately by the development of techniques for OP detection by urinalysis (Shafik et al. 1973). In 1975 aerial sprayings of naled for

Table 2. Deaths from parathion poisoning in Florida, 1959 to 1975. Base data from Florida Department of Health and Rehabilitative Services.

Year	Reported deaths			
	Accidental	Suicide	Homicide	Total
1959	2	0	0	2
1960	7	3	0	10
1961	10	4	1	15
1962	4	2	1	7
1963	12	4	0	16
1964	5	2	0	7
1965	9	4	1	14
1966	6	5	0	11
1967	11	3	7	21
1968	4	4	0	8
1969	1	3	0	4
1970	0	1	0	1
1971	1	0	1	2
1972	2	3	0	5
1973	0	0	0	0
1974	1	0	0	1
1975	1	0	0	1
Total	76	38	11	125
	Analysis by last three 5-year periods			
(a) 1961–1965	40	16	3	59
(b) 1966–1970	22	16	7	45
(c) 1971–1975	5	3	1	9
Reduction (a) to (c)	88%	81%	67%	85%

mosquito control were studied for residues in the human population of Dover, Delaware (Kutz and Strassman 1976). An increase in urinary OP metabolites was demonstrated and shown to be greater in people outdoors during the sprayings than people indoors. "Metabolite levels observed in this study," however, "did not approach concentrations normally associated with cholinesterase inhibition or other clinical repercussion."

Chronic Poisoning

The entire human population of the United States is subject to the incorporation into their bodies of pesticide residues. The problems of monitoring this exposure are monumental. Some monitoring has been underway since 1964 (Kuhr 1976) by several federal departments but a well-organized effort emerged only a few years ago, and that is now threatened by the abolishment last spring of the Federal Working Group on Pest Management. Before getting into the ultimate problem of pesticides in man and his food, we can cover briefly the matter of environmental monitoring.

Soils, water and air are separately monitored: (1) Soils on one quarter of the selected 9,468 cropland sites and 3,832 non-cropland sites are sampled for pesticides each year by the U. S. Department of Agriculture (Wiersma, Sand, and Cox 1971). (2) Waters are monitored by the U. S. Geological Survey and Environmental Protection Agency at 161 sites tested for water residues quarterly and for bottom-sediment residues semi-annually (Feltz, Sayers, and Nicholson 1971). (3) Air monitoring started later and is even now in the pilot stage of program development (Kuhr 1976).

Pesticide residues in United States soils are almost altogether DDT and other OC compounds (Crockett et al. 1974). They have been diminishing since 1970 but total disappearance (Kuhr 1976) cannot occur until near the end of this century. Organochlorine compounds reaching natural waters move into the lipids of inhabiting biota and are thus poorly represented in infrequent water analyses. Nevertheless the water monitoring which started in 1964 did show a peak in OCs between 1966 and 1968, after which a steady and considerable decline set in (Schulze, Mangold, and Andrews 1973). By 1975 this decline was still under way. At no time and nowhere did insecticide levels in water exceed one-tenth the permissible levels for human water supplies (Kuhr 1976). Problems of pesticide monitoring are greatest with air. As with soil and water, the insecticide load in air is also declining. Between 1970 and 1972 (Kutz, Yobs, and Yang, in press) the average reduction (Table 3) was from 71.2 to 29.7 ng/m^3, or 58 percent. Although some have calculated that maximum residues found in ambient air are not sufficient to add significantly to the total human intake of pesticides (Stanley et al. 1971), it has also been shown that contaminated house dust can be a major contributor to human body residues (Davies, Edmundson, and Raffonelli 1975) and that in rabbits of the Mississippi Delta, respiratory intake of DDT equalled or surpassed dietary intake in contributing to the DDT stored in adipose tissue (Arthur, Cain, and Barrentine 1975).

The Food and Drug Administration is charged with monitoring pesticide residues in food, which it does by analysis of "market basket" samples from retail markets in 30 nationwide areas. Each sample represents the recommended diet of a 15 to 20 year old male for the region where it is collected. The program started in

Table 3. Insecticide residues in ambient air, averages for 16 states. Adapted from data in Table 17 of Kutz et al. (in press).

	Mean sample (ng/m³)		
	1970	*1971*	*1972*
Toxaphene	32.4	6.3	13.9
Endosulfan I and II	13.2	N	N
DDT family	11.5	7.6	9.4
Dieldrin	1.8	1.9	1.1
Alpha BHC	1.3	1.0	0.9
Aldrin	1.2	T	N
Other OC	1.6	1.3	0.9
Malathion	3.9	15.5	0.8
Diazinon	1.8	1.1	1.1
Methyl Parathion	1.2	0.2	1.6
Parathion	1.3	0.2	N
Phorate	N	0.2	N
Organochlorines	63.0	18.1	26.2
Organophosphates	8.2	17.2	3.5
Total	71.2	35.3	29.7

1965 (Duggan and Corneliussen 1972). The OC compounds peaked in 1966 (Figure 1) and then dropped steadily. The DDT family dropped from 87 μg in 1966 to 29 μg in 1970, a 67 percent decline. The other OC compounds apparently began their decline only in 1969, and the OP compounds appeared to rise slowly over these same years. Well before the 1972 ban of DDT by the Environmental Protection Agency, the trend in residues in food was downward for OC compounds and upwards for OP compounds. This clearly reflected the use pattern for these insecticides resulting from the marked increase in pest resistance to OC compounds. These trends were still under way in 1973, as revealed (Table 4) in the data from the last Compliance Program Evaluation (U. S. Food and Drug Administration 1975). In the five years ending that year, OC residues in the United States dietary had decreased 78 percent while OP residues increased 35 percent. What is especially significant, however, is that "even at the time of maximum concentrations, the levels ingested by the general public did not approach the suggested acceptable daily intake defined by the FAO-WHO Expert Committee on Pesticide Residues" (Kuhr 1976).

In monitoring pesticides in this country's human population, the Environmental Protection Agency determines the levels of OC residues and metabolites in adipose tissue of humans in randomly selected cities. Last year the program was enlarged by collaboration with the U. S. Public Health Service to include other classes and types of pesticides. From 1970 to 1974 (Figure 2), OC pesticide residues had decreased from 8.6 to 5.8 ppm, a 33 percent reduction (Kutz, Yobs, and Yong, in press). As in so many other parameters of the problem, it is not possible to separate in this welcome development the impact of the DDT ban from that of the pre-existing trend away from DDT usage because of pest resistance to it.

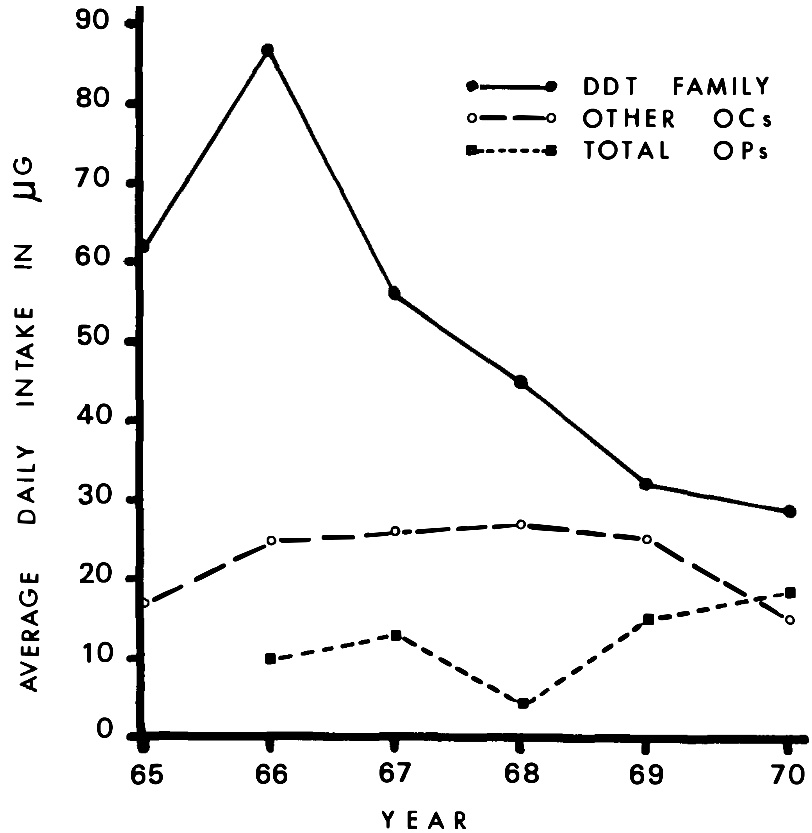

Figure 1. Average daily intake of insecticide residues in food by humans in the United States, 1965–1970. Data calculated from Duggan and Corneliussen (1972).

Occupational Poisoning

With the switch to organophosphate pesticides, occupational poisoning appeared certain to increase, but this has been difficult to ascertain because only California has secured data as a regular procedure. In that state, from 1971 to 1973 use of pesticides increased from 116 million pounds to 183 million pounds (California Department of Health 1975) and organophosphorus insecticides accounted for 68 percent of reports of systemic poisoning due to agricultural pesticides. Actually the trend in occupational disease attributed to pesticides has not changed much over the past twenty years (Table 5), except for an initial 1954–58 increase of about 50 percent. In more recent years (Table 6), there appears to be little change in another set of figures, those reported by physicians in California. All these data from California suggest that the marked reduction in mortality from pesticide poisonings in recent years has not been evidenced in morbidity or exposure rates.

Among the causes of exposure in agriculture most under current scrutiny is the premature reentry of farmworkers into crop fields and orchards treated with OP compounds. In 1970 the State of California, pioneering in this matter, began

Table 4. Change in average insecticide intake by humans via food. Adapted from data in Table 5 of USFDA (1975).

	μg daily intake		
	1965–1970	1973	% change
DDT/DDE	41.17	6.86	− 83
TDE	10.67	.77	− 93
Keltane	6.33	.47	− 93
Dieldrin	5.00	2.81	− 44
Lindane	3.00	.22	− 93
BHC	2.17	.64	− 71
Other OC	4.00	3.82	− 5
Malathion	7.83	11.34	+ 45
Ethion	1.67	.85	− 49
Diazinon	.33	1.07	+ 224
Parathion	.17	.20	+ 18
Carbaryl	31.00	.82	− 97
Organochlorines	72.34	15.59	− 78.4
Organophosphates	10.00	13.46	+ 34.6
Carbamates	31.00	.82	− 97.4
Total	113.34	29.87	− 73.6

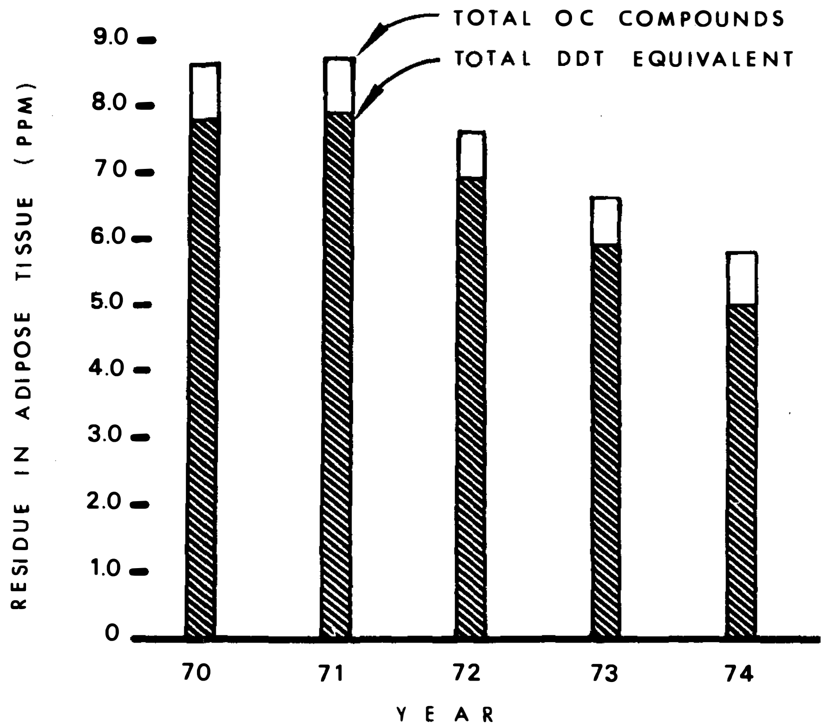

Figure 2. Mean levels of organochlorine pesticide residues in human population of United States. Adapted from Kutz, Yobs, and Yang (in press).

Table 5. Reports of occupational disease attributed to pesticides and other agricultural chemicals in California, 1954–1973. Exclusive of eye conditions and chemical burns. Calculated from figures in California Dept. of Health, 1975, Table 1.

	Annual averages over 5-year periods		
	Agriculture	Other industries	Total
1954–1958	414.2	259.8	674.0
1959–1963	663.8	300.0	963.8
1964–1968	538.8	310.6	849.0
1969–1973	574.8	315.8	890.5

investigations and soon established reentry regulations. Some deem the regulations unsatisfactory (Swartz 1975), but the Environmental Protection Agency had perforce to rely heavily on the California experience in drafting and promulgating nationwide reentry regulations in March, 1974. The dispute goes on, and research is badly needed. This is difficult epidemiological research and recognized as such by all involved in this disputatious meeting ground of agriculture, public health, social work, and the insecticide regulatory agencies. Probably nowhere today does a greater problem exist between insect control and public health.

Subsummary

Deaths from insecticide poisoning have decreased steadily over the past decade, but problems remain as severe as ever with chronic exposure to OP compounds and the resulting morbidity. What has been most pronouncedly ameliorated is the environmental and human impact of OC compound use. Resistance of agricultural and public health insect pests to these insecticides has combined with stringent regulation of their use to assure that the concern they elicited will not much longer exist. This concern has brought about requirements by the regulatory agencies that chemicals before labeling for use against insects must undergo considerable testing for possible mutagenic, carcinogenic and teratogenic properties. The pesticide industry is understandably not happy with the costs and delays this testing burden generates, and much argument over its necessity has resulted. My personal feeling, if I may express it, is that as long as the cancer rate rises, as long as 60 percent or more of it is believed to be of environmental origin, and as long as chemical pollution of the environment remains highly suspect, so long must we, as prudent people, give man and his environment the benefit of the doubt in assessing the cytopathic potential of any new chemical to be released into the already

Table 6. Cases of occupational illness due to pesticide exposure reported by physicians in California.

	California Department of Health 1976	Maddy and Peoples 1976
1971	1,447	
1972	1,505	
1973		1,475
1974		1,157
1975		1,343

overburdened environment. By the same token, any chemical developed as an insecticide where there is any reasonable suspicion of possible long-term health hazard, such as delayed neurotoxicity (Shea 1977), should be either exhaustively examined or discarded out-of-hand.

Insecticides in Public Health Pest Control

The list of vector-borne diseases is a long one, and several still rank as the world's greatest killers and human debilitators. As I stated earlier, we will not discuss here the merit of controlling the insect vectors. It would seem logical, however, to weigh the benefit to human health in banning an insecticide with acknowledged hazard as a poison against the cost to human health of allowing the disease to rage on undiminished. But this also is a difficult assessment because clear-cut black and white cases are rare and most of the discussion would be over gray areas. The fact is that some vector-borne diseases can now be controlled without controlling the vector, and eventually most vector-borne diseases probably will be so controlled. We need only remember that no locally-transmitted malaria has occurred in this country for a quarter century now, and yet the one-time vector mosquitoes are still here in as great abundance as ever. But it is also a fact that most of the world still has common diseases which can be controlled now only with insecticidal combat against the vectors. As a matter of fact, there are arbovirus diseases right here in America that can be subdued only with insecticides, as evidence the epidemic of St. Louis Encephalitis in 1975 over the eastern half of the United States (Monath 1976). A brief review of insecticides and human health could therefore still be useful.

First, I should place insecticide use against public health pests in a context. Compared to agricultural and forest use, public health consumption of insecticides is very small. It obviously varies from country to country, but in the United States in 1971 agriculture consumed 53 percent, or 170 out of the 319 million pounds of insecticide consumed (Andrilenas 1974), while forests, gardens, households, preservation of wood, fabrics and food, and so on consumed most of the balance. In a recent study, the National Academy of Sciences (1976) was unable to develop satisfactory statistics on public health pest control use of insecticides but it appeared to be well under 2 percent of the whole. It is also a well-known fact that the insecticide dosage required in public health pest control is but a fraction of that employed commonly against crop and forest insects. What is common to all forms of insecticide use, however, is the problem of resistance (Figure 3). The World Health Organization tally for 1974 showed 109 insects of public health importance to be resistant to one or more insecticides. This alone, aside from other considerations, has forced medical entomology to emphasize research in non-chemical control of vectors.

Mosquito Control

Insecticides are used in mosquito control in three procedures: (1) residual spraying of home interiors, (2) larviciding, and (3) adulticiding. (1) No health hazard in residual spraying of homes has ever been demonstrated, after over 30 years of world-wide use in millions of human habitations. The insecticide of choice continues to be DDT, its current demand for vector control programs abroad being of the order of 90 million pounds a year (National Academy of Sciences 1976). The

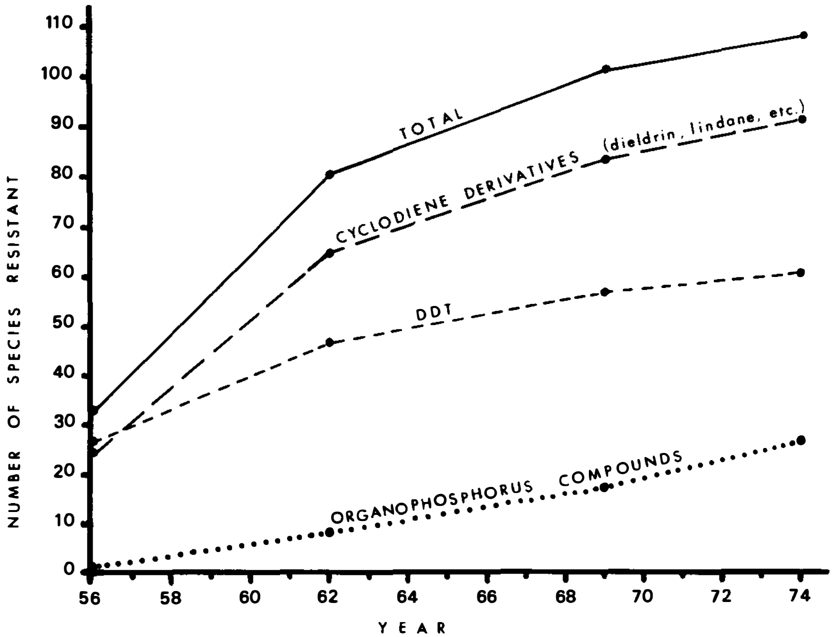

Figure 3. Development of resistance to insecticides by insect species of public health importance. Data from World Health Organization.

ban on the use of DDT in the United States is resulting in a procurement problem for its vital and essential use abroad which bodes ill for the health of mankind in vast areas of the world, particularly Asia and Africa. (2) Larviciding is a control procedure resorted to where habitat manipulation is not feasible for a variety of reasons. Some insecticides used are ecologically unacceptable, but none are human health hazards at the dosages required. As in other forms of insect control, resistance has forced a shift from OC to OP compounds. Among the latter, Abate and Dursban are in increasing use and have excellent safety records. Mosquito control is pioneering in the use, now common in the United States, of the radically new IGR, so-called, compounds. These "insect growth regulators" are not toxic chemicals but hormone analogs which disrupt normal moulting processes and prevent the production of adults. These compounds have no impact on human health. (3) Adulticiding for mosquito control utilizes mostly such OP compounds as malathion and naled which have been shown to have no significant effect on human health at the dosages used (Kutz and Strassman 1976). Here also, mosquito control is in the vanguard of applied entomology in utilizing the new synthetic pyrethroid insecticides, which have mammalian toxicities of the order of table salt and which are very acceptable environmentally. In summary, then, the use of insecticides in mosquito control, as presently practiced, poses no hazard to human health.

Black Fly Control

The vectors of onchocerciasis or river blindness are the black flies which breed in fast waters which are not amenable to environmental control. Early control with DDT, which was ecologically disastrous gave way to methoxychlor and now, almost everywhere, to Abate, a very safe compound from the standpoint of either human or environmental acceptability. It is presently in use by the multi-national onchocerciasis control program over 14,000 kilometers (8,700 miles) of rivers and streams in west Africa (La Berre 1974).

Fleas and lice

DDT's public health significance was dramatically demonstrated toward the end of World War II by breaking epidemics of typhus in Naples and Haifa. Since then human lice have become progressively resistant to DDT, lindane, and malathion. In the United States, human lice are still susceptible to DDT so that presumably an epidemic, if occurring, could still be stopped with DDT. No health problem ever developed from the dusting of human beings and their clothes with DDT. Wild-rodent fleas are also still susceptible to DDT and this insecticide can be invoked in emergencies to combat plague or other diseases vectored by fleas.

Other Vectors

Insecticides are employed abroad in campaigns against diseases vectored by other insects. Dieldrin, for instance, is used widely in combatting the tsetse-fly vector of trypanosomiasis or African sleeping-sickness and the triatomid bug vectors of Chagas' disease in South and Central America. In all such instances of insecticide use, medical entomologists and physicians have given the chemicals a clean bill of health.

Summary

Insect control can affect human health adversely only when it utilizes chemical compounds which are potentially toxic to human beings. Acute poisoning is associated mostly with organophosphate (OP) insecticides, and the incidence of such poisoning is decreasing in the United States, even though these OP compounds are being more heavily used because of insect resistance to the organochlorine (OC) compounds. The latter were responsible more for chronic poisoning, such as the accumulation of residues in the environment, in food, and in man himself. This problem of OC residues has decreased steadily since about 1966, wherever it occurred in this country. Chronic poisoning by OP compounds is still a serious problem, especially as manifested in the exposure of farm workers reentering treated field and orchards. The newly developed groups of insecticides, such as the synthetic pyrethroids and the insect growth regulators pose no hazard whatever to human health. They are coming into increased use and most particularly in the control of insect vectors of disease, where chemical control already had a good record insofar as health-related methodology itself was concerned.

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Forest and Wildlife Management

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Introduction

We can no longer accept the old cliché that whatever the forester does is good for wildlife management. The economic, social, and political climate in the United States requires much wildlife, soils, watershed, and other resource interaction in public land management. This is especially true on the national forests. Recent federal legislation has specifically identified the direction for wildlife management programs. The goal of wildlife management in the Forest Service program under the Resource Planning Act is to achieve improved habitat and species diversity in forest and range ecosystems. The National Forest Management Act of 1976 requires an ecological approach to management and an interdisciplinary approach to planning. The act states that land management planning provides, " . . . for diversity of plant and animal communities based on the suitability and capability of the specific land area in order to meet overall multiple-use objectives . . . " and to " . . . preserve the diversity of tree species similar to that existing in the region . . . . " The need for this resource speciality/forest management approach provided further impetus to develop an "on-the-ground" ecological approach to forest/wildlife management in the national forests of the Forest Service's eastern region.

We have defined diversity as a variety of plant and wildlife communities within a given area. Actually, all components of the ecosystem; the plant, animal, fish, and bird life; along with soils and climate, comprise the factors to be evaluated in a sound land management program.

The 11 million acres (4.4 million ha) of national forest land within the eastern region contain a number of forest ecosystems, from the boreal forests of northern Minnesota with its timber wolves and moose, to the glades of Missouri with its cactus and roadrunners. Each plant community within these ecosystems provides a different set of habitat variables supporting the needs of a distinct group of wildlife. The objective of wildlife management within the eastern region is to provide the variety of habitat components needed to maintain the integrity of each of these ecosystems. The concept of diversity considers species richness in the ecosystem rather than in individual species. Management under this concept recognizes wildlife on a community basis rather than the needs of individual species. This objective is to be met by identifying and enhancing vegetative diversity. To achieve a diverse wildlife population will require a planning approach that ensures a diverse environment.

A wildlife plan or program then becomes the establishment of the desirable mixture of various components that will provide the greatest diversity through time and space on a sustained basis. A management plan geared to provide this diversity would have as its goal not a given number of animals of any one species, but a given acreage of quality environment that would support a variety of species in different densities, dependent upon the inherent capability of the area being managed.

This basic philosophy is not new. Tansley (1920) in his definition of communities identifies vegetative diversity. Leopold was practicing a form of habitat diversity in forest management in the national forests of Missouri in the 1930s. Odum (1971) states that a forest with a high degree of diversity of communities and successional stages provides habitat for the wide variety of wildlife. In 1974, Evans described the concept of diversity for the public forests of Missouri. Thomas et al. (1976) outline a basic approach to forest diversity in the Blue Mountains of Oregon and Washington. A considerable background in evaluating important forest diversity variables can be gained from the investigations by Shugart, Anderson, and Strand (1975), and those of James (1971). Principal component analysis and discriminant function analysis were used to arrive at the habitat variables which appear to have the greatest influence in maintaining a species in a given area. Siderits (1975) provides documentation of the ecological background to management on the Superior National Forest. More recently, Niemi (1976), utilized both previously mentioned mathematical approaches together with breeding bird surveys in northeastern Minnesota to measure the structure components of habitat and correlate these to species distribution. With this system, a probability model may be constructed which predicts species occupants of an area based on the variable selected for the model. As habitats change, due to natural succession or some man-caused alteration, bird composition, and probably other wildlife composition, will change relative to the species tolerance or adaptability to different habitat components.

It is apparent from this comprehensive ecological review, that many habitat dimensions are important in assessing species occupancy of an area. At this point the wildlife biologist may experience difficulty in having sufficient habitat inventory data available to analyze the wildlife situation and provide management recommendations. This review, however, identifies several habitat variables which are found in broad categorizations of habitat and thereby may be used in analyzing wildlife habitat. Although not directly evaluated in our approach, but still important are specific food needs of some species, the temporal nature of size and location dimensions, and inter- and intra-specific relationships which may indirectly or directly influence the occurrence of species.

Although the basic wildlife habitat objective for the national forests of the eastern region is to achieve a diverse environment and a variety of species, there are situations within this approach where management has been directed to meet the needs of specific species. Habitat for endangered and threatened wildlife, for example, may require management to produce a specific plant community. An example is the Kirtland's warbler in Michigan. This songbird requires extensive young jack pine stands located on Grayling Sand soils, and a unique understory vegetation that can be produced only through large clearcut blocks, and prescribed burning (Radtke and Byelich 1963).

Management Application

Habitat management in forested ecosystems requires an ability to manipulate forest vegetation. Timber management practices, if correctly planned and executed, are the only practical, broad scale forest habitat tool that wildlife managers may use to achieve wildlife goals. These practices can be used to produce or insure diversity, or to provide habitat for selected species (Gill, Radtke, and Thomas 1976).

In providing wildlife management direction for the 11 million acres (4.4 million ha) of national forest lands in the eastern region, the primary thrust is not to initially develop detailed habitat plans for the specific areas, rather it is to provide a basic diversity philosophy for habitat management within the framework of a timber management program. The diversity philosophy must be translated into a workable program for the land manager through the development of wildlife habitat guides which will enhance forest diversity while insuring the production of quality forest products. Our approach to achieving habitat diversity through timber/wildlife coordination has been to utilize these guides in land management planning. The object is to maintain and enhance habitat diversity and to insure future options are not lost through present management decisions.

