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Opening Remarks

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

Good morning, ladies and gentlemen. Welcome to the 45th North American Wildlife and Natural Resources Conference.

This year starts a new decade; a decade, some predict, that will be marked by a reverse swing of the environmental pendulum. No evidence supports such a prediction. No evidence suggests that the public is disposed to abandon its firm stand on resources issues. Those who hold otherwise have yet to realize that concern for the environment is firmly embedded in our social framework. It is not a fad. If environmental momentum slackens, it will not be because of public disenchantment.

Among the many problems this decade has inherited from the last is that of energy. It goes to the core of national, community and individual well-being, economically and in other ways. In terms of diminished air and water quality and commitment of surface resources, the national costs of domestic energy development are unknown. There are other costs, too, because the allocation of more and more personal and public funds to energy will depress investment in the management of national forests, wildlife refuges, parks, national resource lands and other conservation programs.

Natural resources management and protection traditionally have low federal and state funding priority. They are the first to feel the axe and the last to receive first aid. Already, in the first few months of this new decade, federal appropriations and budgeting signals have changed. Agencies have been directed to curtail expenditures in this fiscal year and to show how they can spend less next fiscal year. The White House and the Congress are jockeying to see who can reduce federal outlays the most. Where it will end, only time will reveal.

Once again—interminably it seems—we are involved in the quadrennial selection of nominees for President of the United States. The natural resources philosophies and commitments of most of the featured candidates are not well understood. The subject, in fact, has attracted little comment.

Our interest has been served unevenly in the past, including by administrations who claimed personal understanding of the need for improved resources management. Successful resources management requires continuing commitment, and results often are not fully achieved for decades or longer. This feature, unfortunately, offers no attraction to the fix-it-now, claim-it-now pressures of the political process. Hence, the view that resources work has little urgency.

This morning, I want to comment on several issues. One, the "Sagebrush Rebellion," is an old problem returned to pester us in new form. Back in the saddle and riding the canyons of mainly the inland West are the landgrabbers and the sons of the landgrabbers, risen phoenixlike from the ashes of earlier defeats. Their goal remains the same—separate the public from its property, from national forests and national resource lands. Building on public discontent with inflation, taxation and regulation, the sagebrushers urge that federal lands be returned to the states, a pleading that sounds reasonable to the uninformed and uncaring.

Interior Secretary Cecil Andrus, in excellent statements on this issue, points out that the states never owned the lands the sagebrushers seek. They were acquired by the United States, through purchase or war. When western states, the so-called public land states, entered the Union, they received settlements of land and money. And they signed agreements disclaiming all right and title to federal lands within their borders.

The game is over, the bleachers are empty, and the landgrabbers want another turn at bat. Some in Congress would grant their wish. But people are catching on to the fact that the "Sagebrush Rebellion" is not a rebellion; it is an ambush. The "old" West of enviable individual independence and open space is pitted against the "new" West, the most rapidly urbanizing region of the country.

National forests and national resource lands are the heart of western America's outdoor life style, a style rooted in the availability of public lands for recreation of all kinds. The "Sagebrush Rebellion" threatens this life style.

In large part, state lands in the West—other than wildlife management areas and parks—are required to produce revenue, mainly for public school purposes. Grazing, timbering and mining are favored. Recreational access often is at the discretion of the permittee. Locked gates are common. And in some states, recreation and wildlife lack equal standing in law with economic uses of state lands.

Multiple-use concepts have yet to reach western state lands. Further, should title transfer, the states have questionable financial capability to administer federal lands at even present management levels. Idaho, for example, would need nearly $60 million annually to continue current national forest management there. Little wonder that much of the statehood land grants have passed into private ownership. Little wonder, too, that few western Governors endorse the "Sagebrush Rebellion."

The Forest Service and the Bureau of Land Management have many opportunities to ease the public's irritations of doing business with government. In places, for example, where federal lands obstruct community expansion, faster relief should be provided. Permits, leases, application forms and other procedural matters can be standardized. But in seeking to overturn the whole public land system, the sagebrushers point an elephant rifle at a vexsome mosquito.

The next few months offer opportunity to close the circle of wildlife management authority in this country. That being congressional authorization of a federal-state cooperative program for the so-called nongame species of fish and wildlife. The House of Representatives has approved a bill to provide federal and state cost sharing for comprehensive fish and wildlife planning, primarily for nongame species. A Senate bill, now gaining momentum, expands this by authorizing cost sharing for on-the-ground implementation of nongame projects in states where planning is complete, and for emergency work, as well.

A congressionally sanctioned nongame program is needed for several reasons. In addition to coordinating national direction, it will provide some federal funding, the availability of which may induce reluctant legislatures to provide state agencies with financial support beyond that already available for nongame work. In most states, funding is a more critical need than authority at this time.

Neither the House nor Senate bill will provide adequate funding over even the near term. But they offer a start. The House bill represents the best commitment the committee could extract from the Administration, that being a 3-year, $19 million authorization for comprehensive planning. The Senate would authorize $50 million over the next four years. But I caution that talk of any federal funding in this time of retrenchment is speculative at best.

Neither bill calls for manufacturers' excise taxes. That approach is not politically viable at this time. The excise tax option was included in the original Senate bill to flush out the wild bird product industry, to identify the major elements and to catalog industry concerns. The revised Senate bill would have the Fish and Wildlife Service study and report on potential funding sources outside of general appropriations.

The manufacturers' excise tax approach upholds the time-honored principle that the fairest tax draws from the interest most directly benefited. And as we all know from long experience with the Federal Aid in Wildlife and Fish Restoration programs, the manufacturers' excise tax approach tracks market growth and inflation. Given an adequate taxing base, the yield will sustain the program into the indefinite future. Not unexpectedly, the manufacturers and processors of wild bird products were not enthusiastic about the first Senate bill. Their objections were mainly business-related—all surmountable—and from a general lack of recognition—or acceptance—of the public's willingness to bear such taxes providing the receipts are dedicated for nongame work.

Everyone should understand that the House of Representatives, not the Senate, has constitutional authority to initiate tax legislation. It is a jealously guarded right. Any Senate effort to move the tax would have condemned it to early extinction. There would be no intermediate threatened and endangered stages. Fish and wildlife interests should be prepared to take active roles on the funding-source deliberations that will occur in the next few years.

Discussion of the need for elevating attention given nongame fish and wildlife has been marked by some groups denouncing the efforts of state and federal agencies. A favorite ploy has been to compare funding credited wholly to nongame work with that listed, by project title, for game species. Such comparison is inaccurate in the extreme. It ignores the inescapable ecological fact that habitat acquired, developed and maintained for game species routinely supplies life requirements for an infinitely larger number of nongame species. And in most cases, for a much greater diversity and abundance of nongame species than used the original habitat.

In a balanced fish and wildlife program, the distinction between game and nongame species is more a matter of convenience than fact. States contribute to public confusion on this matter, in my opinion, by failing to acknowledge benefits accruing to all fish and wildlife from their programs. States are not taking full credit for what they are doing. Some appear unmindful of the great need for doing so.