The Management Program on the Superior National Forest

Wildlife on the Superior National Forest in northeastern Minnesota are those species characteristic of the near-boreal to boreal forest. The distinctive wildlife characteristics are: small mammals are abundant; many mammals become browsers in winter; a complete food chain is present, including the large predators; wood warblers are the most abundant species; and 80 percent of the nesting bird population migrates.

The wildlife of the Superior National Forest includes 45 species of mammals, 219 of birds and 12 of reptiles and amphibians. Some representative species include the eastern timber wolf, moose, lynx, fox, beaver, deer mouse, red-backed vole, bald eagle, osprey, black-capped chickadee and white-throated sparrow.

Vegetatively, the 3 million acre (1.2 million ha) forest is composed primarily of trembling aspen (*Populus tremuloides*); balsam fir (*Abies balsamea*); black spruce (*Picea mariana*); jack pine (*Pinus banksiana*); and birch (*Betula papyfifera*). Beaked hazel (*Corylus cornuta*); speckled alder (*Alnus regosa*); willow (*Salix* spp.) and dogwood (*Cornus* spp.) are the common shrubs. Herbaceous plants are abundant (Ohmann and Ream 1971).

The initial step was to identify broad ecological units which, to the best of our knowledge, would delineate major wildlife habitats. Fourteen units were identified utilizing wildlife, vegetation and soil variables. These units are compatible with the forest's major soil units and may be identified as basic, ecological units in forest land management planning.

Although these ecological units are not defined for all forests by eastern region guidelines, various national forests have attempted to set down criteria which would aid in delineating units within the forest. This is almost a necessity for land management planning which is occurring on all 16 national forests in the eastern region. Various terms are used to describe this ecological planning unit, such as landscapes or physiographic unit. Strong climatic, edaphic or watershed factors may be determining influences in the units' delineations.

Habitat information on the Superior National Forest is obtained primarily from a forest inventory called "compartment examination." Compartment is a term for the approximate 1,000-acre (400 ha) management unit. The forest is divided into 1,800 of these predetermined units. Compartments are composed of stands—a plant community identified as a distinct unit by site, soil, vegetation and other environmental factors. Habitat variables for which considerable information is available and which the forester may readily influence include stand age, stand type, and the distribution of each of these. On these two major variables, age and type, the program in diversity was built. The resultant guides are called the "wildlife composition guides." Naturally, the density and height of trees, tree species composition within a given area, tree diameters, and other vegetation factors may have considerable influence on the wildlife. Many of these variables are evaluated by the forester in arriving at the stand delineation. The shortcoming, and something which we are striving to improve upon, is that the information about the understory tree, shrub, and herbaceous vegetation, which may have a great influence on species occupance of an area, is presently not collected or evaluated in this basic composition approach. These will be collected as management intensifies.

After 5–10 days of field inventory in a compartment, the forester sends the data to the regional office in Milwaukee for entry on automatic data processing (ADP) forms. Each stand is listed individually with entries made for approximately 30 items ranging from acreage to site index. With 40 or more stands in a compartment, it is impossible for the forester to categorize in his mind the existing diversity in terms of stand ages and stand types. The wildlife composition guides provide this categorization in the form of two ADP printouts. Actually, the resultant list by age-classes and types is what a forester would or should do to accurately assess the timber management potential.

The first printout related to a basic ecologic approach in forest/wildlife management; i.e., the conifer/hardwood relationship. The subdivisions in this step-down evaluation are shown in column 1 of Table 1. This ADP printout organizes the various aspen, black spruce, jack pine, red pine (*Pinus reginosa*), birch and other stands into five categories based on their silvicultural rotation age. This includes the *short rotation hardwood, medium rotation hardwood, long rotation hardwood, short rotation conifer* and *long rotation conifer* categories. For in-

Table 1. Vegetation type composition of a typical wildlife habitat evaluation.

Vegetation categories	Existing % in comp	Existing % in unit	Desired % in unit	Minimum %	Minimum acres	Maximum %	Maximum acres	Management Decision %	Management Decision acres
Hardwood, short rotation	38	35	40	22	349	40	634	38	600
Hardwood, medium rotation	25	31	20	10	158	25	396	19	300
Hardwood, long rotation	5	5	5	3	48	5	79	5	75
Conifer, short rotation	6	10	15	25	396	10	159	12	200
Conifer, long rotation	26	19	20	40	634	20	317	26	410
Totals	100%	100%	100%		1585		1585	100%	1585

stance, aspen is a short rotation hardwood with a rotation age of 60 years, black spruce is a long rotation conifer with a rotation age of 100 years and jack pine is a short rotation conifer with an 80-year rotation. The acreage and percent of each of these categories, relative to the total compartment acreage, is provided on the ADP printout. Wildlife recommendations on the minimum and maximum percent of each of the five vegetative categories have been established for each of the 14 ecological units prior to the initiation of the program. Depending on the ecological unit, the percent conifer/hardwood composition varies from a maximum 65 percent hardwoods to a minimum 30 percent. These objectives provide the forester with long-term direction needed to insure a sustained supply of wildlife habitat. They also provide a major influence on the long-term integrity, stability and diversity of the forest.

A goal is to work toward these composition objectives within each compartment. However, if care is exercised in spacing the habitat components, and if they represent a logical planning unit, several compartments may be grouped together.

Stand age is the next major variable the forester evaluates. An ADP printout (Table 2) shows the five vegetative categories, the existing acres, and percent of total acres for each stand age-class within each category. The different age-classes represent major habitat components. For example, the 0–9 year age-class represents open, herbaceous and low shrub communites. Several age-classes represent the dense sapling to pole timber communities. The mature community of old growth sawtimber is also represented. Each of these age-classes represents a major division in plant structure and succession. The age-class grouping differs for each vegetative category. They are based on silvicultural rotation and what

Table 2. Age class composition of a typical wildlife habitat evaluation.

Vegetation categories	Age class	Acres	Existing percent	Desired	Optimum management recommend. %	Optimum management recommend. acres	Acceptable management recommend. %	Acceptable management recommend. acres	Final management decision %	Final management decision acres	Final age class composition %	Final age class composition acres
Hardwood, short rotation	0–9	200	33	17	None		50	302	50	302		
	10–39	100	17	50			17	100	17	100		
	40+	300	50	33			33	198	33	198		
	Total	600	100%	100%			100%	600	100%	600		
Hardwood, medium rotation	0–9	0	0	13	25	100	75	300	25	100	0	0
	10–39	0	0	37	0	0	0	0	0	0	0	0
	40–59	0	0	25	0	0	0	0	0	0	0	0
	60–80	400	100	25	75	300	25	100	75	300	100	300
	Total	400	100%	100%	100%	400	100%	400	100%	400	100%	300
Hardwood, long rotation	0–9	0	0	10	No Management Proposed							
	10–59	50	66	50								
	60–79	25	34	20								
	80+	0	0	20								
	Total	75	100%	100%								
Conifer, short rotation	0–9	0	0	13	13	13	43	43	13	13	57	113
	10–49	20	20	50	20	20	20	20	20	20	10	20
	50+	80	80	37	67	67	37	37	67	67	33	67
	Total	100	100%	100%	100%	100	100%	100	100%	100	100%	200
Conifer, long rotation	0–9	0	0	8	8	33	29	120	20	82		
	10–69	100	24	50	24	100	25	100	24	100		
	70–99	120	29	25	29	120	29	120	29	120		
	100	190	47	17	39	157	17	70	27	108		
	Total	410	100%	100%	100%	410	100%	410	100%	410		
Grand total		1585										

biologists in northern Minnesota identified as having an important influence on wildlife. Several authors (Hamilton and Noble 1975, James 1971) have stated that the life form of vegetation, which may be thought of as a pictorial representation of a plant community composed of plant structure, density, height and other factors, may be more important than the specific tree or shrub species in determining how acceptable an area is for a given wildlife community.

An ADP printout for the age-class evaluation provides a *desired* goal. This is viewed as a long-term goal. In vegetative categories with small acreages it may not be attained. The desired percent in each age-class is based on the number of years in relation to the rotation age. It corresponds with a regulated forest management philosophy. Following this are the *optimum* and *acceptable* age-class columns. This is where the forester makes the first entries. The *optimum management recommendation* for age-class distribution within each of the five categories is to:

1. Treat an acreage of the oldest age-class to maintain the 0–9 year age class with a goal of achieving the desired percent.
2. Treat 50 percent of the oldest age-class if there is a majority of the acreage in this class. This is especially true in the intolerant types where these species may be lost due to natural succession.
3. Treat 25 percent of the oldest age-class if there is a majority of the acreage in this class, but the majority of the stand ages are near the beginning of this class.

The *acceptable management recommendation* is to maintain, in the oldest age-class, the percent shown in the oldest age-class in the desired column. It is a management recommendation which identifies the maximum imbalance in age-class distribution acceptable to wildlife management. These alternatives provide a level of complexity required in land management planning and provide a basic input into achieving wildlife habitat diversity. Following the recommendations will result in a maintenance or increase in diversity. Telfer (1974) concludes that in a boreal forest, most wildlife will benefit in a diverse habitat, " . . . where a variety of age and composition classes occur . . . . "

After the computations for the optimum and acceptable recommendations are made, silvicultural and other resource needs of the stands are evaluated by the manager. After this evaluation, the manager enters his proposed age-class percentages in the column entitled *final management decision*. In most cases, these decisions follow the recommendations of the composition guides since the guides were derived from sound wildlife, forest and soil management principles. The next column, *final age-class composition* is utilized if conversion of vegetative type occurs.

In the short rotation hardwood category of Table 2, in this case trembling aspen, the forester chose to follow the acceptable management recommendation, column 7, to reduce the oldest age-class from 50 percent to 33 percent or a harvest of 102 acres (40.8 ha). With 200 acres (80 ha) already in the 0–9 age-class, this harvest will result in 302 acres in the 0–9 age-class (200 ac + 102 ac = 302 ac) (80 ha + 40.8 ha = 120.8 ha)). The optimum recommendation in the hardwood medium rotation category, paper birch, is to harvest 25 percent of the old age-class, as a majority of the stands were just over 60 years old and all the acres were in the old age class. The acceptable recommendation is to leave 25 percent in the oldest age-class. The final decision (column 8) was to implement the optimum recommendation (column 6). Final age-class composition (column 9), was computed as 100 acres (40 ha) were converted from paper birch to a conifer short rotation species—in this case jack pine. No management is recommended for hardwood long rotation category (maple, *Acer* spp.) as no commercially manageable acreage in the oldest age-class is present.

The optimum recommendation was chosen for the final management decision in conifer short rotation category. The final age-class composition includes the 100 acres (40 ha) of paper birch converted to jack pine. In conifer long rotation category (red pine), 20 percent of the oldest age-class was chosen for harvest. This was a compromise between the optimum and acceptable recommendations.

Table 1 shows the hardwood conifer composition. Presently 68 percent of the compartment is in hardwoods (column 2) while 70 percent is the hardwood composition in the large ecological unit. Information for columns 3, 4, 5, and 6 are found in the Superior National Forest's wildlife handbook. These figures provide guides for the wildlife management decision. Column 7 is where the forester indicates the final management decision. In the example, 62 percent of the compartment will be maintained in hardwoods. The 6 percent decrease occurs in the hardwood medium rotation cateory. Overall, however, the hardwood composition remains within recommended goals. In evaluating the management decisions for this compartment, the wildlife biologist can first direct his attention to the final age-class composition (column 9, Table 2) and the final management decision (column 8, Table 1). A review of the decisions on this compartment will show that the medium rotation hardwood category requires further biologist input as age-class composition has not been improved although stand type composition (Table 1) is acceptable.

The analysis of type and age-class composition provides the forester and the wildlife biologist with an evaluation of important habitat components necessary to maintain or improve habitat diversity.

The evaluation for layout and shape of management blocks, snags left in logged areas, road location, and coordination with wildlife openings follows this analysis. These wildlife guides are used in the compartment environmental analysis process involving over 100,000 acres (40,000 ha) of Superior National Forest land each year. These reports form the basis of all management occurring on the national forest. Each year, some form of forest management, such as prescribed fire, logging, planting, or herbicide treatment occurs on approximately 20,000 acres (8,000 ha). The wildlife guides are used to coordinate these resource management actions, so the habitat diversity of these acres is improved. Present wildlife funding at the forest level allows only for 500 acres (200 ha) of direct habitat improvement per year. It is clear that our major opportunities in habitat work are through coordination with other resource programs.

One of the most influential additions to this diversity program was the application of computer processing. Prior to this the forester had to compile the various stands in vegetation categories and age-classes besides adding the acreages and determining the percentages. The ADP printouts reduced the forester's "busy work" by at least 75 percent and directed his limited time and attention to the most important concerns, the evaluation of type and age-class composition. This added to the acceptance of the diversity approach to wildlife habitat management.

Additional age-class and vegetation categories could be added to reduce the biological variability of the existing groups. However, with each refinement the complexity and time required for the forester's wildlife evaluation of the compartment increases. The biological value gained from this complexity may be offset by the greater amount of time required to become trained in this system and the acceptability of the detailed program. An important objective to any manager is that the program must be easily understood and the complexity is justified considering the value and use of the recommendations.

This diversity approach in wildlife management has gone through three years of field and office application and review by many state, federal and university biologists and foresters. Based upon this criteria, we believe the program is beneficial. Recently Superior's diversity program has been revised and is applicable on the eight national forests in the Lake States.

Summary

Habitat diversity for species richness is a basic concept of wildlife management in the eastern region. This does not preclude specific habitat management to meet the requirement of specific species, such as those classified as endangered or threatened.

Habitat conditions vary widely throughout the East so no uniform guides can be developed. Habitat guides can be developed, based on an ecosystem approach, to achieve a forest environment containing a variety of plant communities. A forest with an interspersion of different vegetative species, ages, and habitats can best be achieved through forest management. However, these advantages can be fully realized only if a high degree of management coordination exists between timber and wildlife. Timber management practices, if correctly planned and executed, are the most practical broad-scale forest habitat alteration tools that habitat managers may use to achieve wildlife goals.

This forest diversity approach to wildlife management on the national forests of the eastern region has aided the forester in including habitat considerations in timber management programs and has helped to identify and include nongame wildlife habitat management in forest management programs.

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Featured Species Planning for Wildlife on Southern National Forests

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Under the featured species system, a wildlife species is selected for a unit of land depending upon that land's size and habitat capabilities. Then the Forest Service adapts timber and other resource management options to meet its habitat requirements and mobility. All other species with similar needs prosper.

The southern national forests are managed on this system because the habitat requirements of some species may—or may not—be compatible with others. Any land management decision—even the decision to do nothing—favors some species at the expense of others. The choice of species must be made in order to have long-term management direction based upon habitat requirements to guide coordination and direct habitat improvements.

How do species other than the featured species fare? Many will have similar needs. As an example, where red-cockaded woodpeckers are featured in open, mature longleaf stands, we enhance habitat for other piney woods cavity users—bluebirds, crested fly catchers, nuthatches, tufted titmice, flying squirrels, other woodpeckers that enlarge the cavities in the snags, gray and fox squirrels, screech owls, and others, even wood ducks. Species that do not use such stands are provided for by the diversity of food and cover conditions occurring in dispersed even-aged stands at various stages of development and by having a variety of forest types available.

The factors that enter into species selection are: habitat capability (inherent capacity of the land to provide food and cover—example: quail in pine lands and gray squirrels in large hardwoods); compatibility with other resources (a look at potential conflicts with other resources and uses); public interest and needs (includes endangered and threatened species, socio-economic values, and local wildlife preferences); and public and state wildlife agency involvement (state agencies at all levels of inventories and planning. Public involvement through unit plans and environmental statements). Any changes in the featured species designation must also follow these criteria. The decision is a commitment of resources and land management effort.

Our planning under the Sikes Act (PL93–452, Title II, October 1974) was based on the featured species system. The Act sets the stage to prepare comprehensive wildlife plans for the national forests in consultation with the state wildlife agencies. It also provided for implementing these plans with funding through the Act with $10 million being authorized for four years. Plans developed under this Act must: include habitat improvement, protect endangered species, be consistent with overall land use plans, follow provisions for use stamps if adapted cooperatively, retain authorities present in the Multiple Use Act, and consider management of off-road vehicles (ORV's). The planning requirement and the potential for funds were the key issues.

The southern region's planning procedure follows the U. S. Fish and Wildlife Service comprehensive planning outline for Federal Aid. Their outline was adapted to our inventory and socio-economic data and to our management direction. We included all of their steps in establishing the procedure. Three elements are necessary for comprehensive planning. The first is to analyse public interests and needs and to have a means of being responsive to them. The data sources were the Southeastern Socio-Economic Study by Joe Horvath and the Environmental Research Group, Georgia State University; the assessment from the Resource Planning Act of 1974, the U. S. Fish and Wildlife Service surveys of hunting and fishing, and some individual state studies (either as part of the above socio-economic study or as independent studies). To demonstrate, from this data we learned that big game hunters use our southern national forests far more intensively than small game hunters, and that abundance of game and convenience is more important to most hunters than remoteness, trophies, or overnight facilities. We can now respond to these preferences through featured species selections and providing hunter camps and access accordingly.

The next element was to use our habitat inventories and species surveys to show what was available to work with. Here we had the Continuous Inventory of Stand Conditions (CISC)—an automatic data processing (ADP) program which contains up-to-date descriptions of all timber stands including forest types, age classes, stocking, wildlife species featured, dates of cultural treatments, and key wildlife areas. We also used the fish and wildlife survey described in Forest Service Handbook 2609.21R8 and the surveys of endangered and threatened birds, mammals, fish, reptiles and amphibians. The survey for plants is now under way. These surveys were developed by authorities in their fields under contract and have life histories, habitat requirements, recent occurrence, and point out management possibilities.

The final element requires use of a structured, long-term management direction such as our featured species system. This permits the accomplishment of two important jobs. Once the direction is set, it points out habitat shortcomings that must be overcome to meet the recognized needs of the species. Next it guides the use of other resource management options, such as those associated with timber, to manipulate and control wildlife habitat.

Status of Comprehensive Wildlife Planning

So far, we've completed planning for all of the southern national forests (except for 100,000 acres (80,000 ha) in West Virginia and this is well underway). In each case, the plans were developed in consultation with the appropriate state wildlife agency and has its support. The total cost of planned work on the national forests in the 14 southeastern states is $4.9 million for the first year—but none of this money has been appropriated yet. If and when this money becomes available, there are many jobs planned for the first year, including: 12,200 acres (4,880 ha) of wildlife stand improvement; prescribed burning of 400,000 acres (160,000 ha); maintaining 670 acres (268 ha) of high mountain balds; developing 3,000 acres (1,200 ha) of dove and quail habitat on regeneration areas; surveying and rehabilitating 70 miles (112 km) of streams; inventorying 20,000 acres (8,000 ha) of endangered and threatened species habitat; and constructing and developing numerous items such as green tree reservoirs, water holes, forest openings, hunting and fishing trails, warm water ponds, fish attractors, daylight and sod roads, "sighting-in" ranges, boat accesses and wildlife observation areas.

What Comprehensive Wildlife Planning Does

As was pointed out, comprehensive planning is responsive to public interest. These plans give us logical pathways for decision making based upon goals, strategies, and objectives. Later they become part of our unit plans. They also eliminate much of the drift between promise and practice. They are our basis for funding logically developed and coordinated wildlife programs on the forests under present money limitations.

Conclusion

The featured species system is responsive to public interests and guides a big part of the multiple use job on the land. It gives us a perspective that we can work with both in preparing and applying comprehensive wildlife plans. In short, the featured species system provides a set of habitat requirements to guide management of a unit of land, and when applied under even-aged management, achieves diversity of habitat. The major weakness? Attaining public understanding. We feel we have a system that works—for us—that will enhance the enjoyment of wildlife by our users.

In closing, I want to make a special note of appreciation to the state wildlife agencies of the Southeast for their participation in this planning task on the national forests.

Songbird Management in a Northern Hardwood Forest

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Songbird management may have begun to move from the world of dreams to the world of reality on October 1, 1976. On that date Senator Gary Hart of Colorado introduced U.S. Senate Bill 3887 entitled "Federal Aid in Nongame Fish and Wildlife Conservation Act of 1976." Although Congress adjourned before any action could be taken, Senator Hart has indicated his intention to reintroduce the Bill early in 1977.*

The important thing is that the proposal has been made to provide funds for management of nongame species. Perhaps we stand on the threshold of a new era in wildlife management!

At this time, all professional wildlife managers need to ask what management recommendations we would have been ready to make if S.3887 had become law in the last session of Congress. Each of us could propose several lifetimes of needed nongame research, but I wonder if we would have much idea of actual management measures that could be used. What habitat management measures would benefit nongame species? How secure would we feel with our recommendations?

My purpose in presenting this paper is to stimulate thinking on the question of how to manage populations of forest dwelling songbirds. Wildlife Monograph number 55 (Webb, Behrend, and Saisorn 1977) presented data on how logging appeared to influence songbird populations in a northern hardwood forest type. Relatively little was said about management. I propose to use that data here as the basis for drawing conclusions about management. This will require some speculation and extrapolation. I intend that these conclusions be viewed as a set of working hypotheses to be subjected to testing and alteration as additional data and experience are developed.

The presentation will involve four levels starting with the more specific and proceeding to the most general. First the data on individual species management will be discussed; this will be followed by a brief examination of whether avifauna groups can be identified and used in management; then an examination will be made of the effects of management intensity on the entire songbird fauna; and finally some general principles of songbird management will be suggested.

The data on which this discussion is based are fully developed in Wildlife Monograph number 55, and can not be repeated here. However, it is necessary to point out that the study was conducted in five large stands of the northern hardwood forest type in the Adirondack Mountains of New York State. One of the stands was left undisturbed to serve as a control area. The remaining stands were logged at four levels or intensities which involved removal of 25 percent, 50 percent, 75 percent, and 100 percent of commerical timber. Breeding birds were counted for a 10-year period. The data are used as a population index rather than a census since there was no way to convert observations to actual population numbers. Statistical analysis of responses of species was made for the 26 most fre-

*Gary Hart 1976; personal communication.

quently observed species (of a total of 56 species). These *indicator species* included more than 92 percent of all individuals counted.

Species Management

The most basic management question deals with the effects of habitat changes on the population of each songbird species. For example, we need to know the effect of habitat modification on the population of scarlet tanagers *(Piranga olivacea)*, and of Blackburnian warblers *(Dendroica fusca)*, and of white-throated sparrows *(Zonotrichia albicollis)*, etc. Table 1 summarizes the data dealing with management of individual species. Evidence from several analytical approaches is combined to indicate the conclusions I draw when the logged area data are compared with that from the unlogged control area.

Species Not Affected by Habitat Disturbance

Eleven species fall in the category of showing no significant population changes attributable to logging at any intensity. In the terminology of Aldo Leopold, the limiting factor for these species is not affected by changes in crown canopy and the concommitant changes in subordinate vegetation.

The red-eyed vireo *(Vireo olivaceus)* is a good example of the species in this group. It was the most frequently recorded of any species on any of the five study areas. On all five areas the population index of the red-eyed vireo remained constant throughout the decade. There can be little doubt that this species is not affected in any significant way by even the most extreme habitat disturbance we were able to create. Those persons familiar with the red-eyed vireo will not be surprised by this conclusion, since this is a species which is found in a wide variety of habitats from dense mature forest to open orchard.

These 11 species appear to be the "ecological constants" of the northern hardwood forest type. From a management point-of-view they are unmanageable since they do not respond to any level of habitat manipulation short of complete destruction.

It is much more interesting, from a management point-of-view, to turn to the other two categories given in Table 1. These are the species which are affected positively or negatively by habitat disturbance. In other words, they may be managed by alterations in habitat.

Species Positively Affected by Habitat Disturbance

Populations of eight species were apparently increased significantly by logging (Table 1). The songbirds on this list will not surprise persons familiar with these species. Five of the eight species have breeding habitat descriptions in Peterson's field guide which use such terms as bushy, slashings, thickets, etc. These species are specialists at utilizing a stand of trees with an open crown with a low-growing understory where a major photosynthetic zone is close to the ground.

Four of those species show a progressive response to increasing logging intensity. They are somewhat benefited by light logging, and the amount of benefit is increased as logging intensity increases (Figure 1). The remaining four species of this group are not affected significantly by light logging (25 percent and 50 percent), however, they do find the habitat improved at the two heavier logging intensities (Figure 1).

Table 1. Summary of effect of logging on the 26 most abundant songbird species, northern hardwood forest. Species marked **A** respond about equally to all logging intensities; species marked **B** show the smallest response to light logging and a progressively greater response as logging intensity is increased; species marked **C** do not show a response to light logging, but do show a response to heavy logging intensity. Numbers in parentheses are the rank-order of the species on all five study areas.

Populations not affected by logging		Populations increased by logging		Populations decreased by logging
Red-eyed vireo (1) *Vireo olivaceus*	B	American redstart (6) *Setophaga ruticilla*	A	Blackburnian warbler (10) *Dendroica fusca*
Black-throated blue warbler (3) *Dendroica caerulescens*	B	Chestnut-sided warbler (8) *Dendroica pensylvanica*	A	Wood thrush (22) *Hylocichla mustelina*
Swainson's thrush (4) *Hylocichla ustulata*	B	Veery (24) *Hylocichla fuscescens*	B	Ovenbird (2) *Seiurus aurocapillus*
Scarlet tanager (7) *Piranga olivacea*	B	Broad-winged hawk (25) *Buteo platypterus*	B	Least flycatcher (16) *Empidonax minimus*
Chimney swift (9) *Chaetura pelagica*	C	Rose-breasted grosbeak (14) *Pheucticus ludovicianus*	C	Black-throated green warbler (5) *Dendroica virens*
Eastern wood peewee (12) *Contopus virens*	C	White-throated sparrow (17) *Zonotrichia albicollis*	C	Winter wren (11) *Troglodytes troglodytes*
Dark-eyed junco (13) *Junco hyemalis*	C	Canada warbler (18) *Wilsonia canadensis*	C	Yellow-bellied sapsucker (20) *Sphyrapicus varius*
Blue jay (15) *Cyanocitta cristata*	C	Black and white warbler (23) *Mniotilta varia*		
Hermit thrush (19) *Hylocichla guttata*				
Black-capped chickadee (21) *Parus atricapillus*				
White-breasted nuthatch (21) *Sitta carolinensis*				

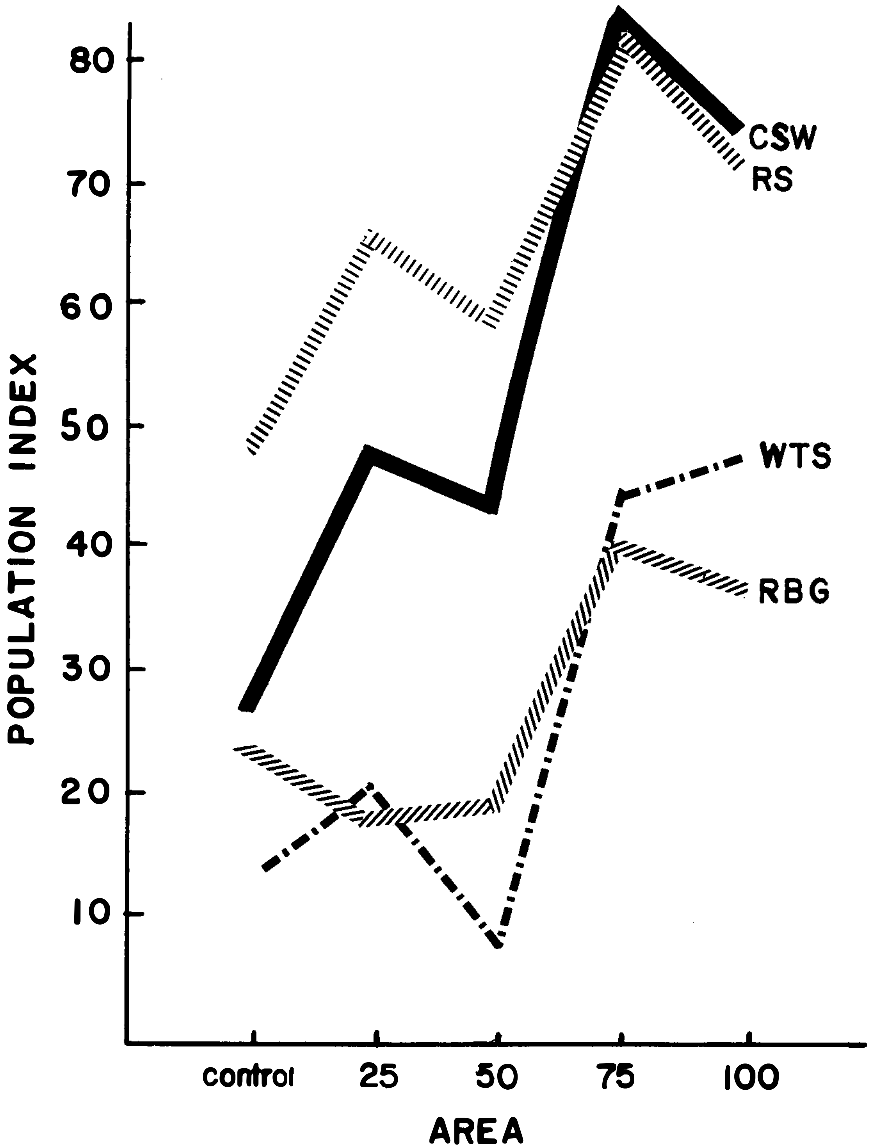

Figure 1. Populations of some species which respond positively to logging. Chestnut-sided warbler (CSW) and American redstart (RS) are examples of species which show a small response to light logging and increasing response as logging intensity increases; the rose-breasted grosbeak (RBG) and white-throated sparrow (WTS) do not appear to be significantly affected by light logging, but populations increase following heavy logging.

The duration of these responses is important in management. When the trends of populations over the decade of the study are examined it becomes quite clear that all populations tend to return to near the pre-logging levels within ten years. This is especially true for the lighter logging intensities, but by the end of the decade even the most heavily logged areas showed a substantial return of populations to pre-logging levels (Figure 2). From a management point-of-view this

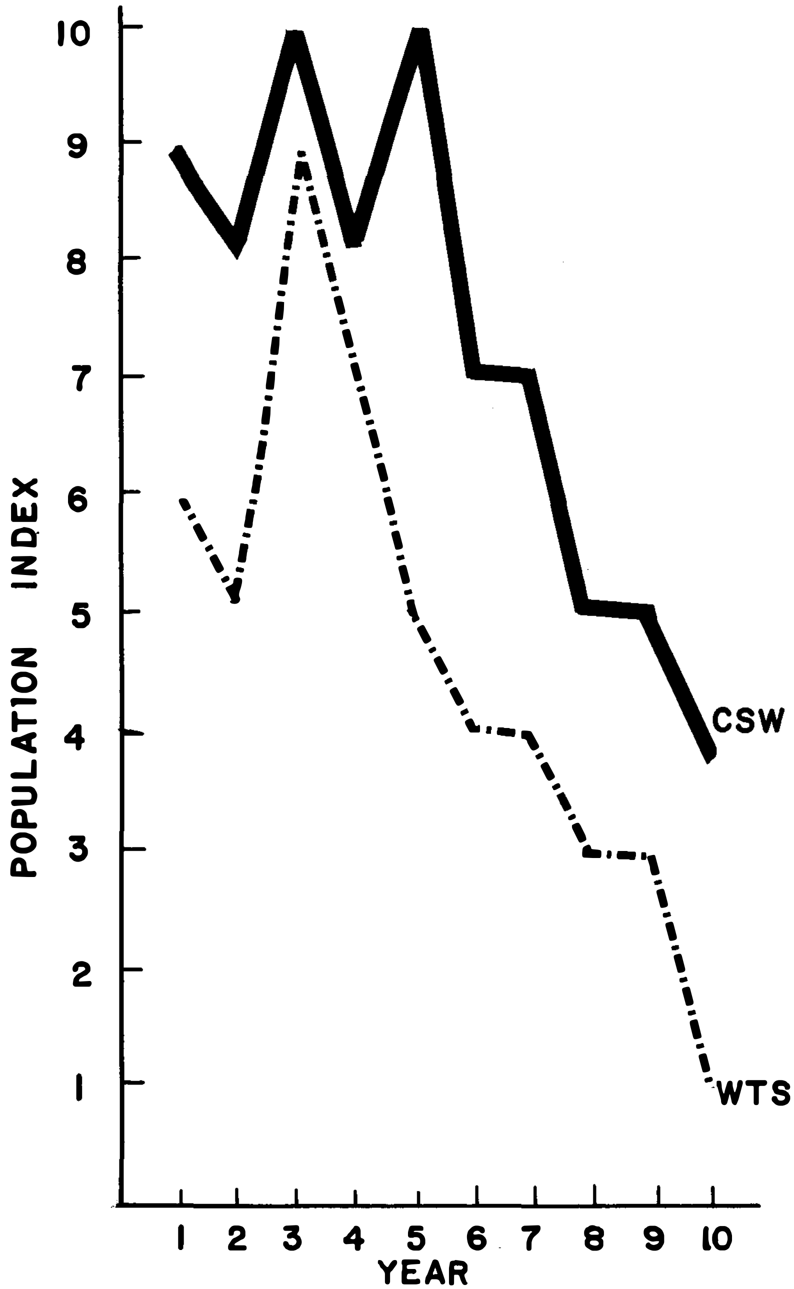

Figure 2. Trends in populations of chestnut-sided warbler (CSW) and white-throated sparrow (WTS) in the decade following logging on the commercial clearcut (100 percent) area.

means that if these species are to be favored, the cultural operations must be repeated at relatively frequent intervals.

Species Negatively Affected by Habitat Disturbance

The remaining seven species are those which appear to show smaller populations on the logged areas than on the unlogged control area (Table 1 and Figure 3). Most interesting among these are the two which are equally negatively affected by all intensities of logging. These must be considered species which are best adapted to stands with a completely closed canopy. It is especially interesting to note that they utilize quite different portions of the forest stand. The Blackburnian warbler utilizes the tops of dominant trees while the wood thrush *(Hylocichla mustelina)* is a denizen of the forest floor and low vegetation.

The two species which show a progressively negative response to increasing logging intensity are those which are limited by some environmental resources which are progressively changed with increasing removal of crown. The final group of three species do not respond to light logging but do find the most heavily logged stands less suitable.

Trends in population in the period following logging indicate that populations of these species are rather prompt in their return to levels characteristic of the unlogged forest (Figure 4). This has important management implications because the populations which are negatively affected are depressed for a relatively short period in a long rotation.

Species Management Conclusions

From these results we can draw some definite management conclusions on a species-by-species basis. For example, if we wished to increase the population of rose-breasted grosbeaks *(Pheucticus ludovicianus)* in a closed-canopy northern hardwood forest stand we would open up the crown by removal of 75 to 100 percent of the basal area. As a consequence of this operation we would have to recognize that the population of ovenbirds *(Seiurus aurocapillus)* would be reduced to virtually zero. Also we would recognize that both these effects would persist for a limited number of years out of a long rotation.

Certainly one of the more significant findings at the species management level is the length of time songbird populations are influenced by extreme habitat disturbance. Apparently even the most sensitive of these species return to very nearly the population levels of the undisturbed forest in the period of a decade. This means that even drastic harvest cuttings result in relatively short periods when populations deviate significantly from levels characteristic of the undisturbed stand.

Avifauna Management

When rare or endangered songbird species are present, single-species management may be possible. Otherwise it seems likely that management objectives will be for groups of species which respond in similar fashion to habitat alteration.

Other than the groupings which have been discussed in the previous section (Table 1), I can find no indication of natural associations of species which respond alike. There is no indication that taxonomic groupings into orders, families, or even genera can be used to identify groups. Therefore it is not possible to state

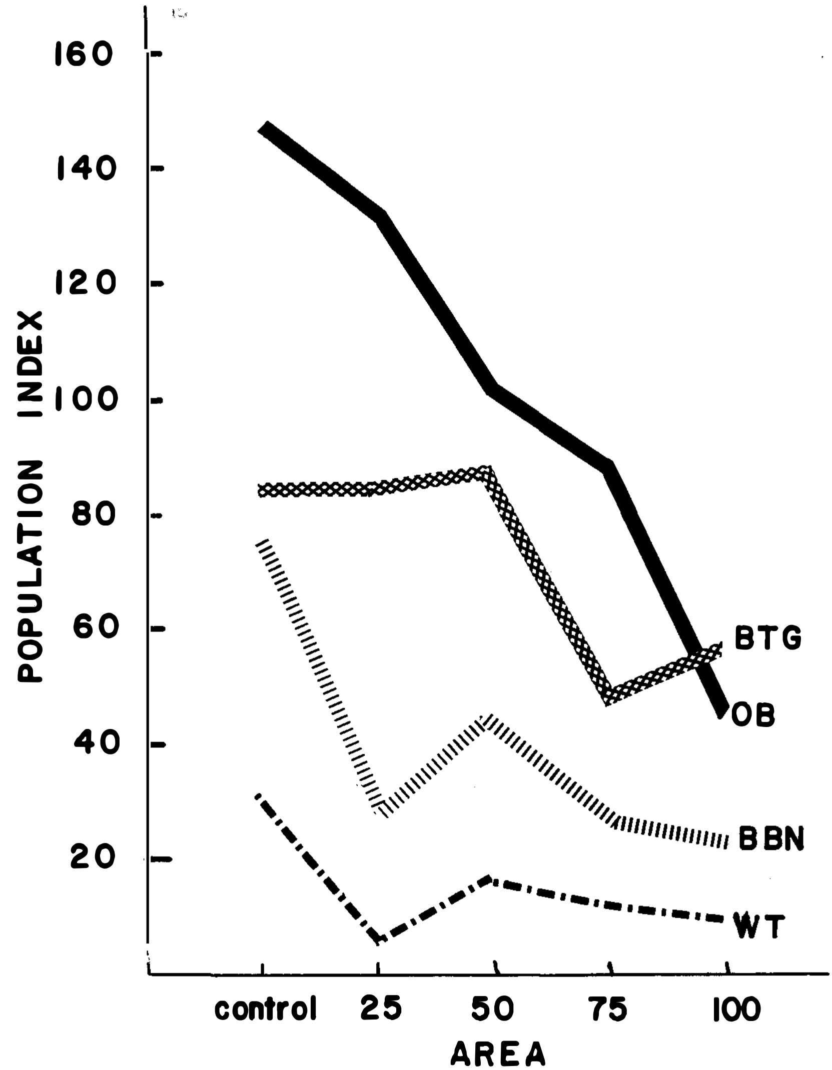

Figure 3. Populations of some species which respond negatively to logging. Blackburnian warbler (BBN) and wood thrush (WT) show approximately equal response to all levels of logging; ovenbirds (OB) show a small response to light logging and increasing response as logging intensity increases; and black-throated green warblers (BTG) appear unaffected by light logging but are significantly affected by heavy logging.

management objectives in even such general terms as "warblers" or "thrushes" since at least one species of both these groups is included in each of the response groups.

Under many circumstances the neutral, positive, and negative response groups may be useful management units. The neutral or red-eyed vireo group is essentially unmanageable and within broad limits may be ignored. The other two groups might be called the Blackburnian warbler group and the redstart (*Septophaga*

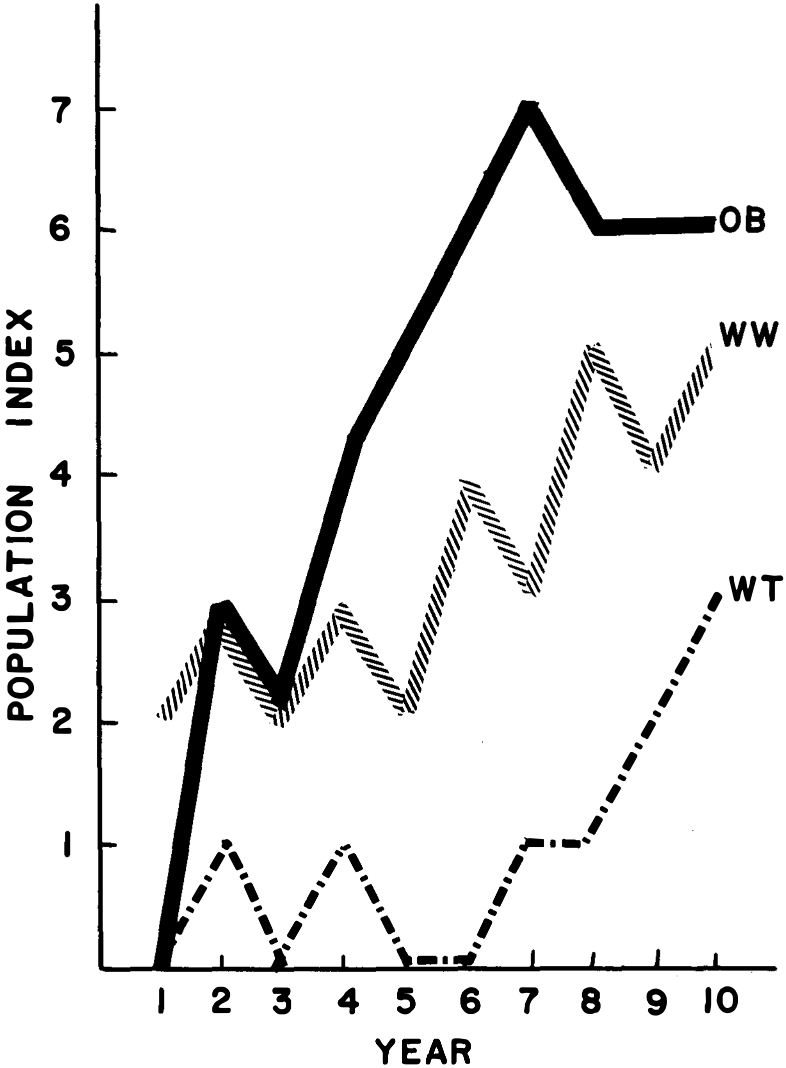

Figure 4. Trends in populations of ovenbird (OB), winter wren (WW), and wood thrush (WT) in the decade following logging on the commercial clearcut (100 percent) area.

ruticilla) group after their two most abundant species. However, it is clear that each of these groups has sub-groups which respond differently to logging intensity. The manager would have to recognize that Blackburnian warblers would decline in population following logging of whatever intensity while the Black-throated green warbler (*Dendroica virens*) population would be affected only by heavy logging.

Perhaps in most situations it is unrealistic to use a single species or a group as a management objective. In some cases it may be more realistic to seek increased songbird diversity as the management objective. Since the number of species on all the logged areas was greater than on the uncut control area (Table 2) it is clear that a dense crown of mature trees does not create maximum diversity. Instead maximum diversity would probably be produced in an area where some form of patch cutting was practiced. The optimum size for such patches is not revealed by this study since all treated areas were over 500 acres.

Management Intensity: Selection Cut vs Clearcut

The broadest, and perhaps most important, management type question is how intensity of management of the forest stand affects songbird populations. Data dealing with this question are summarized in Table 2. Overall productivity, measured by the total number of individuals counted in a decade, is not significantly different on any of the five areas since each contributed very nearly its one-fifth of the total observations. However, it is clear that there is a difference in diversity as the unlogged area had a smaller number of species than any of the logged areas. The Shannon Diversity Index figures indicate that the two lightly logged areas do not differ significantly from the unlogged control, but that the two heavily logged areas do have a significantly greater diversity. Six species occurred on all four of the logged areas but were never recorded on the unlogged control area in the entire decade. No species showed the reverse pattern of being present on the control and absent on the logged areas.

Contrast between the 100 percent logged area and the 25 percent logged area provides insight into differences between an all-age selection system of forest management, and an even-age management system involving very heavy harvest cutting. The 25 percent area was actually a light to moderate selection cut since the trees were marked to remove over-mature individuals, with a conscious attempt in the marking to distribute the cut over the entire area in a reasonably even pattern. By contrast, the most heavily cut area was as close to a clearcut as could be accomplished with a commercial logging contract in the region at that time. Actually a considerable number of small diameter and cull trees were left standing, but crown opening was drastic and allowed regeneration of all tree species.

Number of songbird species was slightly greater and number of individuals slightly less on the clearcut area (Table 2), however, it is clear that the differences are not statistically significant and certainly are not great enough to be important in management.

I have studied these data at considerable length and believe there are three general conclusions regarding songbirds and management intensity which are reasonable working hypotheses in a northern hardwood forest: (1) total songbird abundance is rather constant regardless of intensity of habitat manipulation; (2) opening of a dense forest crown does increase number of species somewhat, and the increase is fairly uniform over a broad range of management intensities; and (3) no intensity of habitat disturbance can be selected as being "better" or "worse" for songbird management.

Songbird Management Principles

My data base for drawing broad general conclusions is obviously limited. However, I do feel a duty to suggest some principles which seem valid to me at this

Table 2. Summary of songbird productivity and diversity data from five study areas for a 10-year period.

	Area				
	Control	25%	50%	75%	100%
Number of individuals counted	1237	1204	1129	1287	1149
Percentage of total individuals counted	20.6	20.0	18.8	21.4	19.1
Number of species	37	43	45	46	45
Average number of species per year	25.3	25.6	25.9	28.1	28.3
Probability that Shannon Index on unlogged and logged area could have been equal, percent	–	over 50	30–40	2–5	below 1

time. They are intended as a set of hypotheses to be reviewed and tested by research and management operations in a variety of vegetation types.

Diversity

These days, diversity is often discussed as a management objective. Just how far the concern for diversity has penetrated into actual land-management operations is not clear to me. I get the feeling we are still at the stage where we speak and hear a good deal, but do little. However, diversity may be a valid management objective even though at present it is more of a cliche than a practice.

Diversity is a concept which must be defined if it is to be of real value in land management. In this respect it is like the concept of multiple-use. We all are familiar with the difficulty of translating that valuable concept into realistic management operations. Defining diversity will not be simple. We need to ask if we are always in favor of maximum number of species. Certainly not if it means reduction of vigor of a rare or endangered species. Certainly not if it involves destruction or disruption of a community which is uncommon or especially beautiful.

Data for the northern hardwood forest do not indicate that diversity is helpful as a management objective. There is only a small difference in number of species between areas heavily disturbed and those undisturbed. Therefore, maximum diversity is hardly a valid management objective, and even maintenance of diversity does not help to select a management strategy.

Featured Species

The featured species concept which has been described in this session by Gould (1977) appears to be the most useful approach to identify songbird management objectives. If an endangered songbird species occurs on an area, it should certainly be the featured songbird, and in most instances should be the only objective of management. Also there are many areas where rare songbird species should be the featured species. For example, areas that have populations of such uncommon species as the gray- or Canada jay (*Perisoreus canadensis*) or the black-backed three-toed woodpecker (*Picoides arcticus*) should be managed so as to maintain or increase their populations so they will not be moved from the rare to the endangered category.

In the northern hardwood forest type of the Adirondacks the Blackburnian warbler and wood thrush should be given careful consideration as featured species on a portion of the area because of their apparent requirement for closed-canopy habitat. Other featured species should be selected from both groups which are increased and decreased by logging. It will require real management skill to plan a long-term series of management operations which will include consideration for these songbird species.

Management Strategy

I have always had a hunch that frequent operations, on small areas, repeated at frequent intervals was a good wildlife management strategy. For songbird management in a northern hardwood forest, I can see little justification for that general prescription. Perhaps the only valid conclusion that can be drawn is that such general prescriptions should be thrown out of our professional formulary. No reasonable physician would ever say "always prescribe aspirin." Why should any reasonable professional wildlife manager say "always cut lightly and frequently in small patches."

Species Sensitivity

The majority of songbird species are probably like those studied in the northern hardwood forest in their sensitivity to habitat alteration. Even very heavy disturbance does not seem to significantly alter the long-term survival of the species in their preferred habitat. However, we know there are species which are so highly adapted to a narrow range of specific environmental conditions that they do not survive if their habitat is modified in what may seem inconsequential ways. The red-cockaded woodpecker (*Dendrocopos borealis*) springs to mind as a prime example of such a species. Obviously land management operations must be designed with accurate knowledge about the sensitivity of each species, and management activities may need to be modified to avoid drastic consequences.

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Forest Manipulation for Ruffed Grouse

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Ruffed grouse (*Bonasa umbellus*) constitute a prominent wildlife resource across a large part of North America. They are the most widely distributed resident game bird on the continent, occurring naturally from northern Georgia, and Alabama to Labrador in the east, and from northwestern California to interior Alaska in the west. Between they occur in the Ohio River basin, as far south as Missouri in the Midwest, and south to Wyoming, Utah and possibly Colorado in the Rocky Mountains, and north nearly to Hudson's Bay in Ontario, and the tree line across Canada's Northwest and Yukon Territories (Aldrich 1963). They are currently residents of 38 states and 13 Canadian provinces. By transplanting wild stock these grouse have become established as a huntable wildlife resource in Newfoundland and Nevada within the past two decades (Inder 1967; Hoskins 1968).

According to a recent survey (Gullion, unpublished data) ruffed grouse are considered an important small game resource in 20 states and provinces (being rated as "most important" in 9); less important in 14 jurisdictions; an incidental resource in 13; and resident but not hunted in only 4 states. Table 1 summarizes their importance as a North American game resource for the 1970–74 period.

These grouse are closely associated with disturbed forest habitats; in fact I believe they can be considered a "fire-dependent" species in the pristine environment. But they prosper as well where forests are periodically disturbed by logging activities, and their response to the re-establishment of forest cover on abandoned farm land was well documented by Bump (1950) nearly three decades ago.

Based on our ongoing research in Minnesota and elsewhere, we believe that these grouse can be maintained as an abundant forest wildlife resource under some types of intensive forest management. Lack of the proper degree of forest disturbance poses the most serious threat to the continued abundance of these grouse over some 72.91 million acres (29.5 million ha) of forest land in the northeastern United States.

At a time when increasing pressure for greater food production threatens the welfare of farm game species (e.g. Labisky 1976), expanded timber harvesting may provide the improved habitat needed to bring these grouse back to the abundance that was common in many regions early in this century.

But across the major portion of the range of this species this recovery is unlikely unless emphasis is placed on re-establishing a diversity of age classes among the early successional forest types.

Two decades of research on the Cloquet project in northern Minnesota has convinced me that the aspens (*Populus tremuloides; P. grandidentata*) provide the basic habitat resources for this species (Gullion and Svoboda 1972). In the belt where snow covers the ground from late November to early April it appears that

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Table 1. The status of ruffed grouse as a North American game resource.[a]

	1970	1971	1972	1973	1974
No. of states & provinces having hunting seasons	45	46	46	46	46
No. of jurisdictions w/ seasons[b]					
less than 30 days	5	6	3	2	2
30–60 days	7	6	12	10	9
61–90 days	14	15	11	15	14
91–120 days	10	10	11	9	11
over 120 days	9	9	10	11	11
Daily bag limit[b]					
2 birds	6	6	6	7	6
3 birds	16	17	17	17	18
4 birds	8	7	7	8	7
5 birds	7	8	8	8	8
6 + birds	6	6	6	4	5
no limit[c]	2	2	2	2	2
Estimated number of hunters taking ruffed grouse[d]	1,810,400	1,789,000	1,736,300	1,668,900	1,556,500
Estimated annual harvest[e]	5,838,000	6,448,000	5,837,000	4,999,000	5,042,000

[a]Based on data from all of the Canadian provinces and 35 of the 38 states having resident ruffed grouse populations.
[b]For jurisdictions having various seasons or bag limits in various management areas the longest season or the largest bag limit is given.
[c]Canada's Northwest Territories had a season lasting from September 1 to April 30, and Labrador's season runs from October 1 to April 30. Northwest Territory has no daily or seasonal limit on the harvest, while Labrador has no daily limit but has a 25 bird season limit.
[d]In some cases these include all "forest grouse" hunters, and there are no data available from 9 states or provinces, which could represent an additional 500,000 hunters.
[e]These are totals of harvest data from 33 states and provinces, but do not include Alaska, Alberta, Iowa, Massachusetts, New York, North and South Carolina, Ohio, North and South Dakota, Quebec or West Virginia. Based on partial data from these units the total North American harvest each year is probably 0.5 to 1.0 million birds higher than these totals.

these grouse have a nearly obligatory relationship with aspen. This belt includes the area where these grouse are usually most abundant (90.3 percent of the reported continental harvest from 1970 to 1974 was taken here), and also encompasses most of the 425 million acres (172 million ha) where the aspens are a prominent part of the forest composition (Gullion in press).

Various earlier studies indicated the importance of aspen to these grouse even if they did not identify the nearly obligatory relationship. Kelso (1935), Brown (1946), Bump et al. (1947), Stollberg and Hine (1952), and Phillips (1967) all showed aspen to be an important food resource. Fisher (1939), Bailey et al. (1955), Boag and Sumanik (1969), and Rusch and Keith (1971) pointed to the close relationship between the occurrence of aspen in the forest canopy and ruffed grouse presence on the forest floor. In earlier project progress reports I have discussed these relationships in considerable detail (Gullion 1969, 1970b).

In Minnesota we have identified the staminate flower buds and catkins of mature aspen as being a critical winter and spring food resource during many years (Svoboda and Gullion 1972). Ruffed grouse on our Minnesota study areas are sufficiently specialized in their dependence upon the aspen flower buds that a scarcity of these buds across northern Minnesota in the 1971–72 and 1972–73 seasons was associated with a 68 percent decline in grouse numbers regionally (Berg 1975), and a 41 percent drop from 1971 to 1974 on our Cloquet study area. Even though the aments of hazel and birch, and flower buds of willows and various other plants were available in seeming abundance these foods did not suffice to sustain the grouse population. Even during this period of decline ruffed grouse across our Minnesota study areas continued to depend upon the elongated aspen catkins as their nearly exclusive diet during the month preceding the nesting season.