On another issue, several national conservation and agricultural groups have been cooperating in a project to open more private land to public recreation. It involves development of a model state act, plus supporting documentation, to remove ambiguities and ease burdensome requirements of state liability and trespass laws. The model act has been approved by the Council of State Governments and is printed in the Council's 1980 handbook of Suggested State Legislation. Governors, state legislatures and others draw on this handbook for guidance in framing appropriate legislation on timely issues of broad public concern.

State committees now are being organized to develop understanding and support. All interested individuals and groups may participate. On your return home, I urge you to help ramrod this worthy effort in your state. Brochures describing this project and listing further sources of information are available at the rear of the room.

Earlier this month, in Washington and in major centers throughout the world, a World Conservation Strategy was unveiled. It was prepared by the International Union for the Conservation of Nature and Natural Resources, under the sponsorship of the United Nations Environment Program and the World Wildlife Fund. It deals with such problems as deforestation, desertification, depletion of fisheries, soil erosion, misuse of croplands, and genetic diversity. It reflects agreement within the world's scientific community on what needs to be done to ensure that natural resources are used wisely for this and succeeding generations. It recognizes that conservation can contribute substantially to development. The World Conservation Strategy and supporting documents are worthy of your study and reflection. A sign-up list for copies is at the rear of this room.

Now, a final point. Senator John Chafee of Rhode Island, a member of the Senate group responsible for wildlife and the initiator and advocate of nongame fish and wildlife legislation in that body, recently introduced a bill to broaden United States' financial and technical assistance for fish and wildlife work abroad. This proposal merits serious consideration. You will recall the sharp scuffle last year opposing the United States' assent to the proposed Bonn Convention on the Conservation of Migratory Species of Wild Animals. The position that prevailed, and continues to prevail, is that the conditions of the treaty, while meritorious in terms of advancing fish and wildlife programs in and among countries lacking them, would be harmful to established and successful programs in the U.S. This view was shared by Canada and several other countries. The Chafee bill would provide a way for the U.S. to assist countries around the world without upsetting established authorities and procedures here. It, too, merits your consideration.

The Changing Resource Scene in Florida

Colonel Robert M. Brantly
Executive Director
Florida Game and Fresh Water Fish Commission, Tallahassee

Good morning ladies and gentlemen. It is my pleasure, on behalf of Governor Bob Graham and all the people of the Sunshine State, to officially welcome you to Florida. Lieutenant Governor Mixson sends his regrets that he could not be with you. As a farmer and avid hunter and fisherman, he is a strong supporter of conservation. Governor Graham has just recently designated him as his chief lobbyist and legislative spokesman. The Governor has proposed a comprehensive energy conservation program which is currently in committee and there are meetings today that require the Lieutenant Governor to be in Tallahassee. I would like to take this opportunity to tell you something of Florida's natural resources, our problems in managing them, and how we are going about it.

Florida is a state of contrasts. We have an underwater park and a "Magic Kingdom." We have counties with more than 2,700 people per square mile and counties with less than 6. There are more than 2,000 miles (3,219 km) of coastline and more than 4,000 square miles (10,360 km^2) of fresh water. In one part of the state, you can drive for hours and see little more than pine trees; in another, nothing but sawgrass; in another, nothing but orange groves; and in yet another, nothing but cities and the development associated with them. Whatever it is you seek, you can most probably find it somewhere in Florida, with the exception, of course, of mountains and snow.

In order to understand more fully the diversity and value of Florida's natural resources, a short tour of the state would help. I will ask you to use your imagination and step with me onto an energy-efficient magic carpet which will whisk us around the state and allow us to examine our major resources.

As we leave this hotel, we encounter one of the best known and most popular of our resources, the beaches and barrier islands. Even our numerous man-made attractions can not rival Florida's beaches in attracting people to the Sunshine State. The beaches, coupled with the subtropical climate, were the first and are still the major factor influencing migration to Florida. The distribution of our population attests to this fact.

Peninsular Florida is basically two coasts back-to-back, since at no point is it possible to be more than 60 miles (96 km) from the sea. With more than 2,000 miles (3,219 km) of shoreline, it would seem that there would be enough to go around, but such is not the case. Since coastal property now sells by the linear foot, in this area more than $4,000 per foot, it should be fairly evident that regulating development of such desirable and valuable property is difficult and complex.

Just off the beaches swim another of Florida's vast and varied resources, salt-water fish. By 1990, it is estimated that salt-water fishing trips in Florida will exceed 100 million per year.

In his quest to be near the coast and on the water, man has dredged, filled and generally altered vast areas of our coast. A total of 60,000 acres (24,282 ha) or 8 percent of basic estuarine habitat has been lost so far to these activities. It is evident that we must protect this resource or, by their presence, people will destroy the very reason they settled on the coast in the first place.

As our magic carpet heads to the west, we look out over one of the areas containing the most critical resource for south Florida, fresh water. We first notice the state-managed conservation areas covering 1,345 square miles (3,484 km^2). Next is the Everglades National Park with 1,400,000 acres (566,580 ha), and last we see the recently created National Big Cypress Preserve totaling 570,000 acres (230,679 ha). In all, Florida has 4,424 square miles (11,458 km^2) of fresh water.

In addition to Lake Okeechobee, with its 700 square miles (1,813 km^2), there are 18 lakes with 10 (26 km^2) or more square miles of water and an additional 5,796 lakes in excess of 10 acres (4 ha). There are 10,550 miles (16,975 km) of rivers and streams and more than 100 large springs, of which 22 are considered first magnitude, producing daily in excess of 64.6 million gallons (244.5 million liters) of water each. The total runoff from just these springs, about 4 billion gallons a day, exceeds the total volume of drinking water used by Floridians daily. In fact, ten to twenty times the amount of water needed by Floridians flows into the sea each day. With this kind of resource base, it would seem that there should be no problems with water supply, but again, such is not the case. The problem is one of distribution, getting the water to the right place at the right time.

As our magic carpet proceeds to the northwest, you will begin to notice vast areas of badly disturbed land, strip mines. Phosphate was discovered in central Florida in 1881, and for the 84th consecutive year we rank as the leading state in phosphate production. In fact, 86 percent of the domestic and 33 percent of the world production is mined from just five Florida counties. As in any large-scale strip mining operation, the effect on other resources can be dramatic. Not only is land destroyed, but the waste products can be disastrous when inadvertently allowed to enter lakes and streams. Reclamation of the mined lands and protection of adjacent lands and waters is obviously a major resource problem.

Florida has other mineral resources, such as petroleum. We ranked ninth in 1977 in oil production. Limestone and Fuller's earth are also major resources. These and all other mineral recovery operations present problems for management of other collateral resources.

As our ride takes us north, we are greeted by trees as far as the eye can see. Timber is a major resource as well as a major industry in Florida. Like most states, Florida has relied on its forest since its beginning. Although most of the virgin forests were cut during the first half of this century and most of the second growth has also been cut, our tree planting program, exceeding 100 million trees per year, and scientific forest management techniques are ensuring the state a continuing supply.

The major commercial tree is the pine and most of the production goes into pulpwood for making paper and paper products. Although annual growth now almost doubles the annual consumption, increasing demand, especially as an alternative form of energy, may reduce this favorable trend unless long-range planning can be effective. It is important to remember that trees planted today will not be ready for harvest until the beginning of the next century.

A major factor which endangers this resource is the conversion of timberland to residential land. As the mass migration to Florida continues, many timber-producing acres become more valuable as real estate for homes than for growing trees. Increasing conversion of these lands could have a significant impact on timber production.