It appears that some plant defense mechanism operated to discourage grouse use of aspen flower buds in the 1973–74 to 1975–76 seasons when these buds were again abundant (cf. Haukioja and Hakala 1975), but by the 1976–77 season this effect has ceased to operate and ruffed grouse are again making heavy late fall and early winter use of these buds.

The quality of cover provided by the aspens is nearly as important to these grouse as the food resource. Where vigorous stands of mature aspen (usually 40 to 60 years old in the Lake States) have been killed by fire, leveled by windstorm, or clear-cut by logging, first-year sucker regeneration can reach 5 to 6 feet (1.5 to 2 m) in height by the end of August, at stem densities which commonly exceed 12,000 per acre (29,000/ha). Within 4 years this cover should be 15 to 20 feet (5 to 7 m) tall. Vertical cover this dense is virtually impenetrable to raptors thus providing the grouse security from avian predation. Furthermore the density of the canopy precludes much sunlight reaching the forest floor, discouraging the development of herbaceous cover (considered horizontal cover) which favors terrestrial predators to the disadvantage of grouse broods (this concept of cover was described at an earlier conference–Gullion 1970a:101).

Aspen suckers are usually evenly spaced, avoiding a clumped, horizontal cover aspect from which terrestrial predators may ambush grouse on the ground. Favorable stem spacing allows grouse to maintain effective surveillance of the terrain through which they are moving. This is the character of top quality brood cover.

Mortality among the less vigorous stems of the intolerant aspens becomes significant by the third growing season and stand thinning commences. A second period of accelerated sapling mortality occurs at about 10 years and then the stand usually becomes too open for brood use in summer. At 5 to 8 thousand stems per acre (14,000–20,000 stems/ha), with a canopy closed about 30 feet (10 m) overhead, optimum cover has developed for wintering and breeding ruffed grouse. Where this quality of cover is within 300 feet (100 m) of mature male aspens we can expect breeding ruffed grouse densities to reach an adult bird per 3 acres (1.2 ha) during peak populations, and decline no lower than an adult grouse per 6 acres (2.4 ha) in May during "cyclic" lows.

As the aspens continue to compete for light the less vigorous trees succumb to shading and at about 25 to 30 years of age stand densities drop below about 2,000 stems per acre (4,900 stems/ha), creating an open, park-like forest stand, where grouse become readily accessible to winged predators. Then we say the ruffed grouse habitat has "gone-by" and stands which formerly supported high density wintering and breeding populations abruptly become vacant (Gullion 1970b:111–117). At this age the aspens begin providing the quality of flower buds these grouse prefer as a winter-long food resource. If adequate cover persists nearby (within 300 feet; 100 m) this aged aspen remains an essential part of the grouse habitat. These older stands appear to be the preferred nesting habitat of hens for about 5 weeks each spring. Nesting hens make heavy use of the emerging leaves of the male aspens (Schladweiler 1968), but quickly move their broods to very dense cover after the eggs have hatched. This movement by broods may exceed 19,000 feet (5.8 km) in the first 10 days after hatching (Schladweiler 1965; Barrett 1970).

In some forest situations shade tolerant hardwood or brush species may provide adequate vertical cover under the aspen canopy and prolong the period of winter and breeding season occupancy, but usually at lower densities (a breeding adult per 9 acres (3.6 ha) at Cloquet in periods of peak populations, but declining to about a breeding adult per 18 acres (8 ha) in low populations).

These grouse have evidently evolved to fill this rather special ecological situation which has probably been prevalent in northern North American forests for at least 8 to 10 thousand years. At some time during their 40 to 60 year life cycle the aspen provide the highest quality habitat resources required by these grouse at sometime during their annual life cycle. No other forest plant does this.

Ruffed grouse occur in regions where aspen is not an important part of the forest composition. But these populations are generally peripheral to the primary range of this species at the present time, and seldom reach the abundance common where aspen is prominent in the forests.

The data for Table 1 show that 17.3 million (62.7 percent) of the 27.7 million grouse reported harvested from 1970 to 1974 were taken in four of the 52 reporting political units where this species is resident, namely Michigan, Minnesota, Ontario and Wisconsin. By adding Maine and British Columbia, 73.5 percent of the reported kill is accounted for. These are all areas where aspen is an important component of the forest composition. It is probably not coincidence that 61 percent of the reported ruffed grouse harvest in the United States from 1970 to 1974 was taken in the three Great Lakes states having 74 percent of the nation's aspen resources.

It appears that the manipulation of forest habitats to benefit these birds is most likely to be productive in situations where aspen is a part of the forest canopy.

Habitat Manipulation Procedures

The best response by ruffed grouse to habitat manipulation occurs where the results approach what appear to have been the pristine environments of these birds. Highest density breeding populations of ruffed grouse can be expected where periodic severe disturbance of the forests provides a proper diversity of age classes within their restricted foraging range. This means providing young, dense sucker or sapling stands less than 10 years old for broods, and 10 to 25 year old pole stands for wintering and breeding cover, near to 25 to 40 year old, flower-producing mature aspen for winterlong food resources, all within the 6 to 10 acre (2.4 to 4 ha) activity center in which these birds prefer to confine their activities.

In regions where there is a market for aspen, extensive habitat manipulation can be accomplished through commercial timber harvest (Dolgaard, Gullion, and Haas 1976).

Our research to date indicates that individual cutting blocks should not exceed 10 acres (4 ha) in size and should be sufficiently dispersed so that at least one-quarter of each 40 acre (16 ha) block provides one of the three habitat requirements noted above. Figure 1 shows the application of this scheme on a portion of the Mille Lacs Wildlife Area, some 70 miles (112 km) southwest of Cloquet, the response already recorded, and the response we expect in the next decade.

The periodicity of cutting may vary between regions. Where aspen reaches commercial maturity at 40 years, the interval between adjacent clearings should be 10 years, but if commercial maturity is reached at 60 years the interval could be 15 years.

Cutting should be silviculturally proper to assure high density aspen regeneration (Graham, Harrison, and Westell 1963; Brinkman and Roe 1975). No more than 5 to 10 percent canopy should remain, and understory brush and regeneration cut or broken down during the logging operation. On our Minnesota study areas (Crow Wing and Mille Lacs) we have specified that all stems over 2 inches (5 cm) be cut, and that skidding be done in such a manner that smaller brush and regeneration be crushed or uprooted (Dolgaard, Gullion, and Haas 1976). We are particularly concerned that no softwood regeneration survives.

The best sucker response usually results from dormant season cutting of aspen, but cutting during the summer can still produce adequate density sucker growth if the original stand is vigorous and aspen are well dispersed across the area. Least desirable is a logging operation in May or June, when nutrient storage in tree roots is at a minimum as leaf development and vegetative growth commences.

We regard conifer cover (particularly pine) as being detrimental to ruffed grouse. For the first 10 years of this project we believed that conifers were beneficial as cover, in agreement with most other grouse research findings across the nation. On the Cloquet Forest a considerable area of aspen logged in the late 1950s developed into the quality of habitat I have just described in the late 1960s. Then as grouse ceased to use conifer dominated sites occupied during the preceding decade and concentrated in this new growth we began to recognize the importance of aspen as cover. By then we had documented the shorter longevity among ruffed grouse living in association with conifers (Gullion and Marshall 1968).

In 1970, 30 percent of the breeding grouse on the 3,365 acre (1,361 ha) Cloquet Forest refuge were living on 243 acres (98.3 ha) of 13 to 25 year old aspen, or 7 percent of the forest available to them. Breeding grouse population densities "in certain age classes of aspen were six to seven times greater than in adjacent softwood stands on the same soils, same topography and exposed to the same environmental conditions" (Gullion 1970b:122).

Usually logging debris should be eliminated as much as possible, both to reduce the amount of sucker-inhibiting shade cast on the ground and to reduce the amount of predator-favoring, horizontal cover. If total tree chipping is feasible, most of the tops and limbs will be utilized. In other situations whole trees should be skidded to a central landing where tops and limbs are removed, piled and burned; or slash should be left on the site and the clearing burned no later than the second spring following logging.

Although I have yet to witness it in Minnesota, Maine, Massachusetts, New York or Vermont, there may be situations where it would be desirable to leave a heavy burden of slash to discourage excessive browsing upon the aspen regeneration by deer or other ungulates. Usually if the aspen being cut had sufficient vigor and the other hardwoods cut out-numbered the aspen several fold, deer preferred the sprouts of the other hardwoods over aspen and use was concentrated on those species. I have seen a very few, small areas where slash effectively screened aspen regeneration from browsing without inhibiting the growth of suckers by casting too heavy shade.

The need for alternative sources of browse for ungulates makes it unwise to use herbicides on other species to release the aspen. If the aspen is vigorous it does not need release from competition when it grows in full sunlight. Few other trees or herbaceous species grow more rapidly than aspen suckers. Under favorable conditions their growth can exceed 1 inch (2.5 cm) per day for most of the growing season.

Where there is no commercial demand for aspen, or where commercial logging is undesirable or not feasible, the same basic scheme should be applied, i.e. provide the needed diversity of habitat resources within each 10 acre (4 ha) grouse activity center. This can be accomplished through several approaches.

One alternative is shown in Figure 1, where a 40 acre (16 ha) "small landowner management unit" is cut in a series of small blocks, not less than 1 acre (0.4 ha) in size, each year for 40 years. Experience shows that ruffed grouse prefer a block of dense cover at least 1 acre (0.4 ha) in size.

Another alternative would be to cut a single 2.5 acre (1 ha) block in each 10 acre (4 ha) activity center every 10 to 12 years, with the area cut-over in a 40 to 50 year period (Gullion 1972; 1974).

These clearings should be as complete as the commercial clear-cuts described earlier, and slashing should be disposed of to encourage sucker growth and reduce predator cover.

As fossil fuel for heating becomes more expensive these smaller cuttings become increasingly attractive as fuel-wood sales.

We have felled aspen and girdled the other species as one means of reducing the amount of debris on the ground. While the latter goal was realized, the aspen did not respond adequately and the resulting cover has been too open.

On wildlife management areas, or larger private holdings, mechanical treatment can be effective. The most satisfactory results usually are achieved by shearing, using a bulldozer on frozen ground. Just pushing trees over often results in poor aspen sucker and grouse response. This is demonstrated by the poor grouse response to bulldozing some 98 acres (40 ha) on the Mille Lacs project, as shown in Figure 1. The scope and frequency of mechanical treatment should be the same as when timber is being commercially harvested.

While aspen can be successfully regenerated through the use of herbicides (Brinkman and Roe 1975), the need for alternate browse for ungulates makes this a questionable procedure.

Prescribed burning can be used to regenerate aspen stands. But this is best used in younger forests, and too often the conditions under which burning is permitted are marginal for obtaining a kill of larger trees. Our efforts to use fire in the 50 year old hardwood forests on the Mille Lacs area in Minnesota did not result in habitat improvement (Sando 1972).

Habitat Manipulation Modifies "Cyclic" Fluctuation

Manipulation of the forest habitat dampens the periodic grouse population fluctuations that have long been called "cycles" (e.g. Keith 1963). On our Cloquet study area, for example, the ruffed grouse breeding population on one 658 acre (266 ha) section consisted of at least 31 drumming males (20 of them trapped and banded) during the "cyclic low" in 1974. During the previous "cyclic peak" in

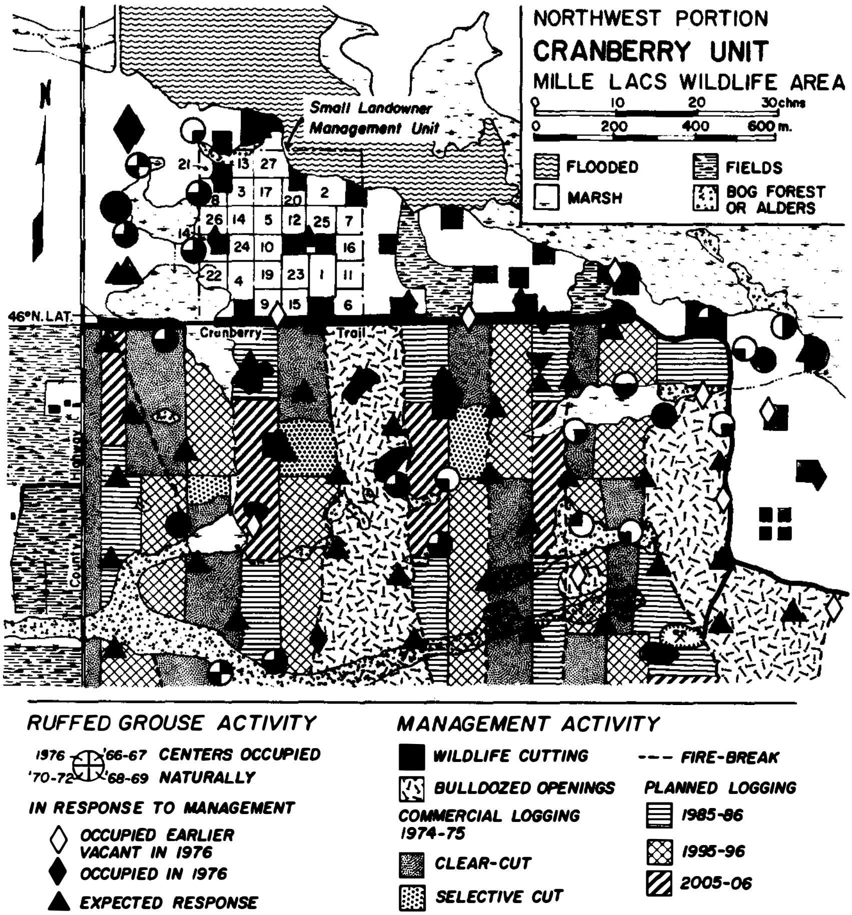

Figure 1. This illustrates a forest management scheme in operation since 1965 on the Mille Lacs Wildlife Area in central Minnesota. This is one 487 acre (197 ha) portion of two areas totalling 2,258 acres (914 ha) included in this program. Circles show the distribution of breeding grouse located prior to or currently independent of management. The portion darkened indicates seasons of use (1966–67, 1968–69, 1970–72, 1976). Diamonds indicate the location of breeding grouse responding to management since 1967, and the status of these centers in 1976. Triangles are where breeding grouse will be expected to be located by 1981–82, in response to management accomplished through 1975–76. These should be in addition to birds occupying most other centers used at some time since 1966.

The "small landowner management unit" illustrates how someone might manipulate a small tract. The numbers in each block indicate the year that block would be cleared, in this case over a 27 year period, since 8 blocks had already been cut prior to 1977.

1960–61 the population on this same section reached only 18 drummers, and then declined to 4 by 1964.

The high density in 1974 was the result of extensive logging of some 116 acres (47 ha) of mature aspen between 1953 and 1963. Scattered clumps of mature aspen were left uncut, providing a food resource close to the dense, young aspen stand. In 1974 19 (61 percent) of the 31 birds were concentrated on 16 percent of this section occupying 104 acres (42 ha) of the regenerating aspen, at a density of a breeding male per 5.5 acres (2.2 ha). The population on this area was only 23 breeding males in 1971.

In older habitats across the Cloquet refuge the population dropped from 56 drumming males in 1971 to 33 in 1974, a 42 percent decline.

Regionally roadside drumming counts had dropped from a high of 3.3 drums per stop in 1971 to only 1.1 per stop in 1974, a 66 percent decline (Berg 1975), and the statewide grouse harvest dropped from 1.297 million birds in 1971 to only 394,000 in 1974, a 70 percent decline (Longley, unpublished data).

On the Mille Lacs study area the population peaked in 1972, and then dropped. We lack data for the 1973 to 1975 period, but in 1976 we found that the drumming male grouse population on a 1,109 acre (449 ha) unaltered control area had dropped 77 percent, from 40 birds in 1972 to 9 in 1976. On 1,149 acres (465 ha) where we have conducted an active habitat manipulation program since 1968, the population declined only 43 percent, from 54 to 31 birds in this same period (Gullion and Hagman, in preparation). On the manipulated area in 1976, 25, or 81 percent, of the 31 active males were in types of habitats not available to grouse a decade earlier.

In view of this demonstrated modification of the so-called "cyclic" fluctuations by habitat alteration, I believe we must consider the probability that our modification of forest habitats over large areas has played a major role in affecting the degree to which grouse populations have periodically risen and fallen in the past. These influences include not only large scale logging and land abandonment, but also the protection of forests from disturbance, notably fire.

These birds require interspersion of habitat resources, and whenever the forest consists of large blocks of a uniform age class, ruffed grouse are at least periodically in trouble.

This is Management of an Ecosystem

While this paper has dealt in detail with habitat modification to benefit one species of forest wildlife, I am actually discussing the manipulation necessary to maintain the aspen ecosystem. This ecosystem provides the basic habitat resources for many of our most important forest wildlife species on about one quarter of North America's forested land north of Mexico (Gullion in press). Moose, white-tailed deer, wapiti, beaver, snowshoe hares, black bears, timber wolves, ruffed grouse and woodcock are some of the more prominent wildlife species associated with and largely dependent upon this ecosystem, but in addition there is a considerable number of nongame birds which are most likely to occur where aspens are part of the forest composition (e.g. Flack 1976).

So maintenance of productive habitats for ruffed grouse on the 425 million acres (172 million ha) where the aspens are prominent in the North American forest composition is in fact management of an ecosystem for the benefit of a large share of the forest wildlife species native to northern North America.

Acknowledgments

Many persons have contributed to the progress of our Minnesota studies over the past 21 years, and many of these were named at an earlier conference. As graduate students R. L. Carlton, T. W. Little, and F. C. Strand have more recently made valuable contributions to this project. Also a number of student interns, including B. D. Anderson, J. R. Anderson, D. A. Faber, G. A. Fladmark, L. O. Holtz, E. Kavanaugh, D. Lubbesmeyer and A. Nerhaugen have assisted us greatly during their "on-the-job" training. Others who have made valuable contributions to the project in various ways include D. C. Keran, T. Higgins, M. Taylor, H. S. Stone, K. M. Sampson, D. Leichtle, K. Harris, J. M. and T. M. Meger, C. Hendrickson, M. F. Stelzer and A. Soukkala, Jr.

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Managing an Elk Herd in the Face of Changing Land Use and Recreational Values

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I was first asked to consider giving a paper on the subject, as printed in the program, 18 months ago in Las Vegas—at the "International." Larry Jahn knew something about the elk, oil, wilderness, love-me-but-don't-touch-me "soapsuds" drama that was unfolding and suggested that when we settle down and get the elk management plan in operation we ought to tell our peers and the public how to maintain an elk herd in the face of changing land use and recreational values. At the time I knew it would be tough to do and that any elk management plan might never get off the ground. But we were in Las Vegas so I took a chance and said, "Sure." And that's the truth.

One and one-half years later we have no elk management plan; we have litigation; the elk herd is still in danger of becoming a museum diorama; normally friendly and supportive organizations are ready to do battle with us, and each other, in court or at 40 paces at sun-up; and this "Smiley" button that I always wear is about to be replaced by a sour-puss face saying, "Oh ___" (expletive bleeped out).

Accordingly I have changed the title of this paper to "Alice in Elkland" or, with a nod to my colleague, Don Inman, to acknowledge plagiarism, "Can the DNR Forget Elk and Achieve Happiness?"

Let me present the story to you as an example of what can happen in cases like this—an object lesson if you will. It will only be a sketch, for trying to tell this elk story in 20 minutes is like trying to read *Playboy* magazine with your wife turning the pages.

Native elk disappeared from Michigan some time after 1877. That's *Cervus canadensis canadensis* to you scientific types. The successful introduction of the Rocky Mountain elk (*Cervus canadensis nelsoni*) came from a 1918 plant of seven animals near the western edge of the present elk range. There were at least three other unsuccessful attempts. By 1925, the herd had grown to about 250. By 1961, the herd appeared to be stabilized at between 1,200 and 1,500. Perhaps it was starting to decline.

This all took place in what we now call the elk country—an area covering roughly 600 square miles (25 miles squarish) (1550 km^2), 35 miles (56 km) south of the tip of the Lower Peninsula. It is rolling forest land with a mixture of poor and fair soils—cold and snowy in winter. It was logged off between 1860 and 1910; burned over frequently; and then, because it grew big pines, some hardy souls thought it could grow big crops. Well, they thought wrongly or were misled because most of their holdings reverted to the state for nonpayment of taxes.

About the time the elk were introduced, P. S. Lovejoy came into the picture. He was a forester, a professor, a writer, a philosopher, and the first chief of the Michigan Game Division. In the 50 years since P. S. there have been only four others, including the incumbent. P. S. bought up over 13,000 acres (5,200 ha) and added them to 6,500 acres (2,600 ha) of tax-reverted land to set up game refuges and the Pigeon River State Forest. He saw the beginning of the boom in both the deer herd and the new elk herd. In 1942, he died and was buried there in his beloved "Big Wild." P. S. was a well-flavored gent who knew what he wanted. He loved the Pigeon River Country and he loved wildlife. Almost half of the elk country is public land and much of it was purchased with funds earmarked from deer hunters' license fees. He wanted his "Big Wild" left as it was. He wrote:

> I'd like to see the Pigeon opened up to insure really good fire protection and damn little more . . . so that it isn't too damn easy for the beer-belly gents and the nice old granmaws to get to, set on and leave their tin cans at. I figger that a whole lot of the side-road country should be left plenty bumpy and bushy . . . so you go in on foot . . . or don't go at all . . .

But things didn't stay wild and bushy. The bushes grew into trees, the big openings started to grow in, deer increased, the swamps were overbrowsed, elk reached higher and overbrowsed even more. They stripped bark and also got in trouble with the local farmers. Some deer hunting club members realized one elk ate as much as four deer and that didn't make elk universally popular or wanted.

Roads and sand trails criss-crossed the elk range; primitive campgrounds were built; timber and pulpwood were harvested; fishermen, hunters, berry pickers, tourists and elk watchers came and went and came back. Cottages were built. Elk were shot illegally. Some were eaten; most were wasted.

In early December of 1964 and 1965, we held very tightly controlled, and very successful, elk hunts. Three hundred elk licenses were authorized in each year. Twenty-three thousand people applied for these $35 permits in 1964, and 35,000 in 1965. Hunter success was 90 percent in 1964 and 61 percent in 1965. Four hundred fifty-two elk were taken legally along with 25 additional in-season illegal kills.

The idea of the two hunts was to reduce the elk population to a specific level; to obtain much-needed biological data on fecundity, sex and age structure, physical condition of the herd, and food habits; and to provide a unique recreational opportunity for Michigan. We were successful on all counts. Much valuable information was obtained. Reproduction was within normal limits; but adult males were disappearing at a too-high rate for a supposedly unhunted herd, and most elk were healthier than most elk hunters. Dick Moran of our Houghton Lake Wildlife Research Station has published an excellent report on these hunts (Moran 1973).

In the late 1960s and into the early 1970s, widespread poaching continued. Range deterioration continued at an accelerating pace, off-road vehicles and snowmobiles snarled their presence, and the cross-country skiers came in increasing numbers. Commercial forestry and special wildlife habitat improvement work continued and oil and gas was discovered about a mile under P. S. Lovejoy's "Big Wild."

The oil folks came to the elk country in 1968, with our blessing and, I might say, with few, if any, complaints from anyone. Their geologists had looked at maps and reasoned that there was a good chance that the same forces that put oil- and gas-bearing formations under other parts of Michigan some 400 million years ago, put the same goodies under a narrow band of northern Michigan. This band went right under the elk country. The companies paid out millions of dollars to private landowners and to the State of Michigan for the right to explore and develop these mineral resources. Thus, the state took millions for the leases on state land and stood to gain the normal royalty of one-eighth of the value of all hydrocarbons produced. Something like $200 million in royalties alone to the state could be involved.

But two big things happened in 1970. Oil was actually discovered and we had Earth Day. A lot of people, in and out of the department, reasoned that oil development, elk, bobcats, bears, beauty spots, and wild country don't mix. But in 1972, the department approved what turned out to be a producing oil well on state land in the heart of elk land.

Later in 1972, another drilling application (called Corwith 1–22) was filed. But shortly thereafter some citizen disciples of P. S. Lovejoy formed the Pigeon River Country Association to prevent any more mineral development and other forms of potential overuse. The department denied the applicant's request to drill. It seems from thereon, life at the monthly commission meetings and almost daily in some department offices was a constant parade of attorneys, hearing officers, and adversaries and advocates of all kinds.

In 1973, a contested case hearing examiner listened to 25 witnesses, looked at 200 exhibits, read 2,500 pages of testimony, and advised the natural resources commission to issue the drilling permit for Corwith 1–22. However, the commission disagreed and upheld the original denial. An important issue, if not the most important issue, was the commission's belief that oil and gas development would be detrimental to the elk herd.

The action went to the circuit court which supported the commission's denial. It was appealed and the appeals court, in a two to one decision, supported the denial. In essence, the courts said that even though the state sold the leases, the state was not obligated to honor the lease's provisions if the drilling would cause serious and unnecessary damage to surface resources, especially elk.

"Us common folks," who are used to getting a refund for goods not delivered and services not provided can't pretend to understand that, but then I don't understand how a TV set works either.

You guessed it. The case is now in the state supreme court.

Now, more or less in the middle of the primary elk range lies the newly dedicated Pigeon River Country State Forest. Dedicated in December, 1973, it covers 145 square miles (375 km^2) of almost solid public ownership—forests; meadows; streams; pothole lakes; not too many roads; a beauty spot; a quiet place with elk, deer, grouse, bears, bobcats, snowshoe hares, beavers and otters, and real good woodcock hunting. It has been called a unique area. Unique because it is the home of the largest wild elk herd in eastern North America. Sixty-five percent of it was purchased by hunters for public hunting land.

With this new dedication, the commission adopted a policy which states that the department will "manage the Pigeon River Country to protect and maintain the natural beauty of its forests and waters, and to sustain a healthy elk herd and wildlife populations." And, more specifically, "to improve and increase favorable habitat for elk" and "to manage, harvest, and use the *timber* and *mineral resources* of the area for the good of man." The question becomes: Can we prosper the elk and develop the mineral resources? Some say yes; others say "Impossible!" The *judges* ruled that overwhelming testimony by experts established the fact that elk could not exist with constant human disturbance—especially oil and gas activities.

Other players now joined the cast. In 1974, we set up the "civilian" Pigeon River Country Advisory Council. In 1975, Governor Milliken asked for an environmental impact statement (EIS) covering the general idea of mineral development in the Pigeon River Country State Forest. The EIS was to be reviewed and approved by his Michigan Environmental Review Board, a combination of agency heads and "civilians."

While all of this was going on, the department was reviewing several plans for the orderly and controlled development of the oil and gas resources. No plan made very many people happy.

Finally, the director announced a plan that, in brief, would permit a limited number of wells on 15,000 acres (6,000 ha) of the southern unit and the oil companies would give up their drilling rights on the northern units (63,000 acres; 25,200 ha) for 25 years. This sounded like a good deal because the elk appeared to be more to the north and the oil appeared to be more under the southern unit. Everyone won a little, or so it seemed.

But the environmental groups, such as the Sierra Club; Pigeon River Country Association; Trout Unlimited; and Professor Joe Sax, father of Michigan's Environmental Protection Act, were horrified and threatened court action. The governor didn't like it at all and said that the "environmental sanctuary should not be violated by further drilling." The Michigan United Conservation Clubs, with 120,000 members, supported limited drilling. So the pot was boiling and through it all the elk herd was the most important stated reason for protecting the Pigeon River Country. But how were the elk doing during all this fuss?

In the early winter of 1975, a concentrated census effort on the ground and from the air showed less than 200 elk remained from the herd that 10 years earlier numbered well over 1,000. A status report was presented to a concerned commission. Fifty years of experience clearly indicated that unless the elk herd numbered at least 500 to 600 it did not provide a practical viewing spectacle. The Commission asked "If we decide to maintain a herd of 500 to 600 elk, what would have to be done? What would be the direct and indirect costs, the trade-offs, the needed alterations to the landscape and to human activity patterns? Are there alternatives?"

Our best information indicated that the decline in elk numbers followed an accelerating deterioration of elk habitat caused by forest successional changes, unacceptable poaching, increasing human activity of all kinds, and possible brainworm mortality.

To correct range deficiencies would require reversing or arresting forest succession in several ways.

About 40 percent (230 square miles; 596 km^2) of the elk range is public land. Most of the habitat manipulation must be done here. Some private landowners like to have elk around. Other owners, including some large clubs that cover thousands of acres want no part of elk. They must be advised how to discourage elk from using their property, short of reducing the animals to elk burgers.

Habitat manipulation proposals follow guidelines based on long studies of elk preference for different cover types. Fifteen percent of upland areas (18,000 acres; 7,200 ha) must be in permanent grassy meadows. We would have to create 960 acres (385 ha) of openings per year for the next 10 years plus do maintenance work on 1,000 acres (400 ha) per year—burn, herbicide, mow, fertilize, and plant herbaceous "crops." Openings should mostly cover 3 to 80 acres (1 to 32 ha) be irregularly shaped, be next to heavy escape cover, be on the better soils, be natural-looking, be on south-facing slopes, and be near water. The cost of this work would be about $98,000 annually.

All opening creation and all timber management work would be done, to the greatest extent possible, by commercial tree harvesting. Sharecropping of legumes and hay on the better soils would be desirable. Special plantings of dense coniferous escape cover near openings would be needed. Where possible, new openings would be created on sites not particularly suited to thrifty tree growth.

There are now about 18,000 acres (7,200 ha) of seedlings and saplings (0–5 year age class) in the intolerant types. Twelve thousand new acres (4,800 ha) would need to be created (or 1,200 acres per year). About 6,000 acres (2,400 ha) of upland brush would be needed. This means 480 new acres (190 ha) per year costing $11,000 annually.

Total cost of special habitat management including new personnel comes to $133,000 annually.

Coniferous hardwood mixtures (50–50) would be maintained as wintering areas along headwater swamps and streams. Projected cost of all required intensive timber management operations is $32,000 in salaries for additional forestry personnel.

Other steps would be necessary to maintain the elk herd. Vehicle use of the area would need to be reduced to pre-1960 levels by eliminating some of the primary road system. Logging access roads would be closed and seeded to grass and legumes when not needed. Some roads and trails would be eliminated. Off-road vehicles and snowmobile use would be greatly restricted. A permit system might be required for public land to control the density and distribution of hunters, campers, and other user groups. Special deer hunting regulations would be established to maintain no more than a reasonable number of deer, for without an increased harvest, deer response to this major habitat improvement would be detrimental to elk by both forage competition and possible brainworm transmission.

Increased law enforcement effectiveness by controlling access, intensive surveillance, public education and cooperation is vital and would cost at least $40,000 annually. Thus, even without initial outlay for equipment, estimated annual costs amount to no less than $205,000.

We have given the commission these cost figures—costs in dollars and in the necessary changes in human use. They have not made a decision as yet. Other groups have responded. An unscientific evaluation (a hunch, if you will) indicates that public attitudes would not favor an expenditure of this magnitude. As one of our more colorful commissioners says, "The heck with those mangy elk."

The Michigan United Conservation Clubs have taken the position that hunters' license fees, and that's where the money would have to come from, should not be used to maintain an elk tourist attraction or living museum piece.

But this is not the cost of just maintaining the elk herd. It's the cost of keeping P. S. Lovejoy's "Big Wild" as it was—open vistas, a mixture of forest types, a quiet place, a vareity of wildlife, elk bugling on frosty September nights, happy woodcock and deer hunters, and families picking mushrooms after a spring rain.

Without major attention to the entire elk range, including the controversial Pigeon River Country State Forest, we will witness a steady march to the climax forest inhabited by red squirrels, porcupines, pileated woodpeckers, "no" elk, and not many deer. We can exclude snowmobiles, motorcycles, and perhaps even buy up some of the private cottages and house trailers. We may even be able to obtain divine guidance to help the oil companies perform ecologically acceptable drilling and pumping. Perhaps elk aren't as disturbed by vehicles as much as some people think. I believe there is some evidence that such could be true. However, unless a lot of trees are cut and even clearcut—to use what some people consider a cuss word—the elk will go, and so will a lot of the deer, grouse, and some other game species.

Many so-called environmentalists, ecologists, naive over-protectionists, and others who have joined the fight to save the Pigeon River Country would have none of the cutting, mowing, burning, herbiciding. Thus the elk herd, the most effective bulwark to date against uncontrolled mineral development, would be doomed. The commission has called for a comprehensive management plan for the Pigeon River Country but it must first address the question: Do we want 500 elk or don't we?

If they say "We want elk," it means a lot of axe and saw work. If they say, "No tree cutting and let the elk survive if they can," what does this do to their position, supported by the courts, that elk would be harmed by mineral development?

If the commission tells us to lock up the Pigeon River Country—no tree cutting, hands off, let nature handle things, then deer hunters who paid for a lot of this land, won't take kindly to hunting only red squirrels and porcupines and I can't say that I blame them.

There are those who say (especially after the winter of 1977) and I'm serious, "Let's get at the oil and gas and use the royalty money to buy a new elk herd from Wyoming." Perhaps Minnesota and Pennsylvania would give us their elk gratis. As I mentioned before, not everyone loves elk. But differences of opinion are healthy and stimulating, for as one old Indian said, "Everybody think like me—everybody want my squaw."

I wish we could tell you how best to manage an elk herd in the face of changing land use and recreational values, but we can't—not yet. In the meantime, like with all other soapsuds dramas, one never knows what the next episode, or the next commission meeting, will bring. It has been fascinating, stimulating, and sometimes amusing, so perhaps I'll keep my Smiley button and save the scowly button for the steel shot problem.

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Wildlife Management on Southern Industrial Forest Lands

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The southern forest is owned by private individuals (73 percent), private industry (18 percent), and federal, state and other public agencies (9 percent) (USDA 1973). The industrial sector is generally referred to in singular form when, in fact, it is as diverse as the products produced by the individual companies. Each company's land management policy is a reflection of these products and its management objectives.

The importance of sound financial objectives and how this relates to wildlife management is sometimes confusing. Questions have been raised as to how these two subjects got together but the basic question is how did they become separated. Harvesting timber adds to the confusion when the money derived from the sale must be related to the internal cash flow and/or overall income of a company rather than the actual timber stand which was cut. If the profit potential is not realized, industry cannot afford to retain ownership of the land and it would be sold to agricultural and/or real estate interests.

Structure and Silviculture of the Industrial Forest

The history of the southern forest is unique. The virgin forests of the South were, of course, climax in the hardwoods and subclimax or fire climax in the pines. Foresters refer to this stage as the "first" forest. The "second," or what we consider the natural forest, came into being after the immense virgin forests were harvested, usually by clearcutting or some abbreviated form of it. Basically, the virgin upland pine stands were a product of fire and the more diverse pine-hardwood stands of the second forest developed due to a lack of it (Barrett 1962).

The "third" forest in the South is being created today and has been necessitated by the ever increasing demand for wood products and the need for greater economic returns, especially for industrial landowners. Where harvestable timber stands exist, conversion to the characteristic even-aged stands of the third forest usually begins with clearcutting. As we have seen, clearcutting is the most controversial and probably least understood of all the silvicultural practices which are used in forest management. In fact, clearcutting is so commonly used in industrial forestry that it is often referred to as the "in thing" to do rather than considering the economic and biological reasons behind its use.

Clearcutting has drawn considerable criticism because of three primary facts: (1) large acreages being harvested at one time, (2) poor utilization of the smaller diameter trees and mixed species, and (3) the regeneration of a large area to a single species. The size of any logging area is related to the economics of the harvesting process, and timber utilization efficiency is directly related to the diversity of the local market and the correlation of tree diameter and logging costs (Smith 1962). Unfortunately, most markets are not as diversified as the timber stands being harvested and the largest market is for pine products. In many areas of the South, pine represents the only economically marketable species.

Table 1. Future trends in forest demands as predicted by the National Wildlife Federation (1975 = 100 base).

Activity/Year	1980	2000	2020
Camping	106	133	180
Birding	107	138	168
Hunting	106	121	135
Fishing	111	156	204
Grazing	117	150	164
Timbering	131	173	219
Water use	103	123	139

Although some degree of site preparation and spacing can be obtained on naturally regenerated sites, mechanical site preparation and artificial regeneration offer the industrial landowner the potential of substantial increases in fiber production. However, only through artificial regeneration can production gains be obtained from tree improvement and genetics. Presently this gain is predicted to be 20 percent through first generation selection.*

Even-aged pine management will, therefore, restrict the industrial forest to the earlier stages of plant succession and these stands will never be allowed to revert to their deciduous climax (Oosting 1956). In this pulpwood oriented forest, wildlife habitat will be confined to a timber stand age which is usually younger than 35 years and will resemble the virgin forests of the South more closely than the natural forest presently being harvested. The industrial forest is rapidly becoming and will continue as a forest where trees are managed by techniques analogous to those of agricultural crops.

The National Wildlife Federation's predictions of trends in forest demands are found in Table 1 (Anonymous 1976).

According to this prediction, timbering demand will rise 119 percent in just 45 years. Generally accepted sawtimber growing periods are 50 to 80 years; therefore, the trees which are being planted this winter (1976–77) will not have reached the presently considered sawtimber class by the year 2020. Forest practices acts which have not yet been enacted in the South will inevitably come and legislation such as the Endangered Species Act of 1973 will place additional pressures on forest land use.

Multiple Use Concept on the Industrial Forest

The trend in all forest management is to manage for more than one use of the land and its resources. Multiple use as a concept is simple. Initiating multiple use as an effective forest management program under any ownership is very complicated. Difficult decisions must be made and the values of each facet of management must be weighed against the other.

Multiple use is practiced extensively on industrial lands in the South but with the obvious bias of timber as the dominant product. In many companies, wildlife work is classed as a non-financial objective and is considered to be a cost of doing business. Wildlife management funds, of course, are direct costs but the use of the wildlife as recreation does have returns (wildlife and recreation are not separated

*Dr. James A. Barker, 1977; personal communication. Dr. Barker is a research forester at the Southlands Experiment Forest.

in industry). However, before wildlife management can gain significant stature in a company's overall management program and be considered in its long-range planning, it must be viewed by top administrators as an integral part of the company's operation.

Many industrial forest owners include game management in their forest management activities and charge a fee for hunting (Halls 1975). This is particularly true for deer hunting. Many aspects of intensive forest management are conducive for deer habitat (Stransky 1976; Perkins 1973; Robinette 1973) and deer hunting has historically been the most valuable for fee hunting in the forest type (Glasgow and Noble 1971; Halls 1975; Horvath 1974).

Wildlife is the only product of the land which is not owned by the landowner. Under a system in which the people own the wildlife, management schemes on private land usually become initiated only when they are economically feasible or pressures are applied on the landowner to do so. Wildlife management is obviously controlled by economics within the industrial forest community and the benefits must be calculated very closely. The first questions a company must answer are (1) what program to follow, (2) to what extent this program should be applied, and (3) for whom.

There have been many references to Horvath's (1974) economic studies in the worth of the recreational use of wildlife. However, the values described in the study are viewed by many managers as just "numbers." This is not questioning the validity of these data, only pointing out the difficulty of balancing real and "valued" monies in the private sector. For example, using the Horvath values, International Paper Company furnished the hunters and fishermen of the South with over $51 million worth of recreation in 1974. If the actual income was one-tenth of that, our wildlife management and research program would be one of the most outstanding in the world. Relationships must be in real dollars.

Problems and Opportunities with Wildlife Management Programs

Shelton (1969) did an extensive survey concerning the economics of wildlife management programs on large private landholdings in the South. His survey covered almost 28 million acres (11.2 million ha) and showed that the three most preferred systems of hunting and fishing programs were (1) leasing to private clubs or individuals (9.2 percent of the land), (2) leasing to state game and fish agencies (8.2 percent), and (3) opening the land to the public without charge. Fee permit hunting (2.8 percent) was popular only in those states which had enforceable laws requiring permission from the landowner before hunting or fishing.

A primary concern for a landowner entering into any wildlife program is the question of tort liability. The degree of liability depends on whether the recreationist is a trespasser, licensee, or invitee (Shelton 1969). However, even though liability laws exist, actual liability is more imagined than real because lawsuits of this nature are rare. Quarterman's research (1975) revealed that this could be linked to three principle reasons: (1) when a claim is small, it is easier to pay an injured party for his losses than to assert a legally sound but expensive defense; (2) public recreational use of private lands may not be of sufficient magnitude to generate a number of cases; and (3) even though a recreationist is injured, he may feel that he should not file a lawsuit against the landowner for various reasons.

A constant problem, of course, is vandalism (Adams 1956).

Wildlife Research

Wildlife related research has not kept pace with that of forest management (Johnson, Landers,and Atkeson 1974; Perkins 1973). This is especially true with the management of even-aged stands (Roach 1974). There are 22 million acres (8.8 million ha) of pine plantations in the South (Crawford 1973) and by 1980, Dutrow (1970) estimates there will be one million acres (400,000 ha) of cottonwood plantations. Other hardwood species which are being intensively managed are sycamore and sweetgum and research is being conducted on the feasibility of introducing eucalyptus. Documentation of habitat conditions as they exist is badly needed (Stransky 1976) and the data must be used as a basis for studies of wildlife management techniques for these even-aged, single species, intensively managed stands.

An Example of One Industrial Forest Landowner's Wildlife Program

In the South, International Paper owns approximately 5 million acres (2 million ha) of woodlands and has long term timber leases on approximately 300,000 additional acres (120,000 ha). International's wildlife management program has eight professionally trained employees, each with a BS degree in forestry and MS in wildlife management. There is a Manager of Wildlife Ecology, five Regional Forest Wildlife Specialists and two researchers.

There is no blanket policy of wildlife management on company lands. Each situation is reviewed on its own merits and management plans are written accordingly. Basically, the use of the land within the program can be divided into four categories:

1. State leases (10 percent[1]): These areas are leased to the individual states for wildlife management areas.
2. International Paper Company Wildlife Management Areas (12 percent): These areas are handled entirely by the Company and permits for hunting are sold to the general public.
3. Club leases (18 percent): Groups of hunters organize into an individual club and lease the hunting rights on a particular tract of land.
4. Free areas (60 percent): The majority of the southern woodlands is still open to the public for recreational use without charge.

A Wildlife and Forest Recreation Research Project was established at the company's Southlands Experiment Forest in 1958. Originally, its responsibilities were (1) to identify the conflicts and compatibilities between modern forest management and wildlife habitat, and (2) to develop methods of accommodating the large numbers of people which used company lands, with particular emphasis on programs which would benefit the company in a direct way. Over the years, the responsibilities have been expanded to include additional facets of game management and forest recreation as well as some studies in the fisheries and nongame fields.

Under International Paper's wildlife program, the company accepts its respective share of the cost of providing hunting and fishing opportunities, and expects the users of the resource to bear a share of the costs. In Florida, for example, under the company's hunting permit system, residents of the county pay a $5 fee to hunt on company lands within their county of residence, or $15 for a permit that

[1]Percentage of company land involved.

covers all company lands in the state. Special consideration is given to those persons under 16 and over 65 years of age.

Currently, specific actions affecting wildlife and timber uses include:

1. Use of timber management practices that enhance habitat conditions of the game populations on the lands. Among these are reducing the size of harvest cuts, leaving buffer strips along streams, timing certain silvicultural practices to aid in natural food production, and prescribed burning.
2. Restocking of game, especially deer, eastern wild turkey and on one area, feral hogs.
3. Establishing supplemental food plots.
4. Maintenance of road systems for hunter access.
5. Monitoring of game populations and recreationist use.

Wildlife Employment Within the Industrial Sector

Approximately 40 to 50 professional wildlifers were employed in the private sector in the South during 1975. Perhaps 15 of these were employed by forest industry and had primary duties in the wildlife management and recreation area.* They are represented professionally by the Private Wildlifers Committee of the Southeastern Section of the Wildlife Society.

The largest segment of activity for a privately employed wildlifer is not his work with the public or outside agencies, but that within the company. Foresters are trained in timber growth and production and have a historical record of doing their jobs very well. They are also the wildlife managers because everything they do in their jobs has a pronounced effect on wildlife habitat. They are not trained in wildlife, however, and neither do they have enough reliable information on the expected improvement before they commit their resources to wildlife habitat (Halls 1975).

Conclusions

It has been said that "they're making more people but no more land." Since wildlife is a product of the land, only by intensifying management can greater numbers be developed. In the face of an environmentally aware public, existing endangered species legislation, imminent forest practices legislation, and ultimate land use planning acts, forest industry has no choice but to develop programs of wildlife management and forest recreation. An obvious parallel pressure is the ever increasing demand for wood products from industrial forest lands. As these pressures build, wildlife and recreation management and forest management must intensify and the success of blending multiple demands into an effective multiple use program of management can only be attained through careful planning and research. Although it is unlikely that research will ever supply our field with enough information to make an absolute statement about wildlife, its relationships with intensively managed forests and the interrelated life histories of plant and animal communities are the real world. Only from research can we begin to understand the complexities of life within these forests and only then can we prescribe accurate management procedures.

*Noel Yoho 1977; personal communication. Mr. Yoho is chairman of the Private Wildlifers Committee.

The industrial forest has, for many years, played an important role in providing recreational opportunities for the people of the South and demands for wood products, water, and other segments of multiple use will broaden and intensify (May, Buckner, and Ursic 1976). Forest research is advancing to meet these expanded demands and may soon have the data and economic conditions to classify today's forest management as "extensive" rather than "intensive." Already, bottomland hardwoods are becoming very intensively managed (Hunt 1976) and it may soon be possible to economically cultivate, spray, or otherwise vegetatively control upland sites.

If we as a profession are to accomplish our goals in meeting the present and future demands in wildlife management, many decisions must be met with action. Two of these are to (1) implement the results of our knowledge to date and (2) conduct research into ecological associations and new systems of management.

A president's panel on timber and the environment (Seaton 1973) has recommended controlling the number of recreationists on federal lands. Examples of extreme demand such as this are convincing timberland managers that they cannot criticize single use programs such as wilderness areas if their woodlands are used for the sole purpose of producing timber. However, forest industry is not looking for alternate uses of its land but complementary ones. Its portion of the southern forest habitat must continue to be managed with economics as a primary goal but it realizes that its land and resources are extremely important to the wildlife management effort.

Only with the combined support of all ownerships—industry, private, and public—can we reach our goals and avoid the "Tragedy of the Commons" where everyone takes what they need from a common source until the source no longer exists (Hardin 1968).

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The Effects of Campgrounds on Small Mammals in Canyonlands and Arches National Parks, Utah

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Introduction

The small mammals encountered in and around a campground are the only wildlife that many people will see during their visit to a national park. Such wildlife is of considerable interest to most campers and adds to the enjoyment of their camping experience. Subsequently, many questions are directed to National Park Service personnel concerning the types of "animals" found in and around campgrounds.

Rodents inhabiting a campground are generally considered interesting and desirable. However, little is known about the relationship between these species and campgrounds. Management plans concerning campgrounds need to consider the influence that campgrounds may have on the small mammal population of an area. The need for this type of information will become increasingly important as the demand for camping sites in our national parks increases and land managers become more involved in making decisions involving resource preservation and visitor use.

Since their establishment, Arches and Canyonlands National Parks in southeastern Utah have received an increasing number of visitors each year. Annual visitation for Arches National Park has increased from 1,835 persons in 1939 to over 237,000 in 1975. Visitation at adjacent Canyonlands National Park has grown from 19,000 in the year of its creation (1964) to nearly 72,000 in 1975. As the beauty of these national parks becomes better known, use of these areas should continue to increase.

Some work has been done on small mammals in Arches and Canyonlands National Parks. Durrant (1952) and Armstrong (1972) covered the distribution of mammals in the area. Wadsworth (1969) studied the reproduction of Colorado chipmunks (*Eutamias quadrivittatus*) from Arches National Park. No information has been gathered, however, concerning the relationship of campgrounds and their use on the small mammal community of an area.

Objectives

1. To study the effects of campgrounds on small mammal populations of Arches and Canyonlands National Parks.
2. To obtain information on the occurrence of small mammal species in Canyonlands and Arches National Parks.

Study Area

Canyonlands and Arches National Parks, located in southeastern Utah, cover approximately 525 mi.^{2} (1,359 km^2) and 114 mi.^{2} (295 km^2), respectively. The two parks occupy the center of the Colorado Plateau with elevations ranging from 4,100 ft. (1,219 m) along the Green and Colorado Rivers to 6,100 ft. (1,860 m) on the Island in the Sky Plateau of Canyonlands National Park (Lohman 1974). Arches National Park does not contain any major rivers, but rather consists of rolling topography broken by rock formations and sand dunes. A more detailed description of these is presented by Baars and Molenar (1971).

This study was conducted at Squaw Flat campground in the Needles District, and at Devil's Garden campground, Arches National Park. An area similar in topography and vegetation was selected near each campground to serve as a control for the study.

Climate

The climate of this area is characterized by hot summers (97°F) (36°C) and cold winters (15°F) (−9°C). Precipitation is low, generally ranging from 5 in. (13 cm) to 9 in. (23 cm). A substantial amount of this precipitation is derived from late summer thundershowers during some years.

Study Sites

Squaw Flat Campground. The Squaw Flat campground is located in the Needles District of Canyonlands National Park at an elevation of 5,100 ft. (1,554 m). The campground contains 27 units and receives moderate to heavy use from early spring through August. The number of persons using the Squaw Flat campground from January through December of 1975 was 21, 83, 1602, 1521, 2019, 783, 1750, 4400, 1710, 1105, 334, and 0. Camping sites are located around a large formation of cedar mesa sandstone (Lohman 1974). This large rock formation acts as an apron, collecting precipitation and concentrating it around its base. The underlying rock at a shallow depth also makes this moisture more available to vegetation by preventing rapid percolation through the soil. This additional amount of available moisture has resulted in the growth of large Utah juniper (*Juniperus osteosperma*) and pinyon pine (*Pinus edulis*).

Numerous potholes are scattered over the cedar mesa sandstone and act as catchment basins, holding water for several days after a storm. Water for camping use is provided by a water truck that is kept at the campground, but no free water is available to wildlife.

Associated with the juniper and pinyon pine around the campsites is four-wing saltbush *(Atriplex canescens)* and Fremont's bareberry *(Berberis fremontii)*. Surrounding the campground is a flat covered by Russian thistle *(Salsola kali)*, sunflower *(Helianthella uniflora)*, and four-wing saltbush. Interspersed among this vegetation is cheatgrass *(Bromus tectorum)*, dropseed *(Sporobolus cryptandrus)*, and galleta *(Hilaria jamesii)*.

The control site is located 0.33 mi. (0.50 km) north of the Squaw Flat campground. The topography of the area is nearly identical to that of the campground. Juniper and pinyon pine are found around the edge of a large formation of cedar mesa sandstone. Surrounding this rock formation is a flat, similar in vegetative cover to that of the campground area.

Devil's Garden campground. This campground contains 55 camping sites and is more developed than the Squaw Flat campground. Running water is provided for campers at three locations, but the water system provides no standing water that is available to wildlife. Devil's Garden receives substantial camping use from early spring through October and is generally full each night during the summer months. The number of persons using the Devil's Garden campground from January through December of 1975 was 118, 370, 2456, 2949, 4317, 5338, 5392, 5523, 4155, 2074, 376, and 0.

Campsites are located adjacent to the base of a vertical rock formation of entrada sandstone where pinyon pine and juniper provide some shade. Scattered among the pinyon pine and juniper are cliffrose *(Cowania mexicana)*, blackbrush *(Coleogyne ramosissima)*, match weed *(Gutierrezia* spp.*)*, and yucca *(Yucca harrimanii)*. Common grasses include cheatgrass and indian ricegrass *(Oryzopsis hymenoides)*. Extending north from the campground are small sand dunes covered primarily with mormon tea *(Ephedra viridis)*, false horsemint *(Poliomentha incana)*, blackbrush, and sagebrush *(Artemisia* spp.).

The control area is located 0.15 mi. (0.25 km) east of Devil's Garden campground and 0.50 mi. (0.80 km) from the nearest trapping station within the campground. This area resembles the campground both topographically and vegetatively.

Methods

Sampling Approach

Two different approaches can be taken in assessing the effect of a campground, or any other disturbance, on the ecology of a given area. The area to be affected can be sampled before the campground is constructed and then again afterwards to allow a before and after comparison. The problem with this method is that different population levels that exist after the campground is established may be the result of seasonal or yearly population cycles that occur independently of any effect(s) the campground may have. This problem is accentuated when dealing with small mammal species that are subject to relatively large seasonal and yearly fluctuations in population.

The second approach is to select an undisturbed area as similar as possible to the campground and sample it simultaneously using the same sampling method as used in the campground. This method allows the study to be conducted over a shorter period of time and eliminates the problems associated with population fluctuations. The disadvantage of this method is that differences in population exhibited between the campground and control area could be the result of habitat or sampling differences, and not because of the effects of the campground.

The simultaneous sampling method was used in this study because the campgrounds were already established, precluding the use of the before and after method. It was also felt that the problems associated with using a control area were much less limiting than the problems involved with sampling before and after a campground was constructed.

Live-trapping techniques

Live-trapping was conducted to collect information on species occurrence and relative population size in campgrounds and control areas. Each campground and respective control area was trapped once a month for five consecutive days (weather permitting) beginning in April, 1975. This schedule was continued until trapping success declined in the fall of 1975.

The occurrence of several species of small mammals of varying size required the use of three sizes of live-traps. Sherman live-traps (8 by 9 by 23 cm) were used to capture the smallest species, such as deer mice *(Peromyscus* spp.), Colorado chipmunks, woodrats *(Neotoma* spp.), Ord's kangaroo rat *(Dipodomys ordii),* and antelope ground squirrels *(Ammospermophilus leucurus).* National brand traps (17 by 18 by 48 cm) were used to capture desert cottontails *(Sylvilagus audubonii),* woodrats, and antelope ground squirrels. Collapsible, double-door Tomahawk traps (23 by 23 by 104 cm) captured adult desert cottontails and rock squirrels *(Spermophilus variegatus).* Apple slices were used for bait in traps of the two largest sizes and birdseed was used in the small Sherman traps. The traps were placed 10-12 meters apart.