Closely aligned with the timber resource are Florida's wildlife and fisheries. To many Floridians and even non-Floridians, the Sunshine State is the "outdoor state." Florida's wildlife and fish are not challenged in number or diversity anywhere in the U.S. However, on the other side of the coin, Florida also leads the continental U.S. in the number of *endangered* wildlife species. A total of 68 species are now listed on the official State Endangered and Threatened Lists and 34 more are species of special concern.

In the areas of game species management and providing public hunting opportunities, Florida has an outstanding record. The state wildlife management area program consists of more than five million acres (2 million ha) of public hunt areas. Over 100,000 hunters annually utilize these areas for their recreation. These areas are scattered across the state and ensure hunting opportunity for those who do not have access to private lands.

I have already mentioned the amount of fresh water in Florida, and game and commercial fish abound in every area of the State. The prize fish of Florida's fresh water and the official State Freshwater Fish is the largemouth bass. It is estimated that by 1990, freshwater fishermen will make more than 78 million fishing trips a year.

As our ride takes us back south along the east coast, the last resource I want to mention becomes less and less available and more and more sought after. I refer to natural areas, parks, and recreational areas. Florida has more than 8.8 million acres (3.6 million ha) of outdoor reaction lands: of this, 4.8 million acres (1.9 million ha) are owned or administered by the State, 3.1 million acres (1.3 million ha) by the Federal Government, and 75,000 acres (30,352 ha) by city and county governments. Although this may seem to be adequate, only a few of these sites are in or near the major population centers, and with rising energy costs, the demand for "close in" recreational sites will increase.

As our magical tour concludes, I hope the extent and complexity of Florida's natural resources have been partially demonstrated. What may *not* have been noted are the many and complex stresses being placed on these resources and the varying and often conflicting demands for their use.

Florida's natural resources are diverse but intimately related, ranging from our expanses of beaches and barrier islands to our inland sea, Lake Okeechobee. I can best characterize the changing resource scene in Florida by a retrospective look at the Everglades, the internationally known "River of Grass."

In 1847, following the Seminole Indian War, Buckingham Smith of St. Augustine was dispatched to explore and describe the Everglades. His instructions from Washington were to find out whether it could be "reclaimed and made valuable." His report documented a vast marsh extending uninterrupted for 100 miles (160 km) from Lake Okeechobee to Cape Sable. It was a vast wilderness teeming with wildlife and storing incalculable amounts of fresh water. However, historically, a marsh has always been considered a swamp and good for nothing but draining. And so it was with the Everglades.

As evidence of this point, Smith estimated that in 1847, no more than 50 persons, other than Seminole Indians, lived south of the northern end of the

Everglades. He predicted, however, that after drainage, " . . . a population of perhaps 250,000 could ultimately live in the reclaimed region." His insight was unerring, but his optimism was not sufficient, since today more than 3.4 million people live in our seven southern-most counties.

In the intervening years, the Everglades have felt the pressure and bear the marks of man. Man has diverted the water, farmed the soils, and built dwellings on much of what used to be the "River of Grass." Most of what is left is contained in state-managed water conservation areas and in the Everglades National Park. The fate of what remains of the Everglades depends on what we do in the 1980s.

The Everglades today is a prime example of man's short-sighted outlook toward the utilization of resources and his failure to recognize the need to coexist with nature. Instead, man attempts to alter it to fulfill his own perceived needs and desires. Man *has* interfered drastically in many areas of Florida, and is now faced with the difficult task of correcting past mistakes and avoiding new ones. One factor that makes this so difficult is people's diverse needs and interests in natural resources.

A resource is basically a reserve source of supply of a desirable commodity. As long as the reserve is large, there are few problems associated with it. It is only when the reserve is small that competition for the resource causes problems. Unfortunately, most, if not all, of our natural resources are now limited and competition for them is intense. Without question, the single greatest factor impacting Florida's natural resources is human population, both in terms of number and extremely rapid growth.

Although Florida became a state 135 years ago, it entered its adolescence, as far as growth is concerned, sometime after 1950. Between 1950 and 1979, while the U.S. experienced a 45 percent growth rate overall, Florida more than tripled in population, going from 2.7 million to 9.2 million people. In the boom years of 1972–1974, new residents moving into Florida totaled more than 380,000 per year. The current rate of 250,000 is somewhat less, but a quarter of a million people each year is considerable. In fact, this is the equivalent of two new Orlandos or three new Tallahassees each year.

In 1950, Florida was the twentieth most populous state. It is currently the eighth and predicted to become the fourth by 1990. During this period of rapid growth, 91 percent of the population increase was due to migration into the state. This means that most of the population increase has been composed of adults. Adults place greater demands on resources than do children. This is due to the fact that children are born into existing households while adults moving into the state require new housing. Also, the number of persons per household is much lower in the retirement areas of the state.

Additional problems are generated by the distribution of the population. Nearly 80 percent of Florida's population is concentrated on the coasts and 30 percent in the southern third of the peninsula. All of this has enormous impact on our natural resources. It is fairly evident that as the number of actors increase, the scene must change. Since there is little control on growth, we must do what we can to direct the changes toward the most effective and efficient utilization of our resources. Florida's commitment to protecting, preserving, and effectively utilizing these resources, can best be demonstrated by looking at the major Florida resource legislation passed during the 1970s.

National consciousness of natural resource problems began building in the early 1960s and probably climaxed with Earth Day in 1970. Shortly thereafter, most states gave high priority to conservation legislation. Although some legislation was passed as early as 1970, the banner year in Florida was 1972. Bills passed since that time, for the most part, simply refine the policies and procedures initiated that year.

The conservation legislation of the 70s groups into three specific areas: coastal resources, air and water, and land and wildlife, and one more general area of planning and organization.

Since Florida's coastal resources are the most visible, this area has received considerable legislative attention. The "Beach and Shore Preservation Act" provides for beach nourishment and erosion control programs, regulates coastal construction, and establishes set-back lines along beaches, seaward of which construction may not occur without special authorization. Prior to passage of this act, the Coastal Coordinating Council had been established in 1970. Although it was disbanded in 1975, the current coastal management program is an outgrowth of the work of that council. A refinement of the previous act, "The Coastal Management Act of 1978," sets the stage for progress in the 1980s.

In the area of air and water resources, there are several laws which provide control. The first, "The Air and Water Pollution Control Act," declares it to be the policy of the State of Florida to conserve the waters of the state, and to maintain and improve the quality thereof for public water supplies; for the propagation of wildlife, fish and other aquatic life; and for domestic, agricultural, industrial, recreational, and other beneficial uses. Also, it declares it to be state policy that no wastes be discharged into any waters of the state without first being given the degree of treatment necessary to protect those beneficial uses.

In addition, this act declares it to be the policy of the state to achieve and maintain such levels of air quality as will protect human health and, to the greatest degree practicable, prevent injury to plant and animal life.

Protection of land and wildlife resources has also received well-deserved attention. "The Environmental Land and Water Management Act of 1972" provides for the establishment of land and water management policies to guide and coordinate local decisions relating to growth and development. "The Land Conservation Act of 1972" and its successor, "The Conservation and Recreation Act of 1979," provide for the acquisition and protection of environmentally unique and irreplaceable lands as valued ecological resources of the state. Through these programs alone, Florida has acquired nearly 400,000 acres (161,800 ha) of environmentally unique land for protection and recreational use.

Two other acts which are important, especially to fish and wildlife, are the "Aquatic Preserve Act" which gives special protection to certain critical water areas and "The Endangered and Threatened Species Act of 1977."

Three other laws must be mentioned as extremely important for the development of future plans for Florida's natural resources. The first, "The State Comprehensive Planning Act of 1972," required a state comprehensive plan to be written, which provides long-range guidance for the orderly social, economic and physical growth of the state by setting forth goals, objectives, and policies. The second, "The Environmental Reorganization Act of 1975," redefined the roles of state agencies in the administration of environmental programs. Finally, "The

Resource Recovery and Management Act" promotes the reuse of many recoverable resources.

All of these acts serve as building blocks for the resource management program of the 1980s. Recognizing this fact, Governor Graham created and appointed in January 1979, a Resource Management Task Force composed of citizens from throughout the state representing different business, professional, environmental and agricultural interests.

In charging the Task Force, Governor Graham asked that they examine the state's major resource management laws and policies, and identify problems and solutions for resource management. In addition to several short-term goals, the Task Force was asked to study ways to improve the administration of resource management to eliminate duplication and inefficiency.

The Task Force report, released in January of this year, will serve as a guidebook for the programs of the new decade. Specific recommendations were made in eight major areas and are too lengthy to discuss here.

However, two prominent concerns transcend and recur throughout the Task Force recommendations. The first involves the lack of proper funding of resource programs. Underfunding has been a chronic problem which has thwarted the basic intent of much of the resource-oriented legislation of the 1970s. The Task Force emphasized that ". . . adequate funding is a critical necessity to the implementation of the Task Force recommendations."

The second concern involves integration of resource programs at *all* levels. The Task Force proposed that " . . . effective programs to manage Florida's resources must be organized and implemented as a part of an integrated policy framework. To accomplish this, concise and specific State policies must guide regional policies which must, in turn, guide local government's comprehensive plans in identifying and protecting State and regional concerns."

The Task Force concluded that to accomplish its goal of reshaping and strengthening resource management in Florida, would " . . . require a concerted and sustained leadership effort by the Governor, the Legislature and the general public."

In reality, adjusting our programs to meet the challenge of the 1980s will take a concerted, unified and dedicated effort by all the people and agencies of Florida. A concerted effort is mandatory if we are to persist under the pressure of an ever-increasing population to protect and properly manage our resources. We must have a dedicated effort from all who are concerned about our resources and our future. I have often heard it said that conservation battles are simply delaying actions designed to forestall the inevitable. I, for one, do not believe this to be the case. I believe the battle *can* be won.

In conclusion, I would like to leave you with this thought. What Florida is facing today, due to population growth, most of you will be facing tomorrow. Hopefully, it will not be as drastic and the impact on your resources will perhaps be more subtle. Take a close look at not only our successes but our failures. During the course of this conference, learn from us and from each other in order that we may chart a course in which wise management and use of natural resources is the norm rather than the exception.

A Perspective on Federal Public Land Policies in the Late 1970s and 1980s

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I take great pride in being asked to offer one of the opening comments at the 45th North American. As usual, your program is rich in professional papers, and those few of us asked to give broad policy messages carry a special responsibility to suggest themes which will help to unify and focus the many diverse subjects which will be covered in other presentations.

In this regard, I come with a very specific mission to report on at least a part of my experience over three years as Assistant Secretary. I intend to offer one firmly held perspective about the events and lessons of that period and the priorities for the year just ahead. Your program committee was extremely kind to me, assigning an almost limitless subject for my presentation on land and water policies. Given my responsibilities, this made the choice of issues to emphasize nearly impossible. The options included the Outer Continental Shelf (OCS) oil and gas program, rangeland management, the Alaska lands, the Presidential water policy and a host of miscellaneous individual issues like pipelines and power plants which have more than occupied my time.

Frankly, however, there was little doubt about the most important message I could bring. I believe that the Carter Administration, and I, both came into office at a time of unique opportunity and risk with respect to federal resource management, particularly on the public lands where multiple-use management applies. In one respect, early 1977 was near the end of one era, and early in the beginning of another.

The era ending, of course, was over a decade of unprecedented national attention to fundamental resource protection and management issues—a period in which one law after another regarding environmental and resource management standards was hammered out in long and controversial national debates. Most people called it the environmental era, correctly recognizing that many of the issues under debate related to environmental protection, but missing the point that far broader concepts of resource management were also involved.

The era beginning was one of practical application of these new laws. It would be a period of integrating the new standards into federal resource decision making and building a record which would sustain the new laws during a time when the growing demands on federal resources, particularly energy resources, would cast doubt on the wisdom of new standards and procedures designed to create balance as development decisions were considered.

In early 1977, what remained of the major congressional work (on surface mining and outer continental shelf leasing, for example) awaited only an administration which would offer support rather than opposition and vetoes. With the arrival of Jimmy Carter, this support was forthcoming, the remaining laws were passed, and a constructive atmosphere for their implementation was clearly established. Considered as a whole, the new laws set sweeping standards for air and water pollution, environmental analysis, federal energy leasing for coal, oil and gas, protection of endangered species, regulation of surface mining, and a number of other critical resource areas.

From the perspective of federal public lands, no law was more important than the Federal Land Policy and Management Act (FLPMA), surely one of the great victories in this century for sound resource management. Definitely ending dominant use management and many federal land disposal practices, this Act provided a long-overdue mandate for responsible multiple-use management of all the resources found on public lands. Improved management of public land, along the FLPMA model, was a theme that Congress also reinforced in its other actions. In the Federal Coal Leasing Amendments Act (1976) and the Surface Mining Act (1977) for example, specific standards for public land-use planning and protection were important elements of the new laws. Later, in 1978, the Public Rangeland Improvement Act was passed, clearly built on the foundation set by FLPMA and the political concensus for more balanced public land management that it created.

The issues which would be affected by such new laws and concepts in 1977 were in no respect abstract; they were immediate and controversial. Various attempts to establish a federal coal leasing program were in legal and political ruin; proposals for major energy facilities on public lands (Kaiparowits, for example) had been stopped cold; and the controversies over abuses of the public rangelands were being settled by court order rather than good management. Even worse, the atmosphere was clearly confrontational. Administrations for several years had attempted to institute new energy programs, such as coal or offshore leasing, while at the same time opposing the basic laws being sought to bring balance to such efforts. Where laws had been passed, the new standards established had clearly not been integrated into federal management systems. The result was predictable—confrontation, litigation and stalemate of many extremely important federal resource actions.

From my perspective, the principal charter for the Carter Administration and for the Andrus Department of Interior was clear. It was to take the new laws seriously and to apply them in such a way that they made the difference between success and continued failure, particularly in the management of the federal public lands. As I saw it, it was up to us to demonstrate that the congressional formula could work—to show that minerals could be extracted, forage used by the livestock industry, timber harvested, energy facilities developed, wildlife and cultural resources protected, recreational opportunities offered, all in a management system that satisfied these competing uses while maintaining the basic integrity of the resource base. Beyond the pursuit of the few remaining fundamental laws which remained to be passed (OCS leasing, surface mining), I believed that the burden had shifted from the Congress to the managers, the interest groups and the public to make the laws work and to sustain them. In no area was the challenge greater than for FLPMA, and for the Bureau of Land Management (BLM).