Transect design. One trapline was located in each campground adjacent to campsites with a second trapline bisecting it and extending into the area surrounding the campground (Figure 1). Permanent trapping stations were located along these transects and three traps of different sizes placed at each location. Ten trapping stations were placed in the campgrounds at Squaw Flat (30 traps) and ten stations were located on the transect bisecting the campground (30 traps) for a total of 60 traps located in and adjacent to these campgrounds. The Devil's Garden campground was bordered on the south by a series of steep rock walls which prevented extending the transect further than the distance of one trap station to the south (Figure 1). The trap line located in the campground contained eight trapping stations (24 traps). The second trapline was perpendicular to the first and extended north from the campground. This line also contained eight trapping stations (24 traps), resulting in a total of 48 traps in the campground and the area surrounding it.

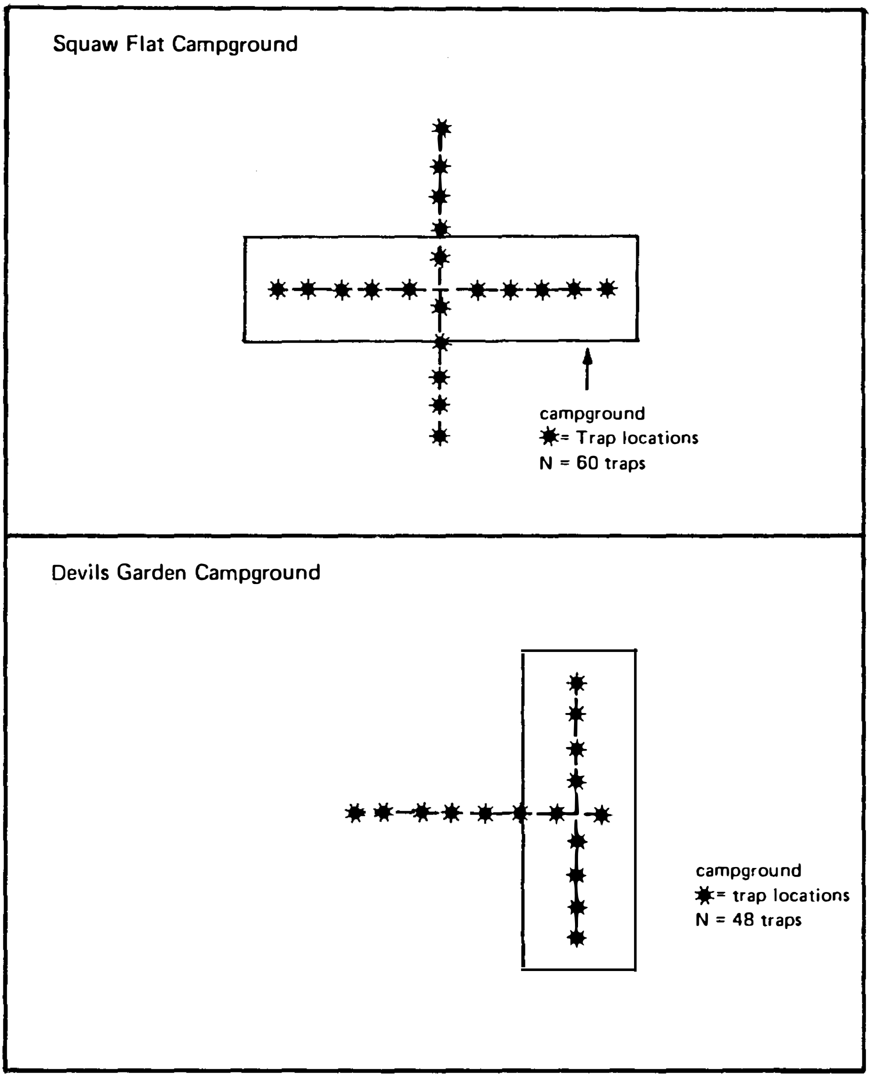

Figure 1. Schematic representation of trap transect design for Squaw Flat Campground, Canyonlands National Park and Devil's Garden Campground, Arches National Park, Utah.

The design of the traplines was the same in each of the respective control areas. Transects were the same length, contained the same number of traps, and were the same distance apart as those transects located in the campground.

Trapping procedure. The different behavioral patterns of the small mammals inhabiting the campgrounds and control areas necessitated the establishment of two trapping periods per day. Species such as the deer mice, woodrats, and kangaroo rats are almost strictly nocturnal. Desert cottontails and rock squirrels are, for the most part, crepuscular, whereas antelope ground squirrels and Colorado chipmunks are diurnal.

Traps were baited each evening just before dark. Traps were checked beginning at daylight and animals captured were identified as to species, sex, reproductive condition, then toe-clipped and released. Immediately after a trap station was checked in the morning, the traps were re-baited and set again. When all of the traps in the campground and control area had been checked and rebaited, they were checked again and then closed for the day. This method allowed sampling of nocturnal and crepuscular species during the first trapping period and crepuscular and diurnal species during the second period.

The sequence of baiting and checking the traps was alternated between the campground and control area daily. One evening the campground would be baited first and checked first the next morning. This same procedure would be followed the next day for the control area. This method prevented sampling bias that might have resulted from having the traps in either the campground or control area consistently open and baited for a longer interval than the traps in the other area.

Vegetational Analysis

Methods. Vegetational analysis of the campsite and control areas followed the method described in Mueller-Dombois (1974). Transect lines 165 feet in length (50 meters) were established in the campgrounds and corresponding locations in the control areas. Plots which measured 1.1 square yards (1 meter) were located every 5.5 yards (5 meters) along the transect to sample grasses and herbs. Plots which measured 5.5 by 5.5 yards (5 by 5 meters) were used to sample shrubs and 11 by 11 yard plots (10 by 10 meters) to sample trees.

Nine of these transect lines were located at the Squaw Flat campground, and seven at Devil's Garden. The same number of transects were located in each respective control area. The number of times a particular plant species occurred in each plot (frequency), and the percent of the plot it covered (cover) was recorded for each plot.

Statistical analysis

The problem of accurately determining the size of small mammal populations received considerable attention. The most common means of estimating the size of populations involves the mark-recapture method whereby individuals are live-trapped, marked, and then released. The subsequent capture history of these individuals is then treated by one or more statistical methods to generate a population estimate. Numerous assumptions must be met for most of the recapture methods involved. In many studies where numerous recaptures are not obtained and/or the requisite assumptions are not met, estimates of actual population size using the capture-recapture method must be viewed with some skepticism. These assumptions include: (1) no "trap shy" or "trap happy" individuals; (2) no immigration or emigration relating to the population; and (3) no mortality or natality during the sampling period. In actuality, few if any of these assumptions are ever met.

Several researchers have recognized these problems (Tanton 1965; Cook, Brower and Croze 1971) and have attempted to adjust the models to account for assumptions that are not met. Methods have also been proposed that would consider the effects of immigration (Ramsey and Briese 1971), mortality (Jolly 1965), recruitment (Parker 1955), and differential trap response (Marten 1970).

There have been studies, working with a known population size in an enclosure and obtaining a large number of recaptures, where a respectable degree of accuracy has been obtained in estimating actual population levels (Edwards and Eberhardt 1967). However, in many studies where numerous recaptures are not obtained and/or the requisite assumptions were not met, estimates of actual population size must be viewed critically.

Two types of data were available from this study that allowed a comparison of the campground and control areas. One was the number of first-time captures (baseline estimate) and the other was the total number of captures for all individuals of a particular species. Examination of the data indicated that the ratio between the total number of captures and the baseline captures was consistent. Consequently, the total number of captures were used as an index to compare the populations of the two areas because of the larger sample size provided by these data.

A statistical method was chosen that tested the hypothesis that there was a one-to-one ratio ($\mu = .5$) between the number of small mammal captures obtained in the campground and that recorded in the control area. A "Z" value was computed using the formula:

$$Z = \frac{\hat{P} - \mu}{\sqrt{P(1-P)/N}}$$

where: $\hat{P}$ = observed proportion between the captures of the two areas.
P = expected proportion between the captures of the two areas (.5).
μ = expected mean (.5).
N = total number of captures for the campground and control area.

This "Z" value was then compared to a critical value of "Z", which was 1.96 in all cases in this study (Steel and Torrie 1960).

A test was also run on each month's data for each species to determine if the differences between each set of the two areas were consistently proportional (Freund 1962). Data that were consistent were pooled, and a "Z" value was computed for all the data. Where monthly differences were not consistent, a "Z" value was computed for each month's data.

Results

Colorado chipmunk

Squaw Flat. A significantly higher number of captures was obtained in the campground than in the control area for this species (88 vs. 25, $Z = 5.91$).

Devil's Garden. Captures for this species were significantly higher in the campground than in the control area (35 vs. 19, $Z = 2.17$).

Woodrats

Squaw Flat. Fifty two captures recorded in the campground compared with three in the control were highly significant ($Z = 6.64$).

Devil's Garden. The number of captures was significantly higher in the control than the campground (24 vs. 11, $Z = 2.21$).

Deer mice

Squaw Flat. Comparison of capture rates showed no significant difference between the campground and control area when the captures for all months were pooled (101 vs. 88, $Z = 0.94$).

Devil's Garden. Analysis of the data indicated a significantly higher number of captures in the campground (88 vs. 58, $Z = 2.51$).

Desert cottontail

Squaw Flat. This species exhibited no significant difference in the number of captures between the campground and control (16 vs. 18, $Z = 0.94$).

Devil's Garden. The pooled data showed no significant difference in captures between the campground and control area (35 vs. 26, $Z = 1.15$).

Antelope ground squirrel

Squaw Flat. Total captures for the campground and control were identical (67, $Z = 0.00$).

Devil's Garden. There was no significant difference found in the number of captures between the campground and control area for this species (46 vs. 43, $Z = 0.30$).

Ord's kangaroo rat

Squaw Flat. The number of captures showed no significant difference between campground and control area for this species (79 vs. 87, $Z = 0.63$).

Devil's Garden. There was no significant difference in the number of captures obtained in the campground and control area (51 vs. 55, $Z = 0.38$).

Trapping success

The number of captures obtained for each unit of trapping effort was recorded for each species as percent trapping success. Trapping success is related to many variables that may be independent of actual population numbers. Some of the work that has been done on trap susceptibility has indicated that many factors, or combinations thereof, may influence trapping success.

Fitch (1954) stressed the importance that seasonal food availability has on trap susceptibility. Smith and Blessing (1969) also felt food availability was important as well as the sex and reproductive condition of the individual.

The effects that weather may have on small mammal captures has been studied with varied and sometimes conflicting results. Gentry and Odum (1957) and Getz (1961) found that warm, cloudy nights resulted in the greatest activity for nocturnal species and a correspondingly higher rate of capture. Blair (1943) and Jahoda (1973) however, found that a clear moonless night resulted in the highest number of captures. A study by Marten (1973) indicated that the activity of the pinyon mouse *(Peromyscus truei)* was positively correlated with high barometric pressure and temperature at sundown. O'Farrell (1974) monitored several parameters throughout the night and found that time after sunset and the amount of moonlight were the most important factors influencing small mammal activity. O'Farrell believed that ambient temperature, wind, cloud cover, precipitation, and barometric pressure had little effect on activity except under extreme conditions.

Hansson (1967) and Wiener and Smith (1972) demonstrated the importance of trap type (live vs. snap type) and efficiency. Additionally, Kenagy (1973) and O'Farrell (1974) pointed out that seasonal activity patterns of small mammals can change and may have an effect on trapping results as well as previous response to a trap by an individual (Getz 1961).

Factors such as weather (precipitation, temperature, wind, and barometric pressure), moon phase, and trap type were constant between the respective campgrounds and control areas in this study. Other factors, such as food availability and human activity, were not the same for the campground as they were for the control area at any given time.

Species such as antelope ground squirrels, Colorado chipmunks, and Ord's kangaroo rat appear to show a general similarity in trapping success between the campground and control area. Other species, such as woodrats and deer mice, seem to display little similarity in their response to live trapping. Desert cottontails at Devil's Garden show a similarity between campground and control, whereas the same species at Squaw Flat shows little resemblence in trapping success patterns between the campground and control area.

Trapping success increased between June and August in 19 out of the 24 cases observed and declined during August and/or September in 17 out of 24 instances. The increase in trapping success between June and August can be attributed, at least in part, to recruitment, as many juveniles were caught during this period. The decline in trapping success during August and September was followed by an increase in trapping success during September and/or October in 16 instances.

This general decline in trapping success followed by an increase in success in September and/or October could be the result of (1) a population decline during this period followed by an increased trap susceptibility of those individuals remaining in the population; (2) some internal or external influence that decreases trap susceptibility during the late summer period despite a relatively high population level; or (3) some interaction of these factors.

Weather. O'Farrell (1974) found that extreme weather conditions can depress trapping success. During the months of August and September, however, there were no cases of violent thunderstorms or abnormally hot or cold temperatures. Precipitation during August and September for Squaw Flat and Devil's Garden was 0.36 in. (0.9 cm) and 0.56 in. (1.5 cm), respectively. This precipitation was provided by a few scattered thundershowers, none of which was severe or of more than a few minutes' duration. Temperatures were close to the eight-year average for Squaw Flat. Although no long-term temperature data are available for Devil's Garden, it is assumed that the temperatures found during this study are representative for this area because of the lack of any abnormal temperatures in the adjacent Island in the Sky District of Canyonlands National Park.

Food availability. Increased food availability has also been mentioned as a possible cause of low trapping success. A situation of increased food availability occurs during August and September. Most of the annual grasses began to mature and provide seeds for small mammals during this time. Four-wing saltbush matured in mid-August, and antelope ground squirrels were often seen climbing into saltbush plants and feeding on the seeds. Pinyon pine nuts also matured in late August, and Colorado chipmunks were observed gathering these nuts throughout the day.

Camping activity. Camping use at Squaw Flat increased from 1,750 persons in July to 4,400 persons in August. It might be that increased camping use provided more food for small mammals, thereby lowering trap susceptibility. Devil's Garden camping use, however, increased only from 5,392 persons in July to 5,523 campers in August. Small mammals at the Devil's Garden campground still underwent decreased trap susceptibility. Additionally, small mammals inhabiting both of the respective control areas, which were subjected to relatively little human activity, also underwent a decline in captures.

Discussion

The results indicate that campgrounds do have some influence on the population of small mammals inhabiting them. Two species at Squaw Flat and three species at Devil's Garden exhibited significant differences in rates of capture between the campground and the control area.

Food Habits

One of the more obvious factors that might influence populations of small mammals inhabiting a campground is the increased food resource provided by camping use. A review of the food habits of the small mammals captured during this study indicates that a variety of plants and some animal matter are consumed. However, the ability of small mammals to adapt to and utilize this resource in a manner that could affect population levels is not well understood.

Woodrats utilize a wide range of plants (Cameron 1971; Cameron and Ramsey 1972) and occasionally some animal matter consisting primarily of insects (Meserve 1974). The nocturnal nature of woodrats makes it difficult to determine if this species actually does feed on garbage. Many woodrats were captured, however, within close proximity of campsites (11-16.5 yds., or 10-15 m).

Colorado chipmunks were observed feeding primarily on green vegetation in the late spring and summer, Pinyon pine nuts were eaten when they became available in late August. Chipmunks seemed quite adaptable to a campground situation and were often seen foraging for food around campsites seemingly oblivious to human activity in the immediate area.

Williams (1959) found that deer mice as a group *(Peromyscus* spp.*)* eat primarily seeds and leaves with some insects taken when available in the spring. A study by Jameson (1952) stressed the importance of seasonal availability of food. Seeds and fruits were consumed by *Peromyscus maniculatus* and *P. boylei* in the summer and early fall, and insects (primarily arthropods) were taken in the spring.

Woodrats, Colorado chipmunks, and deer mice appear to be quite opportunistic herbivores and granivores that will consume some insects when available. This type of dietary adaptability could enable these species to exploit the food resource provided by camping activity. The ability to utilize this additional food supply may be one of the reasons for higher populations of such species in campgrounds.

Species such as Ord's kangaroo rat, desert cottontail, and antelope ground squirrel that did not exhibit a higher population in the campground may have a limited range of dietary adaptability that precludes utilization of campsite garbage.

Studies by Johnson (1961) and Flake (1973) indicate that Ord's kangaroo rats consume seeds almost exclusively. Chew and Butterworth (1964) found antelope ground squirrels to be herbivorous, consuming a variety of plants and seeds. This species was never observed, however, foraging around tables and garbage cans as the Colorado chipmunks commonly did. The desert cottontail consumes a variety of grasses, forbs, and shrubs (Turkowski 1975) and was frequently observed in the campgrounds but never seen around campsites searching for food.

Another factor that may be a determinant of different population levels of small mammals found in the campground and control area is the difference in predator populations of these areas. Numerous signs of coyotes *(Canis latrans)* were observed around the control areas, particularly at the Squaw Flat control area where several desert cottontails that were in live traps were killed by coyotes. Swainson's hawks *(Buteo swainsoni)* were also frequently seen perching in pinyon pine and juniper trees in the Squaw Flat control area.

If there are fewer woodrats in the Devil's Garden campground than the control area, one explanation of this situation could be the lack of ground cover found in the Devil's Garden campground. The Squaw Flat campground and control area contained large amounts of Russian thistle situated in and around the cedar mesa sandstone. This cover provided nesting and escape cover in close proximity to campsites and may have allowed the woodrats to utilize the additional food resource provided by campers.

The Devil's Garden campground lacked this type of cover and also received much heavier camping use than Squaw Flat. This lack of cover may have prohibited woodrats from utilizing the additional food source provided by camping activity, at least to the degree that might have been reflected in higher population levels.

Summary

1. The data collected in this study indicates that campgrounds may have a significant effect on populations of small mammals inhabiting them.
2. More captures of small mammals were recorded in campgrounds than their respective controls.
3. Additional food made available by camping could have an important influence on small mammal populations to increase to a higher level in campgrounds than in non-campground areas.
4. There is probably a point beyond which increased camping activity would not result in an increase in small mammal populations.
5. The factors responsible for higher populations of small mammals in campgrounds than in non-campground control areas are not clear.

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Hunter Success and Education Needs

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Introduction

One of the most striking observations when working a game check station is that some individuals have seen and/or bagged much game, while others, who have spent the same amount of time and have hunted in the same area, have not been as successful. One proposed explanation for such observations has come from James et al. (1964) who suggest that hunter success is related to the effective use of an area, that is, most hunters in their use patterns are near trails or roads. The assumption underlying these results is that hunters do not have an adequate understanding of wildlife movement patterns, feeding habits, etc. Further evidence of this is offered by Evrard (1970) who illustrates the problem through the misidentification and the killing of the wrong waterfowl. In recent years, most sociologists have not been concerned as much with hunter success as a measure of satsifaction. They have been looking for other indicators and benefits derived from the hunting experience (Porter et al. 1973; Stankey et al. 1973).

The purpose of this study was to explore possible hypotheses to explain differences among the sighting and/or bagging of game to help game agencies and private organizations design programs for hunter education. Of the previous research, James's study (1964) is suggestive of an efficiency factor in the use of recreational and wildlife resources. An assortment of demographic and attitudinal variables found to be significant in other studies was employed in this case study to explore potential differences among those sightings and/or bagging of game.

Study Area

The area chosen for this case study was State Game Lands 176, a 5,800 acre tract near State College, Pennsylvania. This is a prime hunting site for both big and small game and also has an elaborate pistol and rifle range. Because of its proximity to a densely populated area, it receives heavy use during all seasons of the year. The heaviest use is during hunting season and it accounts for 63 percent of the use. Game Lands 176 is a natural frost pocket and produces much browse for big game. It also supports a diversity of other wildlife including amphibians, reptiles, songbirds, small mammals, small game, game birds, and waterfowl.

Funds for this study were provided by the National Rifle Association and Wildlife Management Institute in cooperation with the Pennsylvania Cooperative Wildlife Research Unit, the Pennsylvania Game Commission, and The Pennsylvania State University.

Methodology

Users were identified through a sampling technique developed by Cushwa and McGinnes (1968), which was refined by James and Henley (1968). This method is based upon an on-site interview, which obtained such information as purpose of visit, amount of time spent afield, and game sighted and/or bagged. On the edges of Game Lands 176 where on-site interviews could not be conducted, McCurdy's (1970) information collection system was used. Names and addresses were also taken to allow collection of additional data through an off-site interview. A random sample of users, stratified by purpose, was selected for further study. Eighty-seven useable interviews were the data basis for analysis. The big game analysis was based upon a sample of 75 and the small game analysis upon a sample of 67.

A semi-structured interview patterned after an instrument developed by Harvey (1970) was utilized for the off-site phase. This approach was designed to obtain a knowledge (cognitive), feeling (affective), and action (action tendency) commitment using how and why questions to secure information about other variables in the analysis. A tape recorder was utilized so that the interviewer could concentrate on his technique. The recorder also allowed a team of three experts, as a group, to examine the information for classification. The minimum criteria for placement on a level was based upon a two out of three decision by the judges.

Analysis

A stepwise regression analysis was used with two different series of equations: one for big game and one for small game. A dummy variable framework was utilized as an indicator of the dependent variable (Suits 1957). A comparison was made between game sighted and/or bagged and expectations with regard to sighting and/or bag. If the ratio was less than 0.5, it was assigned to the less successful group. If it was 0.5 or greater, the individual was assigned to the more successful group. The 0.5 standard was established through analysis of sample distributions. The dependent variable is a measure of amount of game sighted and/or bagged based upon a less successful vs. a more successful dichotomy. There were four types of independent variables used: attitudes, functional perspectives, situational, and adolescent experiences. A different regression equation was used for each variable type. A description of the independent variables is given in Table 1.

Results

Small Game Hunters

The cognitive (standardized beta coefficient = 0.6) and the action tendency attitudinal components (0.5) were directly related to success in game sighted and/or bagged. Of the functional perspective components, selection process styles (0.7), use (0.3), and habits (0.4) were directly related and emotion (−0.4) was inversely related. Of the adolescent experience components, recreational activities participated in during youth (0.7) was directly related and type of community (−0.4) was inversely related.

Table 1. Independent variables used in regression equations.

Variables[a]	Scales
Attitudes (Bloom et al. 1956; Krathwohl et al. 1964)	
Cognitive	A 6-point hierarchical scale based on knowledge utilization about an object
Affective	A 6-point hierarchical scale based on amount of emotional involvement with an object
Action tendency	A 6-point hierarchical scale based on extent of of action involvement with an object
Functional Perspective (Katz 1960)	
Selection process styles (Bettman 1971; Kernan 1968; Lime 1971)	A 3-point hierarchical scale based on an evaluation of amount of awareness and rationality used in selection of alternatives
Meaning (Gibson 1950)	A 3-point negative, neutral, and positive scale for each meaning component
Concrete	Tangible results (higher taxes, fire, noise, etc.)
Use	Utility value (for hiking, bird watching, etc.)
Emotion	Intangible results (aesthetically pleasing, invigorating, etc.)
Symbolism	Intangible results that represents more than is seen (freedom, bygone years, etc.)
Needs (Maslow 1954)	A 5-point hierarchical scale based on motivational components
Habits	A subjective percentage scale based on the respondent's estimate of his learned recreational behavior
Situational (Witt and Bishop 1970; Knopp 1972; Barker 1963)	Sex, age, residential status (resident vs. non-resident), occupation, and marital status
Adolescent experiences (Sofrenko and Nolan 1970; Yoesting and Burkhead 1973; Sendak and Bond 1970; Groves et al. 1972)	Organizational activities participated in during youth (outdoor and conservation vs. non-outdoor and non-conservation), recreational activities participated in during youth (remote vs. non-remote) occupation of father (white collar vs. blue collar), occupation of mother (employed outside home vs. housewife), and type of community (rural vs. urban)

[a]A 0.1 probability level was employed to determine variable significance and a 0.3 coefficient of determination (R^2) was used as a guideline to report significant equations. A dummy variable framework was used so that qualitative independent variables could be incorporated into the regression equations.

Big Game Hunters

The cognitive (0.5) and the action tendency (0.4) attitudinal components were directly related to success in game sighted and/or bagged and the affective component (−0.4) was inversely related. The selection process styles (0.5) and habits (0.3) of the functional perspective components were directly related and the symbolism component (−0.5) was inversely related. Of the adolescent experience components, type of community (−0.6) was inversely related.

Results indicated that small game hunters who were successful were better able to utilize their knowledge than those who were not. The action tendency components, habits, and selection process styles indicated that those who were more successful usually spent more time afield exploring hunting areas and made decisions about hunting areas through low risk methods. Additional evidence indicated that those who were not as successful were looking for intangible outcomes from their experience. Another important finding is that those who were more successful participated in outdoor activities during their youth and were reared in a rural area.

The same trends were noted with the big game hunters with the emotional component becoming clearer. The affective attitudinal component and symbolism were related to the lower success group.

Implications

The implications of this and other studies indicate a need for extensive hunter training to clarify the types of outcomes that they desire from their experiences (Peterle 1975). The second phase of such a program should help hunters learn how to utilize wildlife and habitat to satisfy their recreational desires. This point is emphasized even more because 46 percent of those interviewed in the onsight interview on an open-ended response indicated that doe season should be closed. This indicates a lack of understanding management policies.

This case study has implications for land management agencies because it points to the need to find ways to help dissatisfied hunters. Is the solution education or is it through management techniques such as the opening of trails into areas where there is abundance of game? Even in areas such as Game Lands 176 where wildlife is abundant, some individuals are not as successful. This seems to point to the need for education to help these individuals understand habitat and wildlife. Hunting is like any other outdoor sport or hobby. To be successful the individual has to be educated in use of wildlife and habitat in a more meaningful way. They have to be taught to become "students of the outdoors."

The results of this study are not meant to be definitive, but suggestive of the need for more definitive information upon which to build resource education programs.

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Hunter Qualification and Education Programs in Finland

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It is a strong tradition in Finland that we have public access to private lands, and in some areas even private hunting access in part of the public lands. Every citizen is entitled to hike, observe wildlife and camp out temporarily everywhere providing his activities do not cause disturbance or damage. The land owner is entitled to prohibit this kind of nonconsumptive use only in his garden, park or otherwise in the immediate vicinity of his house.

In contrast, the right to hunt in a certain area belongs to the land owner. Only in the two northernmost provinces are local inhabitants allowed to hunt on most of the public lands without special permission. The rights to hunt on private property or on the public lands in the southern part of the country may be leased. Most often the rights are leased out to a local hunting club, which in this way obtains control over harvesting game in a larger area.

Despite the private hunting system, shooting of game is not a privilege of just a few Finnish people. The number of small private farms and forest lots is very large in Finland. The hunting possibilities are further increased by hunting clubs accepting members who do not own any land. During the past 15 years the number of hunters has doubled in Finland and is now 230,000. Since the total population of the country is less than 5 million, our relative hunter density is higher than perhaps in any other European country. The large number of hunters in a northern country with low productivity of game populations naturally raises many problems. These, we tackle partly by following the model typical to all Scandanavian countries and partly by developing our own solutions.