While most parties with a stake in the public lands were convinced that, in theory, balanced, multiple-use management was the proper approach, most parties were also skeptical, watchful, and ready to assert a dominant priority for their special interest, including wildlife. Such doubts are always based on very realistic concerns. Can an agency with resource development responsibilities, such as minerals production, be truly sensitive to the needs of wildlife and wildlife habitat? At the same time, can ranchers, miners, and oil producers be confident about the ability of resource managers to apply a concern for wildlife without putting the brakes on what those users see as essential actions of resource development? There were, in other words, many good reasons to believe that the new environmental laws would fail to stimulate cooperation among all interests in working toward balanced resource management; including prompt actions on sound development programs. Rather, there was fear, and some early proof in litigation, that the new laws would simply provide new footholds for fighting the old battles, often to a bitter standstill. While such litigation is often necessary, as perhaps it was in the action against the EMARS coal leasing program, or in the action to secure adequate environmental analysis of federal range allocation decisions, such a predominate end use for the new environmental laws would be self-defeating and shortsighted for all interests involved.

From the beginning, my own priority was to shift the emphasis from congressional struggle or litigation to successful management decisions based on the new laws. The immediate challenges were obvious: rebuild the federal coal leasing program, establish a new range management program, build coalition to support those programs, and begin to set examples for settling specific energy facility problems which had, in the past, defied resolution. In each area, I believe we have been successful and learned lessons which should serve us in the future.

Where once there was significant and legitimate opposition, not only from environmentalists, but also ranchers, farmers and western states, there now exists a new and functioning federal coal leasing program, largely free from litigation and enjoying broad and diverse support from most of those who earlier had opposed it. It will lease coal, but do so through a process which gives more consideration to wildlife, agriculture, rural communities, and other resources and resource users that could be damaged unduly by federal coal development. One feature of the new program is a requirement that local BLM managers apply a set of unsuitability criteria to federal coal lands, to screen out the most environmentally sensitive lands so they will not be considered for leasing. In a management sense, the biggest impact of the unsuitability process is to require an accountable, on-the-record procedure for decisions by field managers, decisions that may continue to be based on subjective judgements about the meaning of wildlife data, for instance. Industry fears to the contrary, we did not expect the unsuitability standards to screen out large amounts of federal lands. What we expected, and what we got, is a system that provides a much better chance of assuring that genuinely critical wildlife habitat and other highly sensitive areas are identified and protected. As we predicted, applying the criteria has put some coal lands off limits to leasing, but only a reasonable percentage, leaving most of the federal lands open to further consideration. We are proving that it is possible to operate a coal leasing program to meet the Nation's energy needs, and do so while incorporating standards that give real protection to wildlife and to other resources.

We have also shown that it is possible to build new powerplants in the West, but do it right. No energy facility siting issue could hold potential for more conflict than proposals to build major coal-fired powerplants in Utah. The Kaiparowits issue had demonstrated the inability of industry or government to plan for energy development in a way that would meet power needs without damaging some of our finest national parks. And when this Administration took office, another major proposal for energy development in southern Utah was facing the Department.

The City of Los Angeles and other municipal power systems from California and Utah proposed to build a 3,000 megawatt coal-fired powerplant only 9 miles (14.5 km) from Capitol Reef National Park in southern Utah. The plant, called the Intermountain Power Project, would have caused undisputed air quality violations in the national park. Secretary Andrus acted quickly to protect the national park. He informed the company that he would not grant the use of federal lands for the plant site and transmission lines. But then the Secretary took the next step, something that had not been done before—he offered to work with the company, and with the Governor of Utah, to find a place where Intermountain Power Project could be built. The Department worked actively, with the company and with the state, to study alternate sites, review coal and water supply questions, and coordinate funding for social and economic impact aid from federal agencies. The result was truly balanced, multiple-use resource management. Finally, a new site was approved, and the project is going forward, enjoying not only formal approval, but broad support, as well. Coal-fired power will replace electricity now being made with costly imported oil—and the air quality in the national park will stay pure.

Again looking back to early 1977, few areas had a longer or more chronic tradition of mismanagement than the public rangelands, and the condition of the resource showed it. The continued dominance of livestock grazing had eventually forced a major lawsuit seeking a full environmental accounting of the effects of range allocations. Only early and effective implementation of FLPMA seemed likely to reverse a future of continuing conflict, with problems being resolved more often by the courts than by resource managers and the public. What was needed was an historic bargain between livestock users and other users of the range, which would move toward faster recovery through a combination of reduced grazing pressure, a greater balance of uses, and immediate efforts to accelerate range improvement. In many respects, that partnership has begun to form. Both the passage of the Public Rangeland Improvement Act and the passage of appropriations for range improvements under the Act were the product of an unprecedented coalition of ranchers, environmentalists, states, the wildlife community and others. From my perspective, this is proof positive that the new laws can lead to productive management rather than greater controversy.

Looking back over the past three years, even in this limited summary, I think it would be fair to say that we have made remarkable progress in dealing with issues that had seemed beyond the reach of sound resource management. We ended years of management paralysis in the federal coal leasing program, and did it by implementing a new program that offers much higher levels of protection to the environment while assuring increased production of coal. We showed that the country does not have to make a choice between parks and power; that with the right kind of leadership, industry can be helped to develop plants that do not violate the air quality of our national parks. And we began to show that, for the first time, management of the federal rangelands really can be balanced—even when that translates into reducing livestock grazing allotments. More important, I think, than any of the individual achievements, is the demonstration that the principle works: that the laws Congress spent more than a decade to enact are reasonable, that they protect our environment and make it possible to reach decisions about grazing, energy leasing and production, and economic development. We have given the lie to the argument that protecting wildlife or bringing the public into resource development decisions would put unreasonable obstacles in the path of development.

Obviously, this is not the end of the story, but these are encouraging signals of success. I believe they are part of the trend which clearly demonstrates the capability of the new laws not only to promote balanced management of federal resources, but to allow needed decisions for resource development or use to progress in a reasonable way when they meet the standards. I believe most of us behind this remember that these laws were debated very often on extreme and unfair terms with regard to environmentalism.

There are, however, other trends, and I believe one of them is important enough to highlight today. I believe it represents a threat to the success we have had in many specific areas, but more important, I believe it represents a more serious threat to the basic laws so many of us fought for, and now seek to sustain. Let me be specific. In the Secretary's new coal leasing program, new information requirements, new public participation opportunities, and new procedures to require that careful planning be done prior to decisions about coal leasing have been incorporated. I consider these new elements to be strong improvements over the minimal environmental or planning requirements of older leasing programs, and I believe that most environmental observers share than belief. But it is apparent that building these reforms into the day-to-day work of field officials of the BLM will take time. We will go through a learning process, a period of uncertainty, mistakes, and corrections. But now, some environmental critics have made it clear to us that if our performance under the new standards is less than perfect, if a BLM field official makes a mistake, if our initial information is not up to the standards we aim for, those mistakes may be treated as legal vulnerabilities—as footholds for litigation to prevent any decisions about coal leasing.