It seems characteristic to the traditional private hunting philosophy that the harvesting and management of game are considered to concern only those who hunt. Society is allowed to interfere only when public safety is concerned, and the game populations exist only for the benefit of hunters. Thus, some people feel that is little need to develop a strong wildlife administration and spend taxpayers' money to support something which belongs solely to the hunters. In fact there is no Finnish word corresponding to "wildlife," meaning all wildlife species. The Finnish word "riista" covers game and fur animals but excludes all nongame species.

This cultural background still affects public opinion and political decisions concerning hunting and game management although it is obvious that new ideas of environmental conservation have already improved the situation.

Traditionally, the hunting administration belongs to the Ministry of Agriculture and Forestry at cabinet level. However, there is only a small Office of Fishing and Hunting Administration in the ministry without any local government game authorities. The Game and Fisheries Research Institute is an independent research unit under the ministry and supports the administration in developing ecologically sound game management policies. There are only a dozen administrators and game biologists all together on the government payroll and no game managers.

On the basis of the Hunting Law of 1962, a strong national sportsmen's organization was created. The law gives a semi-official status to this Hunters' Central Organization which consists of 14 districts, 300 local game management associations and 230,000 members. Each hunting license holder is automatically a member of one local association and in this way also of the organization at the national level.

Seasons and other hunting regulations are set by the government, often following the recommendations given by the Hunters' Central Organization. Almost all educational activities are carried out by the organization, with game management being taken care of by the hunters themselves. This divided responsibility seeks to activate the hunters to do something for the game without waiting for some government officials to work for them. The system is economical, but it does not guarantee that any adequate management is really done. It all depends upon the motivation, wildlife knowledge, and management skills of the sportsmen.

Each hunter must purchase a hunting license by paying the so-called "game management fee" of Fmk 30 (corresponding to about $8 U.S.). The fees are collected by the Ministry of Agriculture and Forestry and the activities of the Hunters' Central Organization are financed from this fund. Typical to the private hunting philosophy, expenditures for official game research were covered by appropriations from the game management fund until 1971. Even this research was thought to benefit only hunters.

In addition to the Hunters' Central Organization, there are two national voluntary sportsmen leagues with some 3,000 hunting clubs all over the country. Although the clubs are the real working units of management work in the field, these voluntary organizations are in no way supported by the game management fund.

As mentioned earlier, the success of the Finnish system with its weak authorities and strong hunter organizations depends largely upon the quality of the individual hunters. Since 1964 a special examination has been compulsory before obtaining the first hunting license. This examination mainly aims at improving the hunter's wildlife knowledge and promoting hunting safety. A third function of the test is to screen out applicants who are not seriously interested in hunting as a hobby, but just want to get the license and shoot a couple of animals.

The entire examination system was developed by the Hunters' Central Organization and is run by its local associations. Several hundred voluntary members have been trained to give this examination. Each applicant is supposed to read the "Hunters' Manual"—a 150-page book published by the Hunters' Central Organization.

Contents of this manual cover the biological background of hunting and game management, principles of game legislation, species identification, the most common hunting methods and special advice to moose hunters, hunting dogs, guns and ammunition, management techniques for the most important game species, and a brief introduction to environmental conservation. Information on hunter organizations and a list of further readings are also included.

For the written part of the examination each applicant must answer 80 true-false type questions and insert some simple figures. To pass, the applicant is not allowed to miss more than 8 questions. Examinations are open to everyone and arranged more than once a year by each local association. Those who do not pass may try again as soon as the next examination is arranged.

Those who pass the written part attend the oral part which actually is a lecture and group discussion on good hunting manners and gun safety. Nobody is flunked in this second part. It is the first personal contact between the new hunter and the representatives of the local game management association. Each applicant pays a small fee and the officials of the local association work more or less voluntarily.

The approved applicants get their first license and may start hunting providing they own some land, or belong to a hunting club, or are invited to hunt as guests somewhere. Only in northern Finland are the state-owned lands open to the inhabitants of each municipality.

More than 100,000 Finnish hunters have passed the examination during the first 12 years since 1964. The benefits of such a screening system are generally recognized but we have not measured its effects upon wildlife knowledge or various hunting practices.

The compulsory hunter examination is the only way to reach every new hunter. But it does not reach every hunter. It fails to reach the older hunters whose knowledge often seems very limited indeed. More than 1,000 lectures and short courses are arranged each year by the local game management associations, but it is obvious that they are attended by the same active members—perhaps only by 20 percent of all hunters. The others go out hunting instead of sitting in the meetings.

The Hunters' Central Organization publishes a small magazine which is sent free of charge to all hunting license holders. With six issues of the magazine annually, information is sent to every hunter. But again it may be true that the same interested people—those who go to the meetings—read the magazine, and others are less apt to absorb the knowledge available. However, everybody is given a chance to learn all new regulations and the old ones. There also are some other very good sportsmen magazines which help to inform hunters.

It is, however, impossible to solve all management problems by means of hunter education. Sportsmen seeking recreation often have an emotional attitude toward game animals. Any management carried out by them is bound to be single species oriented. Hunters may try to compensate habitat losses by winter feeding. They may also grow game food plants and set out nest boxes for goldeneyes, for example. But, too often they are interested in introducing new species if the management of the native species of their hunting ground seems difficult and unsuccessful.

Pressures against wildlife habitat caused by increasingly intensive land use practices make it necessary to integrate game management with other uses of natural resources. Sportsmen's groups are not able to solve problems related to such land use activities as clean farming or single-purpose silviculture. Integrated management of a combination of natural resources requires professional services and official status.

Well educated hunters maintaining their keen interest in their own hunting grounds still constitute the main power sources of game management in Finland. This invaluable human resource deserves professional support in the form of the administration's active interest in game management problems. Hunter education and strengthening of our game management administration are not two alternative approaches. On the contrary, both are necessary if game management is going to keep up with other uses of our national resources.

Hunter and Hiker Education Programs in Canada: Recent British Columbian Innovations

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It is the intent of this paper to briefly outline the development and curriculum of two outdoor recreation education programs presently servicing British Columbia. The (CORE) program Conservation and Outdoor Recreation Education provides compulsory hunter training throughout British Columbia. The Wilderness Leadership Program presently serves the needs of the Greater Vancouver metropolitan area, and is now being modified to reach more remote areas of the province. While the Wilderness Leadership Program provides training in canoeing, nordic skiing, and backpacking (hiking) options, emphasis is placed only on the latter theme for the purposes of this paper. The paper does not attempt to examine the development of outdoor recreation education curriculum in elementary and secondary schools.[1]

Wilderness usage by urban British Columbians has risen substantially since 1970, creating significant demands for better access, more direct public participation in recreational resource decision making, and public safety educational programming (Radford 1975). British Columbia's major urban regions are usually closely juxtaposed with mountainous forest land. The rural landscape transition from urban fringe to forest lands often experienced in areas with lengthy settlement histories is less commonly encountered in British Columbia, by virtue of the ruggedness of the mountain terrain. Very dense metropolitan populations exist only minutes away from wilderness and semiwilderness mountain forest lands, which increasingly serve as a recreational hinterland for the cities. During the decade 1960–1970, more frequent hunting accidents and significant increases in the number of rescue operations created a demand for more selective regulations governing hunting, and for training and certification programs for schools, recreation agencies, and other organizations using the wilderness for hiking, canoeing, and winter activities.

The most obvious motivation for the provincial government to examine various legislative control options was public safety, which many conservation and wildlife groups feared would lead to very restrictive regulations. Another consideration which provides context for the following discussion is also of significance. Public lobbying during the period 1965–1970 forced the large timber companies to open hitherto inaccessible Tree Farm License lands to public access. The Tree Farm License holders were operating on Crown Lands, and had previously restricted logging road access to prevent public mischief and reduce fire hazard. Concurrently, the provincial forest service expanded public wilderness access significantly in provincial forests by upgrading fire control roads and developing substantial numbers of primitive campsites. The peculiar schism between "urban" and "non-urban" recreation in British Columbia began to break down. (Toovey 1975). Much of the easily accessible wilderness outside of Provincial

[1]For a review of school-based outdoor education in British Columbia, see Bateson and Worthing 1976.

class "A" Parks was previously "locked up" to all but those with informally gained technical and geographical knowledge, and those who were members of hiking or fish and game clubs. The sudden popularity of all outdoor recreation pursuits unleashed a flood of neophytes into potentially dangerous wilderness environments. Hiking guide books gave access directions, but did not provide adequate information on pre-trip planning, and safety precautions. The image of the "British Columbia frontiersman" was unfortunately firmly implanted in the minds of many of these very urban people, and all too often this myth was exploded only when they encountered emergency situations for which they were totally unprepared.

Responsibility for designing a solution to the problem of public safety education was assigned to the B.C. Department of Recreation and Conservation, which began to significantly extend its jurisdictional mandate in 1972. Developmental work for the CORE program was undertaken by the Information and Education Branch, on behalf of Dr. James Hatter, Director of Fish and Wildlife. The development of the Wilderness Leadership Program was also coordinated with the help of this department, which had the structural flexibility to monitor public response to program development.

Since the CORE program and the Wilderness Leadership Program evolved through similar consultative research and development processes, it is possible to provide an initial outline of instructional priorities which encompasses both programs:[2]

1. Safety and survival education could not be effectively marketed to the public in isolation. While it was quickly recognized that hunters would need specialized programming, the consensus of all agencies was that a broad environmental education and wilderness awareness base was essential if any programs were to have significant impact.
2. Delivery systems for hunter education would succeed only if offered in conjunction with the existing infra-structure of clubs and federations, and outdoor recreation leadership training would have to take into account existing skills certification programs.
3. The need to broadly educate wilderness users was seen to supercede the particular motivation for the individual to be in the wilderness. For example, canoeists, nordic skiers, hunters, hikers, and mountaineers all have different technical skills, but have a common core of required capabilities as outdoor recreationists. Therefore in any education program, standards could be established once these common components were designated by mutual consent.
4. The educational methodology would have to emphasize actual field experience as much as possible, and include practical field examinations.

The CORE published in July of 1972, contains the following curriculum items (Cameron 1972). Ecology, Conservation and the Future; Outdoor Ethics; Hunter Safety and Gun Handling; Why we have regulations; Wildlife Management; Animal Identification; Birds of British Columbia; Survival; First Aid; Compass Use; Outdoor Safety; Freshwater Fisheries; and Observing and Photographing Wildlife.

The student textbook is *Fish and Wildlife: The Recreational Resource* by R. L. Cameron, Director, Information and Education, Department of Recreation and

[2]For a philosophical summary of priorities in Outdoor Recreation Education see Hasell 1975.

Conservation. An instructor's manual to accompany the text provides extensive instructional aids, lesson planning tools, practical test guidelines, and examination papers.

Students must be a minimum of 12 years of age, and must attend at least five of the six evening lessons.

As of September 1974, all persons applying for a hunting license who have not held such a license subsequent to their 14th birthday, and all those 14 years of age regardless of whether or not they had held a previous license, must successfully complete the CORE program before the hunting license is granted. The sections on ecology, freshwater fisheries, wildlife management and observing and photographing wildlife are discretionary. The instructor may choose to follow the interests of his particular class beyond the central curriculum necessary for the practical and written examinations, thereby accommodating specialized regional interests in the province.

Administratively, the CORE program relies on a non-bureaucratized, local-level delivery system, which is coordinated by regional fish and wildlife branch offices throughout the province. Examinations, films, slides, and other visual aid packages are forwarded to instructors from the regional offices as required. Performance levels in the examinations are established through detailed and standardized evaluation techniques, and successful graduates receive a certificate upon completion of the course. Instructors must achieve a high mark as a student in the CORE program, be at least 19 years of age, and serve an apprenticeship period with another instructor. Instructor candidates also participate in training courses run by fish and wildlife personnel.

CORE evolved from an expressed need of the hunting public for hunter safety education. The curriculum reaches beyond safety to expand general public awareness about conservation and outdoor recreation, in essence using hunting as an *activity vehicle* for mass environmental education. In the curriculum, emphasis is placed on the "ground" or context surrounding the activity, thereby diversifying the participants' potential for outdoor recreational activity (Fig. 1).

Flora and Fauna
Identification
Ecological
Relationships

(Non-physical
Activity Skills)

Fishing
Wildlife Photography

HUNTING
AND
GUN SAFETY

(Physical
Activity Skills)

Hiking
Canoeing
Nordic Skiing

Survival
and
First Aid

Figure 1. Ground skills.

The potential participant's avowed goal, dictated by regulations, is therefore met while concurrently providing the background skills for other types of outdoor activity. The potential repressiveness of dictated courses in hunter education is reduced in part in the CORE program by the highly localized instructional format and close ties to provincial fish and wildlife clubs. Instructors are usually members of these clubs, and use the CORE curriculum to fulfill the clubs' responsibility for public education. Individual clubs often sponsor or provide facilities for CORE courses, and can initiate a course by informing the regional fish and wildlife office. Course content is variable enough to accommodate both adult and teenage classes, and in some cases instructors chose not to emphasize the broad environmental education philosophy of CORE.

The formal curriculum is delivered by an essentially grassroots, informal communications system, which adapts readily to small rural communities and to municipalities within conurbations such as Greater Vancouver Regional District. CORE has pioneered public outdoor recreation education in B. C., and provided a basis for modeling other activity vehicle based outdoor programs which have appeared since 1972. The election of the New Democratic Party to power in 1972 corresponded with a surge of public interest and participation in outdoor recreation policy formulation. This government sponsored an Outdoor Recreation Management Conference in April of 1974, and invited a representative sample of outdoor recreationalists and conservationists to make their views known. Various mountaineering, hiking, and conservationist clubs had already united to form the Federation of Mountaineering Clubs of British Columbia, thereby consolidating the voice of one major section of the outdoor recreational public.[3] The B.C. Fish and Wildlife Federation was present, together with representatives of resource extracting industries, skiers, and Canoe Sport B.C.

Major recommendations of this conference included the following:

1. There should be an outdoor recreation branch within the recreation and conservation department to coordinate outdoor recreation on a province-wide basis.
2. Voluntary leadership certification programs should be implemented in outdoor recreation activities in consultation with educational institutions and appropriate provincial governing bodies.

The broad outdoor educational philosophy voiced at this conference can be outlined as shown in Figure 2. Moving from hunter education to hiker education involved significant contextual changes. *Hiking* represents a wide spectrum of activities, ranging from short walks in an urban park, to day hikes, overnight backpacking, extended backpacking trips, and mountaineering expeditions. Physical and organizational skill levels required for the activity vary accordingly, and the legislative-regulative mechanisms applied to hunter training via the CORE program quickly proved to be unworkable.

The Department of Recreation and Conservation quite understandably was anxious to identify public opinion insofar as hiker education was concerned, but soon found a bewildering variety of attitudes and priorities, reflecting the full range of hiking activities. One very clear message was enunciated by the federation of mountain clubs: compulsory certification of hiking and mountaineering instructors

[3]For an overview of the functional effectiveness of this Federation, see Federation of Mountaineering Clubs of British Columbia 1974.

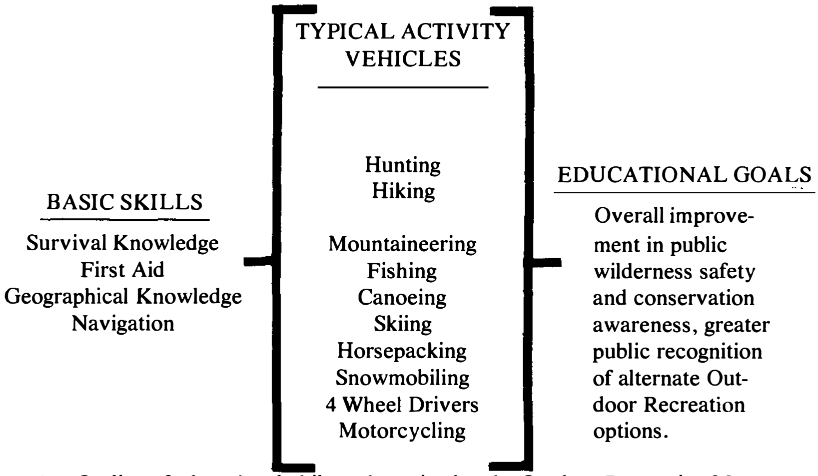

Figure 2. Outline of educational philosophy voiced at the Outdoor Recreation Management Conference.

by government would be unacceptable on a provincial basis. The British Mountain Leadership Training Program was cited as an example of such a program, with instructional standards allegedly pulled down to the lowest common denominator level by the programs' compulsory nature and universality of application. Wilderness *leadership training* is the central issue in the eyes of many club and federation members. The scoutmaster, the teacher, the enthusiastic parent—these people often lead groups of children and adults into dangerous situations because they lack the necessary basic skills previously identified.

Many hikers voiced concern that mandatory certification for such leaders would cause school districts to insist that all teachers involved in outdoor activities be certified, resulting in meaningless standards, and considerable resistance from teachers from such arbitrary dictums. Voluntary accredited certification, together with mechanisms for mass public outdoor recreation education, were recognized as more viable approaches. A significant number of people in mountaineering clubs and hiking clubs totally rejected the idea of formalized training programs at all, maintaining that development of such programs would create problems of overuse in sensitive wilderness areas. They opted instead for the existing club-based system of informal education. The Federation of Mountaineering Clubs of British Columbia in particular recognized the importance of developing more sophisticated in-house training programs in mountaineering.

During the summer of 1973, the Canadian Federal Government funded a research project on outdoor winter recreation safety. The researchers, Donald Basham and James Boyde, identified the alarming movement of unprepared and uneducated people into outdoor recreation pursuits, and suggested an education-certification program be instituted on a trial basis. Since education in Canada is a provincial responsibility, their proposal was presented to Jack Radford, then British Columbia Minister for Recreation and Conservation. The researchers defined their purpose in the fall of 1973 (Basham and Boyde 1973:2):

> It is too large a task . . . to educate and equip everyone who enters a wilderness area individually. We can however train our recreational leaders to assist in the development of our Outdoor Recreational areas in three ways:

—by teaching leaders outdoor activity skills so that they can promote and encourage this area of recreation and fitness,
—by teaching the necessary wilderness knowledge,
—by teaching safety and preventative programs connected with the activities and with nature.

A 1972 study, "Outdoor Education in British Columbia" by Dr. Milt McClaren and Margaret Ramsay, had previously recommended to the provincial government that "consideration should be given to establishing a competency certificate scheme in the field of Outdoor Recreation."

The input from outdoor recreation conferences, research studies, and continuing alarming statistics from the Emergency Measures Organization provided a positive context for the acceptance of the Basham-Boyde recommendations in 1973. The curriculum proposal was as follows:

WILDERNESS NORDIC SKIING OPTION
Wilderness Backpacking I
Wilderness First Aid I
Wilderness Nordic Skiing I
Wilderness First Aid II
Wilderness Nordic Skiing II
Log Book Experience

WILDERNESS CANOEING OPTION
Wilderness Backpacking I
Wilderness Canoeing I
Wilderness First Aid I
Wilderness Canoeing II
Wilderness First Aid II
Log Book Experience

WILDERNESS BACKPACKING OPTION
Wilderness Backpacking I
Wilderness First Aid I
Wilderness Backpacking II
Wilderness First Aid II
Log Book Experience

The delivery system chosen was the British Columbia regional community college structure, which offers 2-year career diploma programs, university academic transfer programs, and community noncredit education. Capilano College in North Vancouver, a suburb of Vancouver, was chosen as the starting point for the Wilderness Leadership Program, since the college already operated a 2-year diploma program in outdoor recreation management. Significantly, the Wilderness Leadership Certificate Course curriculum was given credit status immediately, providing a reliable funding source from the Department of Education, and an assured evaluative mechanism for participants. Curriculum development and the assembly of a wilderness resource centre was funded by the Department of Recreation and Conservation (Capilano College 1974).

The location at Capilano College provided a regional population base of over 1 million people, almost half the total provincial population. Individual course time commitments involved one evening a week plus weekend field experience over a 14-week semester.

The canoeing and nordic skiing components involve interim external instructor certification. Certification by St. John Ambulance is a requirement for successful completion of First Aid I. The backpacking (hiking) component involves certification only upon completion of the three-year curriculum.

Second-year courses in canoeing and backpacking were developed on an *expedition* basis, with the class leaving on a 10-day extended trip which challenges all their abilities as leaders.

The hiker education theme in the Wilderness Leadership Program contains the following curriculum:

Wilderness Backpacking I: Trip organization, wilderness access, group assessment, first aid and survival kits, camp crafts, nutrition, clothing, equipment, navigation, mountain ecology, outdoor ethics, legal liability (series of day hikes, weekend overnight hikes, and lectures).

Wilderness Backpacking II: A 10-day expedition into trailless mountain country. Leadership psychology, navigation skills, survival methods, solo experience, environmental perception study and special group study.

Wilderness First Aid I: Incorporates St. John's First Aid Certificate exam. Covers basic senior first aid curriculum with special emphasis on wilderness medical emergencies. Evacuation techniques, hypothermia, frostbite, hyperthermia, altitude sickness, pulmonary edema, and group mental attitude are some of the areas covered.

Wilderness First Aid II: Emphasis on realistic field rescue simulation exercises. Develops medical emergency management skills, helicopter evacuation, cardiac-pulmonary resuscitation.

Log Book Experience: Students maintain a detailed log of all trips organized and led over a one year period. The log is then evaluated and if satisfactory, the student is awarded a Wilderness Leadership Certificate in the particular option completed.

The Wilderness Backpack I course together with the first aid theme, are mandatory for all prospective graduates in the Wilderness Leadership Program, constituting a core curriculum which focuses primarily on *preventative survival education.* Students are given skills to stay out of trouble as well as the correct response systems necessary to cope with wilderness emergency situations. Pretrip planning, nutrition, fitness, equipment selection, weather and terrain, routefinding with map and compass, and leadership psychology are considered to be the most significant topic areas in reducing hiker accidents. If a survival situation does indeed occur, emphasis is placed on correct mental attitude, effective improvisational first aid and evacuation techniques and maintenance of the best possible level of comfort. The program does not teach survival from the "living off the land" perspective. For example, it is felt that knowledge of edible plants is not a viable survival tool in British Columbia. Those who have experimented with "living off the land" in the mountains of British Columbia will ruefully a test that the calories burned in gathering and preparing edible vegetable matter usually far exceed the available calories in the food. The ecological impact of experimentation with edible plants in fragile wilderness areas also prompted instructors to take a hard line against this "survival" school of thought.

The concept of "woodcraft," i. e. adapting the wilderness settings encountered with axe and twine to create a campsite, is also rejected. The wilderness leadership philosophy insists that environmental impact be as minimal as possible. Everything must be packed in and out of an area on the hikers' back.

Fires are not used on backpacking trips unless a government primitive campsite is available, although firebuilding and plastic shelter construction are stressed as important survival skills. Two significant reference points for the Wilderness Leadership Program hiking/backpacking curriculum have been the Survival Education Association and the Council for Survival Education, located in Tacoma, Washington. Close liaison with these organizations provided a curriculum source based on experience with terrain and climate almost identical to the coastal mountains of British Columbia. (Fear 1972)

The focus on environmental awareness and outdoor ethics closely parallels the CORE program and was modeled on the activity vehicle concept of outdoor education. Emphasis is placed on the importance of developing leadership skills within hiking groups, so that wilderness leadership students recognize the responsibility of the leader to constantly educate and upgrade the collective hiking skills of each group being led into a wilderness situation.

The initial concept of the program theorized that mass education for outdoor recreation safety could best be effected through the pyramid effect of leadership training and insofar as the Wilderness Leadership Program as a whole is concerned, some significant results have been achieved with the following client groups: school teachers, corrections branch leaders, scoutmasters, Girl Guide leaders, municipal recreation leaders, community school employees and YMCA-YWCA employees.

The generator effect of the program via such client groups has not yet been measured, but the potential contact of such students with the outdoor recreational public is substantial.

The first year of the Wilderness Leadership Program, particularly the canoeing and nordic skiing options are to be modified for delivery anywhere in the province where they may be required using regional community colleges as the instructional base. These courses will run on the 8-day "total immersion" basis, and will operate on a cost recovery model, or on a subsidized funding formula where appropriate.

A final note is in order on another recent innovation in outdoor recreation in British Columbia. The Recreational Uses of Wildland in British Columbia Conference, held in April of 1975, launched a new provincial organization which coordinates input to government from most organized outdoor recreation groups in the province. The Outdoor Recreation Council is structured on a regional committee basis, and serves as a vehicle for research and public outdoor safety education through leaflets and other publications. The council seeks to resolve potential recreational conflicts between user groups, and facilitates club representations to government on conservation issues. Membership includes motorcyclist groups, four-wheel drivers, snowmobilers, natural history societies, The Federation of Mountain Clubs, The Sierra Club, and educational institutions.

This paper has outlined some aspects of the evolution of public outdoor recreation education in British Columbia since the inception of the CORE program in 1972. The CORE program achieves the specific goals of hunter safety training and public outdoor awareness based on legislated safety requirements. The public dialogue over educational methodologies prompted the establishment of the Wilderness Leadership Program in 1974, based on a pyramid concept of public education. The establishment of these two outdoor recreation education programs represent adaptive government responses to public and expert input. The establishment of the Outdoor Recreation Council as a result of the 1972–1975 dialogue on outdoor recreation policy between the B. C. Government and the clubs and federations provides a vehicle for further mass education by a nongovernmental agency and a versatile, publicly accessible research facility on outdoor recreation problems. The organized and interested outdoor recreationalist in British Columbia now possesses opportunities for coordinated outdoor recreation action and education over a wide range of specific topic areas.

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Hunter Education Programs in the United States

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The United States once provided unlimited opportunities for participation in outdoor recreation. During our developing years the skills required to enjoy these opportunities were the natural outgrowth of our rural beginnings. Hunting, a necessity in those formative years, gradually transformed into a sport, an extension of our pioneer heritage. But with the evolution of our distinctive culture came a number of interrelated factors which have altered the future of recreational hunting in America.

Our increasing population with its migratory flow toward urban centers and then back to the suburbs has caused villages and cities to expand into the rural countryside. Natural resources are being exploited to service and promote these human habitation centers. The increase in leisure time coupled with a renewed interest in the environment has caused urbanites to invade the outdoors and vacationers to saturate the landscape. The results are two-fold: first, deterioration and loss of habitat poses a mounting obstacle to the sound conservation and management of the wildlife resource; second, requests for outdoor opportunities from the wide diversity of recreational users are ever increasing.

In encouraging participants in most activities, the trend has been to motivate and recruit as many as possible into its pursuit. However, mere recruitment is no longer an acceptable goal, either for leaders in outdoor recreation in general or for hunter education in particular. Because the outdoors has more recreational demand and less recreational space, hunters find ever fewer places and opportunities to hunt. Rather than increasing hunters quantitatively, the goal of hunter education must be to enhance the quality of the outdoor experience. Today's hunters must recognize the value of hunting as a management tool, realize their responsibility to safety, and have respect for the land and the rights of others. Most importantly, hunters must be able to pass these values and responsibilities to succeeding generations.