We have also been told by three environmental organizations that they do not want any more powerplants built to serve California, even if the plants can operate in compliance with all environmental laws. And we have been put on notice that the procedural work of all Interior agencies will be scrutinized, to see if any technical mistakes can be discovered that might be grounds for litigation to delay development of the plants. The department has not prejudged these projects, and Secretary Andrus has already demonstrated his commitment to making sure that energy development does not degrade our national parks. But now, for some, even the process of taking a fair and honest look at a proposed project has become, instead of an effort to see that plants are developed according to law, a procedural game in which some interests are determined to use the process to try to kill specific projects totally.

In the area of range management, the situation is better, but still uncertain. There we have lost two important battles as the coalition we need is forming. Over the strongest case we, and many of you, could muster, we lost the effort to raise grazing fees to a responsible level. In the last appropriation bill, we were forced to accept a compromise which limited, but did not preclude our ability to impose overdue and justified reductions in grazing allocations. These are discouraging signals indeed. Still, we continue to move very near a consensus on a balance between grazing reductions and range improvements. As we do, I believe there is at least a minority in the wildlife and environmental community considering a return to a broad legal challenge to range management decisions and the confrontation we seek to avoid.

I am not in any way challenging the right of any party to work for the resource management scheme they believe to be most appropriate or against a project they oppose. I have done the same, and will continue to do so. It is true, for example, that at least to some degree the utility industry's acceptance of energy conservation, or of new technologies, will be influenced by the cost and the convenience of pursuing more traditional energy investments, and it is certainly true that some projects and development decisions deserve opposition. How it is done, however, concerns me. I do question the wisdom of parties who, no matter how sincere, are shortsighted enough to believe that broad social or economic goals can be achieved through the use of more narrow or more technical restrictions on the activities of our industrial economy. In my view, such an approach simply reinforces the stength of those who would like to do away with our environmental and planning standards. The widespread belief in the Congress that an Energy Mobilization Board should have the power to waive substantive federal environmental laws is, I believe, in large measure an over-reaction to the fear that environmental laws will be used to block development rather than to modify development and make it acceptable. While the Administration, and most of you, I am sure, strongly oppose such an approach, it has much greater support than it should, in view of the work of the last decade.

The "sagebrush rebellion," for another example, is largely the reaction of people and interests who, for the first time, are seriously being asked to share power over resources that are vital to their survival and which they have traditionally dominated. The reaction is understandable even if it seems to be a part of our American nature to think in extremes. Most of you will remember when, just a few years ago, the West was being talked of as a "national sacrifice area," the place where wildlife and Indians and agriculture and states' rights would be swept aside in favor of energy development. Now, after the passage and implementation of the laws we have talked about, we hear of the other extreme—about BLM planning or wildlife protection laws bringing the energy industry to its knees, or the states and the Indian acting like independent OPEC nations, or the Federal Government assuming dictatorial resource powers. This tendency to look for and believe the worst can make it hard to reach sound decisions under the best of circumstances. At a time when our country, for legitimate reasons, is concerned about our national security and our economy, it is essential that everyone concerned about our natural resources avoid reinforcing the fears of those who do believe the worst. For that minority in the environmental community who believe, no matter how sincerely, that there should be no more federal coal leasing, I urge that the issue be faced directly. Because if the unsuitability criteria we have developed to protect wildlife become used instead as tactical weapons in a larger war to prevent coal development, the first casualty may well be the criteria themselves or the program, or the laws that support it. If those who believe with equal sincerity that California utilities should not develop any more coal-fired power plants are unable to put a lid on California energy growth, but use our national parks or our air quality laws as procedural obstacles to plant development, it could well be the parks and the air that suffer.

I believe that all of us have every reason to be proud of results of our work, not just of the past three years, but over the decades that led to our current body of law in support of better environmental protection. Support from President Carter and this Administration will continue. I believe the Congress, too, recognizes the value of its work of the past ten years. Building on this support, and on the continued commitment of the organizations and people here today, I am confident that protection of our natural resources will continue to be a high priority for America. To assure this continued success, all of us are going to have to work a little harder, not just in the improvement of our performance in our own disciplines, but to demonstrate our own commitment to what we know to be true: that our work in behalf of a sound environment reinforces the integrity of our economy and our society as a whole. Thank you.

Managing Rural Resources: The New Era of the 1980s

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There are many conservation success stories coming out of the 1970s. I am not going to talk about one today. We are entering the 1980s with a dawning awareness of the importance of agricultural resources, but we have scarcely begun to adapt our values and our behavior to this discovery. I will describe some promising efforts under way, but my message today is more one of alert, alarm, and of the need to raise public consciousness of severe problems, than it is a report on successes in dealing with them.

We are entering the 1980s with a 1960s world view of our nation's renewable resources. This view is tightly locked into many of the plans and programs of all levels of government and of many private institutions and decision makers. Before we will be equipped to deal with the issues of the 1980s, we will have to stand the views appropriate to the 60s, and, even to some extent, the 70s, on end. Let me explain what I mean.

The Nation's Renewable Resource Base

New Demands on the Land Resource

I want first to review a variety of powerful pressures on the nation's renewable resource base. We might begin with people and the pressures caused by people as they move and as they use land. You may recall that the 1960s were a period of very rapid urbanization and of serious public concern with the environmental impacts of urban growth and development. A new mood in America arose in response to a popular public belief that growth was too much, too rapid, and too ugly. During the 1960s, 23 million people reached the age of household formation, the age of 30. Compare that number with the number of people who will reach the age of 30 in the 1980s: 42 million. This fact suggests that there is an enormous potential demand for new housing in the coming decade. There are those who believe that high interest rates and continuing high inflation will seriously depress the number of new housing starts. In the short run, I believe they may. However, Americans have been willing to allocate significant amounts of their income to housing. During the past 20 years or so, that proportion has gone steadily up from less than a quarter to more than a third of income. Americans clearly consider housing a high priority item.

It is not unreasonable to believe that the same people who placed considerable pressures on our public schools in the 1950s and our colleges in the 1960s will now put pressure on the housing market.

Suppose that there is a large volume of new housing starts begun in the 1980s. Where will these new households choose to live? Increasingly, evidence suggests many of them will choose to live in rural America. Again it is interesting to contrast about settlement trends from the early 1970s to those of the 1960s. During the 1960s, 3 million people moved out of rural America to cities, and we saw and heard about the kinds of problems that the rural migrants brought to the cities. During the first 6 years of the 1970s, however, 2.3 million people reversed this migration and went from metropolitan to nonmetropolitan counties, including many that were remote, but which offered scenic or climatic amenities. I believe the 1980 census will confirm a continuing migration of Americans from urban to rural areas. There are those who argue that rising energy costs will deter people from moving to rural locations. I do not agree. Europeans, who pay up to four times more for a gallon of gas (when net disposable incomes are compared), have moved to rural areas throughout the period of the 1970s. This is despite powerful growth controls and planning policies designed to favor urban locations. In my opinion, the savings that people are able to make in housing costs and land costs, in property taxes and the benefits from the amenities of rural America will more than offset rapidly rising gasoline prices.

An extraordinary characteristic of the movement of Americans to rural areas is that it is happening everywhere. People are moving to northern New England and to the Southwest, to Appalachia and to the upper Michigan peninsula, to the Rocky Mountain West, the Northwest, Wisconsin and Minnesota.

In all of these areas, rural counties are showing steady growth. The result is a new rural population of non-farmers. In the 1940s, the majority of the rural population was comprised of farmers; now farm people account for only 15 percent of the total rural population.

In combination, these two considerations—a high housing demand and a high rate of population dispersal—lead one to suspect that there will be a profound transformation of the American landscape within the next 10 years.

Other economic forces reflect the population's high interest in rural land. There is a courthouse in Hardy County, West Virginia, which has a room where property records are kept. For the period 1790 through 1800, all the property transactions were kept in a single book. For the next 100 years, perhaps a dozen or 15 books were sufficient to record the county's land transactions. By the 1950s, each year's transactions required a book of its own. During the 1970s, a dozen books were required for a single year. This tells a story which has been repeated in countless rural counties throughout the United States during the 1970s: the decade saw large increases in the total number of non-farm rural land transactions over the 1960s.

The Rural Land Market

Accompanying the increase in land transactions, was at least a tripling in rural land prices in the 1970s. The statistical record is incomplete, but it is interesting to note that forest land purchased by the federal government under the Weeks Act cost twice as much per acre in 1979 as it had in 1969; and recreational land bought by states using Land and Water Conservation Fund monies cost eight times as much as a decade earlier. Farm land prices tripled in most areas, although farmers proved so reluctant to part with land that the volume of transactions actually fell.

One price comparison I find astonishing and quite disturbing. Between 1971 and 1977, total net farm income was $136 billion. During the same period, total farmland appreciation was $223 billion. In short, all that farmers were able to earn by the sweat of their brows, by their own hard work, during those six years was dwarfed by the appreciation in the value of their lands.

Farmland must be used very intensively to justify these prices, and it is. I will discuss land erosion in a moment. In some areas, rapidly rising land prices threaten to reduce the availability of certain lands for production of crops and timber. Traditional land holders of heavily appreciated land often do not realize how low their return on land value is, and how much better they could do financially by subdividing or selling in farmettes or house lots. During the past 18 months, The Conservation Foundation economist, Robert Healy, has directed a study of the rural land market. Research based on case studies in seven diverse rural counties located throughout the United States suggests that significant changes in land use are likely to result from the rapid increases in rural land values. It is difficult to review land prices and property taxes in northern San Diego County, the largest source of cut flowers in the country, and not conclude that flowers are a waning business. Flower sales and income simply are insufficient to justify the very large property taxes that are attached to those lands. In the East Texas Pineywoods, an area of important soft timber production, forest lands have appreciated in value as a result of a steady in-migration of people. The companies which own large tracts of forest land may one day be forced by the rising values of their lands to consider their alternative economic opportunities. Ultimately, they may decide that they cannot justify to their shareholders retaining land in forestry when it could be very profitably sold off or subdivided for residential or recreational uses.

Nationally, 3 million acres per year of farmland are being converted to urban uses or to highways, house lots, reservoirs, shopping centers, and industrial parks. (This compares with 1.2 million acres annually converted in the 1950s, the period when the vast suburban expansion took place. Difficult as it is to believe, these numbers suggest we are urbanizing more farmland now than we did in the era when we built the suburbs.) Figures developed by the federal Agricultural Land Study project the impact of continuing conversion of agricultural lands through the end of the century. At current rates, 7 percent of all U.S. *prime* farmland will be lost in the next 20 years. For certain states the losses of prime farmland projected are staggering: for Arizona and Colorado—19 percent; for Michigan—11 percent; for California—15 percent; for New York—16 percent; for South Carolina—20 percent; for Pennsylvania—21 percent; Washington and Montana—23 percent; Vermont—43 percent; Maryland—44 percent; Massachusetts—51 percent. The figures indicate, if recent trends continue, that 4 states will lose nearly all their prime farmland within the next 20 years: New Hampshire, New Mexico, Rhode Island, and Florida. (I should point out two limits on the usefulness of these numbers. First, they are projections of current trends. The future could unfold in a continuous way, but probably it will not. Secondly, the agencies that developed these numbers are not entirely disinterested. Nevertheless, if these figures are even approximately accurate, they present cause for serious concern.)

The "Mining" of Our Soil Resources

It couldn't be happening at a worse time—at the very moment when we most need high rates of commodity production. Ten years ago the United States contributed a third to world grain exports. Last year this nation was the source of 61 percent of the coarse grains, and 48 percent of the wheat and wheat flour which moved in international trade. One in every three acres cultivated in America is planted exclusively for export. U.S. farm exports earned $32 billion in 1979, and produced a net trade surplus of $16 billion, which bought a lot of oil. The United States contributes as much to the world's food trade as Saudi Arabia contributes to the world energy trade. Like Saudi Arabia, we are depleting our critical resource. Unlike Saudi Arabia, there is no excuse for it, for soil, unlike oil, is renewable. Nevertheless, according to journalist James Risser, every bushel of corn we export results in a loss of two bushels of soil to erosion.

The statistics on soil losses are even worse than those on agricultural land conversion. They are so serious as to question whether we can sustain agricultural exports at continuing high levels at this cost in soils. For the United States the average soil loss per acre per year is estimated by the government to be near 5 tons, that's 5 tons for every acre cultivated in a single year. In the Cornbelt states of Illinois, Iowa, Indiana estimates are 6.7, 9.9 and 5.2 tons per acre per year, respectively. For the state of Colorado, the figure is 2.5 tons and for the hill country of western Iowa, an area which has been carefully monitored for some 25 years, the annual soil loss per acre is 17 tons. It is as though the dustbowl never happened. We have seen a steady destruction of the shelter belts and the tall grasses, the shrubs and the hedges so important to conservation of soils as to conservation of wildlife during the past 10 years.

There are some stirrings of public concern about these losses. Vice-President Mondale went to Iowa to explain the Russian grain embargo to farmers and, according to the *Washington Post,* one group of farmers he met with wanted to talk only of their anxiety about soil losses. The Vice-President brought their concerns back to Washington, and there is, I believe, a heightened interest on the part of the Carter Administration in soil conservation.

New Alliances For a New Era

There is also growing public interest in the energy costs of dispersed development and in their service cost. These concerns are beginning to produce some curious alliances. You have all no doubt heard of Proposition 13, the ballot initiative of California voters which directed a reduction in property taxes throughout the state. You have probably not heard that, as a consequence, a new alliance has arisen between conservationists and fiscal conservatives against urban sprawl. When new developments are proposed on undeveloped exurban land, or on farmland in Southern California, it is not uncommon for conservative supervisors and councilmen to ask whether or not there is sewer and water available at that site. Also asked is whether or not the development requires highways or bridges. Also considered is whether or not there is land closer to the existing town which is suitable for the development and which is already serviced by utilities. Increasingly, the tendency on the part of local governments in California is to discourage development in unserviced outlying areas where it would entail substantial public cost. The long time objective of conservationists has been to encourage more compact development patterns that are less wasteful of land. It appears that conserving public monies can reinforce this objective.