Looking at the pioneer heritage of which hunting was an essential component, young people learned from their parents or relatives not only how to safely and properly use firearms, but also the identification and behavior of the many species of plants and animals encountered as an integral part of nature. Hunters developing in such an atmosphere had a strong feeling for their place in the natural environment and herein lies a major obstacle for the future.

The majority of young people interested in the sport of hunting and other outdoor related nature activities have long since severed their ties with their rural heritage. While the skills necessary to work with nature and understand its intricacies must still be acquired, the traditional avenue of "apprenticeship" is too often unavailable. If we are to assume this teaching role, we must broaden the already successful firearms safety instruction program to include more areas of outdoor education and responsibility—hunter ethics, basic wildlife conservation and management, wilderness survival, species identification, and other basic skills. Our failure to develop, implement, and promote this broad spectrum of hunter education learning programs will truly be a detriment to the continuation of sport hunting as we know it today.

As the late Dr. Julian Smith once remarked, we are on the threshold of a new frontier in education which will bring into proper focus the absolute need for an environmental ethic. While the world of today's outdoor recreationists is far different from that of their forebearers, they nonetheless face a "frontier" that may be as challenging as any in our history. Not only must they have the characteristics of good citizens and be sufficiently educated to enjoy and survive, if necessary, in the outdoors, they must also bear the awesome responsibility of maintaining an environment that has helped make this nation great. This, then, becomes the challenge of hunter educators: today's hunters must develop an awareness of their relationship to the total environment.

Numerous state wildlife agencies, sportsmen's groups, and the National Rifle Association have long encouraged the safe handling of firearms. However, it was not until 1949 that the State of New York enacted the first law requiring firearm safety instruction for all hunters who had not previously held a hunting license. As a result of the National Rifle Association's successful Marksmanship Instructor Program, New York solicited and received NRA's assistance in training and certifying instructors.

From that beginning, the program was revised for nationwide distribution in consultation with the National Education Association. States began to implement the program, and NRA continued to enter into agreements with requesting states to train hunter safety training counselors from personnel of their game departments and to certify and maintain files of hunter safety instructors. We also began producing training materials and coordinated the programs among the states.

Today, hunter safety training has been implemented in 49 states and all the Canadian provinces. Many, through their legislatures, have adopted mandatory requirements for first-time license holders. As of January 1, 1977, hunter education was mandatory in 24 states and provinces, with an additional 4 states and 4 provinces pending mandatory legislation. The remaining states are reaching a large number of young hunters through voluntary programs. In 1976 nearly 1 million people graduated from hunter safety programs, bringing the total number of people certified in safe firearm handling to almost 10 million since the inception of the program.

Until recently, each state financed their hunter education program from their own limited resources, although some states were more successful at generating revenue than others. For example, in 1976, Mississippi became the first state to require hunting and fishing law violators to help pay for hunter safety training by imposing a $2 "penalty assessment" on each $25 fine levied for a violation. However, the passage of federal legislation in 1970 and 1975 amending the Pittman-Robertson Wildlife Restoration Act by adding a 10 percent excise tax on pistols and revolvers and an 11 percent tax on archery equipment permitted financial assistance for hunter training to all states. This new funding source, administered by the Office of Federal Aid of the U.S. Fish and Wildlife Service, is apportioned to the states on a matching basis of three federal dollars for each state dollar. Thus, sportsmen are providing additional support and funding which should permit greatly improved hunter education and public shooting programs in the future. The passage of a handloading component parts excise tax in 1977 should inject even more financial assistance into the programs.

During these past 28 years, the program has changed measurably. Hunter safety training is expanding beyond the traditional aspects of safe firearm handling to a more complete education program teaching hunter ethics, hunter responsibility, wildlife biology and management, game identification, and wildlife law. Other items, such as survival, first aid, black powder hunting, field care of game, and bowhunting, are also entering the instructional programs. However, the basic hunter safety program adopted by the states was, by design, very general to permit the flexibility necessary to adapt the program to any province, state, or community. The responsibility of the administration of the program resides within the state wildlife agency and the content of each state's instructional course was modified to meet the needs of that particular state. The result is a wide diversity of approaches and requirements within a general framework of enhancing the knowledge and image of hunters and reducing the possibility of hunting accidents.

While it is impossible to outline each of the 59 programs operated state-or province-wide in North America, it is important to recognize that many emphasize different aspects of hunter education and employ different approaches, ranging from incorporation into school systems for academic credit to sessions conducted at local sportsmen's club facilities.

In recognition of the wide diversity of hunter education programs across the United States, several organizations and agencies have devised ways to strengthen and improve the quality of this instruction. The International Association of Fish and Wildlife Agencies developed a program which annually recognizes the achievements of the 10 most outstanding hunter education programs in North America. In 1976, the IAFWA also adopted a resolution encouraging all states and provinces currently operating voluntary programs to implement mandatory training for all first time license holders. The North American Association of Hunter Safety Coordinators was formed to give direction, discuss training methods and trends in hunter education, and work towards the continual upgrading of state and provincial hunter safety programs. The U.S. Fish and Wildlife Service's Office of Federal Aid conducts regional hunter safety training workshops for the state program coordinators and establishes minimum educational requirements to qualify to use Pittman-Robertson funds for hunter education. Finally, following the establishment of hunter safety programs in most states, NRA is shifting its emphasis from teaching instructors to retraining instructors, conducting workshops, and improving instructional standards.

Hunter safety education programs are excellent examples of cooperation between government and private citizens and organizations. However, the capabilities of governmental agencies to promote the values of hunting are often limited by their many other obligations. Part of the burden of responsibility and the reservoir of knowledge and skills required to develop and enhance hunter education is within the domain of the private sector. These private organizations and special interest groups must accept the responsibility of assisting in the education of the outdoor recreating public.

Many organizations have reacted to the responsibility in a most positive way. Ducks Unlimited, long known for its dedication to the waterfowl resource and its ability to raise large sums of money to reserve and improve nesting habitat, recently developed its "Greenwing" program which provides youths up to the age of 15 an opportunity to learn about waterfowling. This program, started in 1973, is chiefly under the jurisdiction of local chapters, which permits a flexible approach to learning marksmanship, appreciation of the outdoors, and waterfowl identification.

Another organization, the National Field Archery Association, has designed a bowhunter's education program to greatly increase the recreational values gained from the sport. Designed as either a supplement to the traditional hunter education course or a separate course, this program has enjoyed wide implementation across the country since it was introduced in 1975.

Both Ducks Unlimited and the National Field Archery Association have recognition programs which provide their participants with certificates, identification cards, pins, and decals to increase their sense of accomplishment. Often these tangibles are extremely valuable parts of the program, for they not only serve a purpose for the recipient, but are effective public relations devices as well.

Further, while both programs are dedicated to safe and ethical use of hunting equipment, they go much farther by attempting to instill in youth an appreciation for the outdoors and knowledge and understanding of basic wildlife management concepts.

In addition, many other organizations, including the Izaak Walton League and the National Wildlife Federation, particularly at the local level, are very active in educating the public and enhancing their enjoyment of the outdoors.

Hunter safety training programs have played an important role in improving the quality of sport hunting. However, it is becoming increasingly clear that these safety programs alone do not provide sufficient impetus to secure the future of sport hunting. If this sport is to survive, it must be viewed by the public as a worthy use of leisure time and as an integral part of outdoor education, benefitting both the wildlife resource and the participant. A multi-faceted approach to hunter education is needed to improve the public's understanding of sport hunting.

To accomplish greater public understanding, more emphasis should be placed on the importance of properly oriented and accurately presented conservation education in the school systems. There is a void in available materials favorable to hunting and wildlife management, particularly in the primary grades.

One state which has sought to remedy this situation is Arizona. Their game and fish department has developed an excellent program where individual members of private organizations with an interest in children and wildlife can take a series of instructional blocks and go into the classroom as docents. The docents spend one classroom period introducing a wildlife management concept to elementary students. The students are then evaluated at the end of the period, after engaging in a variety of multidisciplinary, but related activities.

Other states and private organizations have developed a wide variety of workshops which encourage the use of well developed teaching materials on a variety of instructional grade levels. The NRA is involved in several such activities. The Julian Smith Outdoor Education Workshop provides professional educators with concentrated learning experiences in adventure, archery, angling, and shooting activities. The Survival Leadership School, conducted in cooperation with the Wilderness Institute of Survival Education, offers classroom and practical field instruction in survival for outdoor recreation teachers and other leaders who commonly take groups into the wilderness.

In addition, NRA has supported the American Alliance for Health, Physical Education and Recreation and the Outdoor Education Project since its founding in

1955. The project's primary goal is to further the training of professional educators and leaders in the area of outdoor recreation. It has trained and assisted thousands of professionals in developing and operating outdoor education programs for young people and adults. Also, NRA has worked cooperatively with educational institutions, agencies, and professional organizations in designing curricular and co-curricular educational programs concentrating on the development of sound leadership.

The general public and the hunting fraternity can also benefit by the close cooperation and interaction of private organizations and the state wildlife agencies. An example would include the Help Our Wildlife (HOW) concept. Conceived in 1974, this approach encourages hunters to police their own ranks and report incidents of vandalism and game law violations. Eight states have similar programs, while 19 others have adopted HOW, enhancing the image of the hunter as an ethical, law-abiding citizen.

We believe the future existence of sport hunting largely depends upon the development of diversified hunter education programs. Private organizations must respond to the challenge imposed by rapidly diminishing public recreational space. While the private sector cannot bear the burden of hunter education alone, it must share in accepting the responsibility of leading and setting the trends for the education of tomorrow's hunters. It may well be that hunters are becoming a threatened species. However, there is no reason hunting should deteriorate, because a successful nationwide framework exists to effectively adapt recreational hunting to the changing American culture. The challenge now is to collectively develop and implement viable, well-rounded, dynamic programs to enhance the knowledge of hunters and improve the public's understanding of hunting, in the context of managing America's renewable wildlife resource.

The Hunter and Firearm Safety Training Program in Florida

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Florida's original Hunter and Firearm Safety Training Program began in 1958. It was staffed by one information-education officer of the Game and Fresh Water Fish Commission who devoted about five percent of his time to the program. Between 1958 and 1970 he had trained and certified only 97 instructors and 448 students. The amendment to the Federal Aid in Wildlife Restoration Act (Pittman-Robertson Act) provided for federal assistance to the states for the purpose of hunter and firearm safety education programs to enhance the safety and wellbeing of hunters and other citizens by teaching the prevention of all types of accidents and hazards associated with hunting and gun users. In 1971, the Game and Fresh Water Fish Commission adopted a program of hunter and firearm safety which would enable them to become eligible for receipt and expenditure of federal funds. While ownership of firearms and the privilege of hunting belong to the citizens of Florida, little had been done to prepare them to accept the great responsibilities that accompany such rich heritages. To better prepare them to accept these responsibilities, a full-time state coordinator was employed. Training programs and procedures were re-written and a new, accelerated program began. Since then, more than 2,000 instructors and 28,000 students have been trained and certified. Because of the emphasis being focused on the Hunter and Firearm Safety Training Program by the commission, and the increasing acceptance by the public, the program is one of the fastest growing in the United States today. With this rapid expansion, the enormous task of coordinating and directing every aspect of the operational plans of the statewide program (Florida covers approximately 58,500 square miles) revealed the need for the establishment of regional assistance for the state coordinator. In 1974 five regional supervisors were employed. Their duties include assisting local volunteer instructors in teaching the hunter and firearm safety classes, providing training materials, recruiting and training new volunteer instructors and recommending them for certification, personal contacts with local civic and school groups promoting the Hunter and Firearm Safety Program, investigating all firearm accidents within their region and reporting the results to the state coordinator for the compilation of statistical records. Each of the five regional supervisors has been equipped with a "traveling warehouse"—a van equipped with handout literature, a chalkboard, textbooks, flipcharts, movie projectors and films, slides and slide projectors, demonstration guns and ammunition, a built-in BB gun shooting range, bows, arrows and everything else the volunteer instructors need. These men circulate statewide, assisting their instructors and publicizing the program.

Modern industrial techniques and education have combined to give us all more leisure time through more holidays, shorter workdays and the four-day work week, to name a few. Because of this added leisure time, each year more and more people are taking to the great outdoors, gun or bow in hand, stalking that trophy deer, that elusive turkey, that fierce wild hog. In Florida last year, 15 of those who ventured into the woods did not come out alive. What were the causes of the accidents that took 15 lives? Here are just a few of the reasons, taken directly from the accident reports: the victim was mistaken for game, the victim was covered by the shooter swinging on game, the victim moved in the line of fire, the victim was playing with the gun or didn't know it was loaded. Some were killed while placing in or removing their gun from their vehicle or boat. Webster's defines "accident" as, "an unfortunate event resulting from carelessness, unawareness, ignorance or a combination of causes." *Every one of the 15 deaths that occurred in Florida last year could have been avoided through education—hunter and firearm safety education!* Since the beginning of firearm accident investigations in Florida several years ago, *not one single incident* has involved a Hunter and Firearm Safety Training Program graduate. We think that's pretty significant! We also feel a greater obligation than ever to try to reach as many people as possible so that one day, hopefully, a firearm accident will be a rare occurrence in Florida. Education through a training process will reduce and virtually eliminate accidents caused by the improper use and handling of firearms. It will help prepare our citizens to accept the responsibility of firearm ownership and better appreciate and understand wildlife, as well as improve relationships between sportsmen and landowners. Aside from making hunting in Florida a safer sport, we want to make it a pleasant, productive and enjoyable recreational experience. It is our desire that safety oriented students be the future hunters of Florida.

Florida's program requires a minimum of 12 hours of classroom instruction, plus range firing and a field demonstration exercise. While only 12 classroom hours are mandatory, an average of 28.5 hours are taught per class in addition to the range firing and field demonstration. The student course consists of 14 components, 12 of which are taught in a classroom situation. Each classroom component is taught in one, two or three hour segments. The 13th and 14th components, the range firing and field demonstration, are combined in the final exercise at a local field course and firing range.

Students are required to attend all class periods, pass all tests given and satisfactorily demonstrate their acquired abilities and knowledge of firearm and archery safety procedures during the range firing and field demonstration periods. Home study assignments equalling the number of hours of classroom training are given after each class period. A review covering material in the previous class is given at the beginning of each class session and a written examination is administered. At the completion of all classroom training sessions, a 100-question written final examination is given to all students. The final examination, as well as all other written examinations given during the course, must be passed with a minimum score of 80 percent. During the field demonstration exercise the students must also pass a 30-problem field test. Upon successful completion of the course, the student is awarded a Certificate of Training, an identifying shoulder patch and an identification card verifying that he is a Florida Certified Safe Hunter. To be certified, all students participating in the Hunter and Firearm Safety Training Program must be 10 years of age or older.

This training program was designed to present a uniform course of instruction in hunter and firearm safety. A closer look into the individual components will provide a better understanding of its contents.

Components of Florida's Program

Component One

This class period deals with hunter ethics, rules, regulations and laws in Florida regarding firearms and the taking of wildlife, the safety rules we call the "Ten Commandments of Gun Safety," how to recognize dangerous hunters and important points to remember while hunting. Landowner-sportsman relations are emphasized, because over half of the land in Florida is privately owned and hunting is by permission only.

Components Two and Three

These class periods deal with firearms, primitive to modern. Nomenclature of firearms, assembly and disassembly, major groups and the functional parts of each group, the component parts of all types of modern ammunition, including the different types of powders and their uses are taught. Because of the vast amount of information taught on this subject, two classes are devoted to it.

Component Four

This class is on proper gun handling. Many of the students have never handled a gun or have very limited experience. This class provides an opportunity for them to gain experience by actually handling all types of guns, simulating loading, unloading and firing, and care and cleaning. Students are also taught correct methods of storing and transporting guns in vehicles and boats, crossing fences and other obstacles, crossing rough terrain and correct methods of storing ammunition and guns in the home.

Component Five

This class period is on rifle marksmanship. Students are taught how to sight-in a gun, sight alignment, sight picture, shooting positions, breath control, trigger control, target analysis, scoring targets, range procedures and commands, range safety rules, and the proper use of the firing range.

Component Six

This class is on wildlife identification. The importance of proper game identification is stressed for safety purposes and identification of legal game. A series of slides of Florida's wildlife is combined with a narration of facts and specific information on the habitat, food, migration, location, reproduction and physical characteristics of each species of bird and animal. Wildlife is presented in a series of groups such as protected, unprotected, threatened, endangered, game mammals, game birds and dangerous species such as panther, bear, wild hog and wounded animals.

Component Seven

This class centers around the hunter and his relationship to wildlife management. The subject matter provided by the book *Game, Gunners and Biology* is used as a basis in teaching the background, history and purpose of wildlife management in this country and takes the students up to what is being done in this field today in habitat conservation and restoration, research, ecology, and the harvest and non-harvest aspects of wildlife management. Hunter and firearm safety students are taught some of the dividends of wildlife management. How the vision, study, planning and implementation of modern wildlife management programs are paying off. How it has drawn dozens of our wildlife species back from the brink of extinction and has maintained game in such numbers that millions of Americans can harvest several million animals each year. Slides and films of Florida's game management programs are used as visual aids.

Component Eight

This class is on first aid. Students are taught through lecture, visual aids and demonstration-performance methods how to identify and treat emergency first aid situations they may encounter at home or in the field, such as gunshot wounds, puncture wounds, severe bleeding, fractures and sprains, shock, stoppage of breathing, burns, frostbite and snakebite. They perform bandaging, splinting fractures and sprains, the proper use of compresses and how to substitute and utilize those materials available to them in the field.

Component Nine

This class teaches survival. Many persons go into the woods and suddenly discover they don't know how to get out. Some are temporarily confused while others become hopelessly lost. A few needlessly lose their lives. Because of this, we teach the importance of pre-trip checks, basic precautions, important clothing items, footwear and basic equipment that should be taken into the woods depending upon the length of the trip. We teach the eight basic rules of survival, the use of compasses, the construction of lean-tos and other means of shelter, food gathering and edible plants and construction and use of water stills and sundials. Students are taught how to read a topographic map, distress signals, how to determine direction by signs that are available in the woods, and how to detect the danger signals of hypothermia, commonly referred to as "exposure" (the loss of body heat). Because hypothermia is often called "the killer of the unprepared," particular emphasis is placed on its causes, effects and cures.

Component Ten

The subject of this class period is archery and safe bowhunting techniques. The popularity of competitive and hunting archery has risen very rapidly with a reported 300 percent increase in the sale of archery equipment during the last year. Because of the simplicity of the sport, and the relatively low investment required, an ever increasing number of novices are taking to the woods to hunt with bow and arrow. We stress the safety aspects of bowhunting and the proper methods of taking game with bow and arrow. We also teach bow and arrow nomenclature, the different types of arrows, shaft weight and draw lengths, accessories that are available, care and maintenance of equipment, proper bow handling, how to shoot the bow and Florida's bowhunting laws.

Component Eleven

This class period is on black powder and muzzleloading. The sport of black powder shooting, like that of archery, is enjoying a great resurgence of popularity at the present time. During this segment the history and background of muzzleloading is discussed from the original primitive weapons up to today's modern muzzleloaders. Examples of primitive guns are shown. The unstable characteristics of black powder, methods and techniques of safe loading and unloading, care and cleaning of these guns with special emphasis placed on cleaning, and nomenclature of muzzleloaders and the different types of firing locks are taught.

Component Twelve

In this class period the students are taught pre-hunt preparations. They are briefed on what type guns they will be using, the type of terrain they will be covering, what activities they will be participating in and what they will be tested on. A review of previous class periods is held and students are informed how the information they have learned in previous classes will be utilized in the live range firing and field demonstration exercise. The instructor informs the students where this exercise will take place, the time it is to begin, what type clothing to wear, what articles to bring (such as maps, compasses, food, drink, survival kit) and what type activities they will be engaged in.

Components Thirteen and Fourteen

These components cover range firing of live ammunition and the field demonstration and are held jointly on the last day of the course. They consist of approximately 8 hours and encompass the live firing of rifle and shotgun, shooting archery and a simulated hunt. Here is where the students demonstrate to the instructors what they have learned in the classroom. The field demonstration is a simulated hunt through the woods where the students are graded on their ability to follow a pre-set compass course, handle their guns properly while crossing fences, rough terrain and other obstacles, demonstrate and simulate first aid and survival situations, and properly identify game. The live range firing gives the student the opportunity to shoot a rifle from all four positions, prone, sitting, kneeling and standing, and shoot a shotgun at moving targets to demonstrate his marksmanship and gun handling techniques. The archery portion of the exercise gives the student the chance, for many of them the first chance, to shoot a bow and arrow. A separate archery field course is specifically designed to simulate bowhunting situations and includes shooting from ground level and multiple level platform elevations at several targets at varying distances.

Instructor Certification, Training and Evaluation

There are two methods of becoming a certified hunter and firearm safety instructor for applicants 21 years of age or older. Number one, upon successful completion of the Hunter and Firearm Safety Training Program, the applicant must make formal application for instructor certification. The information on this application is used to check character references and local police agencies. A personal interview is required. The applicant must then plan, organize and teach two classes under the supervision of a certified instructor and be recommended by him for certification. He must also pass a written instructor examination.

Number two, the applicant, if not a certified Florida safe hunter, must satisfactorily complete a minimum 18 hour instructor training course which includes teaching methods and techniques and subject matter to carry out the instructional phase of the program, make formal application for instructor certification with accompanying character references, and undergo local police checks. He must also have a personal interview, pass an instructor examination, and be recommended for certification.

Junior Instructors

Applicants between the ages of 18 and 20 may qualify only as junior hunter and firearm safety instructors. Junior instructor candidates must successfully complete the Hunter and Firearm Safety Training Program and be certified as Florida safe hunters. Upon completion of the course they must make formal application to become junior instructors with accompanying character references, local police checks, and have a personal interview. They must also pass a written instructor examination and be recommended for certification. Upon certification, junior instructors may assist in the classroom and may teach only under the supervision of a certified chief instructor. All instructors upon certification are awarded an identifying shoulder patch with instructor bar and identification cards.

Recertification

All instructors are required to participate in a minimum of two hunter and firearm safety courses per year in order to be recertified automatically. They must also uphold the basic concepts and ideals taught in the Hunter and Firearm Safety Training Program. Any violation of these concepts or ideals will immediately result in the revocation of their instructor certification.

Evaluation

Instructors are evaluated monthly via computer printout sheets which indicate the number of classes taught, the number of students per class, the total number of hours by subject per class, type of guns and archery equipment used, types of ranges and field facilities used, success-failure ratio per class, total number of classes taught from first certification date till present, and number of classes taught during present certification period. Every ten months instructors are evaluated and, if they haven't participated in the required two classes, are advised that they have 60 days in which to meet that requirement in order to retain their instructor certification.

Instructor Re-Training Workshops

Instructor Re-Training Workshops designed for the purpose of providing additional training for certified hunter and firearm safety instructors are planned for each year. In these workshops we update training methods, materials and training aids; critique instructor performance and teaching methods; provide the opportunity for communication of problems of instructors to the professional hunter and firearm safety staff and update instructors on game law changes.

Data Processing and Recordkeeping

A statewide standardized reporting system has been provided through electronic data processing for the purpose of maintaining accurate training records, student and instructor certification, and data on hunting and firearm accidents. This system has three basic input forms necessary to build and maintain magnetic tape files that produce the eleven working and statistical reports needed to coordinate the program throughout the state.

Training Aids and Materials

The volunteer instructor is furnished with training materials, training aids, and audio-visual aids without cost to them or the students in order to assist them in carrying out a uniform course of instruction. These materials are: 35mm slide series: "Marks of a Sportsman" and "Wildlife Identification; 16mm sound films: *Sweet Sunday's Gone, Before You Hunt, A Question of Hunting,* and *Men in Green;* handout materials: "Ten Commandments of Gun Safety," "Is Your Pet Gun Housebroke?," "Guns in Your Home," "You're a Sportsman When. . .," "Vision and Hunting," "Home Firearm Checklist," "What Every Parent Should Know," "Essentials of Safe Hunting," "Hunter & Firearm Safety in Florida," "Game, Gunners & Biology," "Federal Shotshell & Cartridge Identification Sheet," "Federal Ammunition Guide," "Migratory Bird Regulations," and "Hunting and Fishing Regulations of Florida;" equipment such as: 16mm sound projectors, 35mm slide projectors, screens, and tape recorders; and firearms such as: .22 caliber rifles, 20 gauge shotguns, muzzleloading rifles and accessories, ammunition, bows, arrows and accessories, and BB guns and BB's. Other training aids such as 16mm films obtained on a loan basis from local libraries, schools and various film services, instructor manuals, student handbooks, flipcharts, firearm casualty reports and established field training areas and firing ranges are also used.

Summary

Florida's Hunter and Firearm Safety Training Program is a well-rounded, comprehensive course of instruction designed to help sportsmen safely enjoy Florida's wildlife and better understand and appreciate their responsibilities to their fellow sportsmen, the landowner and the natural resource. It is hoped that one day all firearm users and hunters will have completed the Hunter and Firearm Safety Training Program. This educational process will, hopefully, facilitate the attainment of our ultimate goal—the virtual elimination of all hunting and non-hunting firearm accidents in Florida.

Closing Remarks

Laurence R. Jahn
Vice-President, Wildlife Management Institute
Washington, D.C.

Friends, we come to the close of another North American Wildlife and Natural Resources Conference. Sessions have focused on assuring fish and wildlife values to society. Chairmen, cochairmen, and speakers have contributed in an outstanding manner in defining how to achieve that objective. The Program Committee appreciates sincerely the dedicated efforts of all participants. Special acknowledgement is due Phil Agee, Vice Chairman of the Program Committee, and his assistant, Carl Thomas, both representing The Wildlife Society, for their fine contributing efforts.

We hope the information presented here in the last few days will help you and others receiving the transactions to improve our understanding of resources management and advance it on a variety of fronts.

In 1978 the conference will be held in Phoenix, Arizona from March 18 through 22. The National Wildlife Federation's annual meeting will be in the same city from March 15 to 18. We invite you to attend.

The Program Committee will meet next month (April) to start building the agenda for the 1978 North American Conference. Your suggestions for topics and speakers to highlight research findings and practical experiences to help enhance the management of wildlife will be welcomed. They should reach me no later than early April.

On behalf of the Wildlife Management Institute, many thanks for your attendance and attention. Best wishes for a pleasant trip home.

The 1977 North American Wildlife and Natural Resources Conference stands adjourned.

Registered Attendance

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Bob Barker, Tom Counts, Thomas R. Eubanks, F. H. Farrar, Barbara M. Hilyer, W. L. Holland, George I. Horton, Keith Hudson, Tim Ivey, Bruce C. Johnson, Charles D. Kelley, Paul R. Krausman, Neal Lambert, J. Phillip Mason, Doug Miller, Robert H. Mills, Eleanor K. Moody, Raymond D. Moody, David Pylant, Kathryn Rosene, Walter Rosene, Jr., Todd Schaffer, Kenneth R. Sims, Jim Tisdale, Chip Wallace

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