A second curious alliance has occurred in some communities of New England, particularly in Vermont, where business leaders in small towns have allied with planners and environmentalists against new shopping centers proposed for exurban or rural locations. The business leaders feared the competition that the new shopping centers would bring and the resulting loss of economic vitality from the central business districts of New England's small towns. The environmentalists sought to prevent the destruction of farm and forest land. Thus, they were able to work together.

The most interesting alliance I know of has taken place in Oregon where farmers, developers and conservationists have all allied in the support of growth limits around communities. The Oregon land use law requires communities to establish areas where growth will be permitted, and it requires that farmlands outside these growth areas be kept substantially agricultural. Conservationists in Oregon have very shrewdly become effective proponents of development within the growth limits. They recognize the need to accommodate development somewhere; they saw that, if the growth areas failed to provide enough housing, the agricultural zones would inevitably have to be urbanized. One Thousand Friends of Oregon has actually sued municipalities in Oregon to require them to construct more development within their growth areas than they had proposed. Homebuilders and developers as well as conservationists have together supported a continuation of the Oregon land use law in the most recent voter referendum on the measure.

Some of these and other experiences illustrate lessons for the 1980s that contrast sharply with thinking in the 1970s. The first lesson is that single-focus approaches are no longer enough. We know now that many environmental efforts of the 1970s involved taking a lead on a single problem, setting a standard for it, and then tightening that standard over time. Water quality offers an example of that approach. We now know, however, that our water pollution control efforts have resulted in the accumulation of mountains of sludge. Obviously, we cannot dump this sludge back into the water. We cannot burn it without creating an air pollution problem. It might be used to fertilize crops; but given that this sludge contains high amounts of heavy metals which are taken up into crops, that option is foreclosed. What are we to do with this sludge? I don't have the answer, but I doubt very much that we will discover an ideal solution to this problem. No single solution is likely to be satisfactory to all interests, but we must do something with the sludge.

Similarly, our efforts to control toxic substances have involved the creation of regulations which have had the effect of causing some people to drive toxic materials into the countryside and to illegally dump them into roadside ditches. It would appear that a more sophisticated control apparatus will have to be devised—one that creates an incentive on the part of those disposing of toxics to dispose of the materials properly.

Apropos of farmland conservation, we have had tax abatement available to reduce property taxes to farm use values in 44 states. We have agricultural districts functioning in a number of states. These kinds of measures are necessary although they are not sufficient to prevent the continued conversion of farmland. We will require more systematic and comprehensive land policies which deal with a number of aspects of the development problem, if we are to conserve farmland in the 1980s.

A second lesson learned is that courts can no longer be looked to as the primary forum in which to solve these problems. The kinds of problems I have been describing involve too many tradeoffs, and the reconciliation of too many equally pressing priorities and values to make them suitable for judicial resolution. You may be aware that the Environmental Protection Agency has prescribed regulations for siting solid waste repositories in communities throughout the country. The criteria prescribed suggest that land be relatively level and well drained. These criteria describe a prime development site, and in many communities, there are fights between public bodies seeking to build solid wastes sites and developers who wish to build houses. Prime farmlands also are frequently the object of agencies trying to locate a dump. This kind of problem will require new problem-solving approaches and new conflict resolution techniques such as mediation.

A third lesson is that those most affected by rural conservation, farmers, landowners and developers absolutely must be involved and supportive of efforts to conserve farmland whether from urban conservation or erosion. There must be a public debate about the effects of conservation measures and particularly about who pays.

The fourth lesson is that the federal government will probably be the principal governmental level to deal with these problems in the 1980s. These problems impact across jurisdictional boundaries. Localities will be the action centers, and they will need help, for many of them are unprepared psychologically and financially for the kinds of problems that growth will bring. In many communities, plans have been fashioned for many many years to obtain growth. The idea that growth needs to be managed will strike them as novel and disturbing. The object of many programs in rural areas at all levels of government has been to promote their industrialization and development. The soils, farmlands and wildlife have been the residual losers. The discovery by these communities that growth has costs will contribute to severe difficulties within and between jurisdictions and will inevitably compel the attention of higher levels of government.

I began this talk by suggesting you stand the views and programs of the 60s on end to prepare for the 80s. The lessons I described are not illustrated during the 1970s either. The 70s were a time preeminently of federal government solutions, of a high level of court activity, of single focus adversary approaches to environmental problems, of significant estrangement between interest groups on questions of land use and the environment. The 1980s pose a new set of challenges and call for a new set of solutions. We will need many new ideas. We may get some from Europe. In the Netherlands, farmers are paid to maintain their tall grasses and to defer cutting their tall marsh grasses until the annual migration of wildfowl passes through in June. Farmers in the high meadows of the Voralps in Bavaria are paid to graze their sheep and keep meadow grasses down lest they grow long, trap the melting spring snows, and foster avalanche. In the Netherlands and Germany, farmers are, in effect, paid to be stewards of the land as well as producers of food and fiber.

If formerly we asked "how are you going to keep them down on the farm," now we must ask "how are you going to keep them from subdividing the farm and building shopping centers on it, from eroding its soils and mining its water, from destroying the hedgerows and shelterbelts and degrading the land, the wildlife, and the environment of rural America?"

Acid Rain: Living Resource Implications and Management Needs

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Wildlife resources have, over the past 100 years and more, faced almost every type of threat from human intervention. These have ranged from over-exploitation and direct destruction of habitat to inadvertent chemical poisoning which affected wildlife success, either locally or regionally. Throughout this period, natural resources management has developed and adapted to the needs of wildlife decimation to achieve the considerable recovery of big game, fish, and other wildlife we have today—with some notable exceptions.

Now, over the past two decades, portions of our wildlife resources have begun to show the effects of another in this series of technological incursions—the deposition of acidic materials in rain, snow, and dust, commonly referred to as acid rain. To describe for you the present and apparent future implications of acid rain for wildlife management, I have the following objectives for this paper: to summarize the sources of formation of acidic deposition; review the mechanisms by which effects are expressed in wildlife populations; provide a survey of the magnitude of these effects in North America; and comment briefly on the few approaches for management we have at this time.

The Phenomenon of Acidic Deposition

Although questions remain about some details of atmospheric chemistry, acidic substances are known to be produced in the atmosphere when sulfur dioxide (SO_2) and nitrogen oxides (NO_x) from fossil fuel combustion combine with oxygen to produce sulfuric and nitric acids, as well as dry particulate sulfate and nitrate compounds. These pollutants can be carried hundreds of miles from their source. Some of the acid pollutants drop out as particles—a process called dry deposition—but more are washed from the air by rain, snow, or mist, yielding acid rain. The result is the acidification of surface waters in areas of sensitive soils, such as the Adirondack Mountain lakes and streams.

The dissolution of these pollutants in water in the atmosphere can increase the acidity of rain 100 to 1,000 times—from a pH 5.6 for "normal" rain to a pH of 3.0, now being observed occasionally in parts of New England. Vinegar, at a pH of 2.6, is a key reference point. Acidity is measured by a logarithmic scale of ionic dissociation that ranges from pH 0 (very acid) to pH 14 (very alkaline). Each unit drop in pH represents a tenfold increase in acidity. Distilled water has a pH of 7; "normal" rain is slightly acidic due to the dissolved CO_2.

In addition to acid in rainfall, acidic substances are produced by dry deposition of SO_2 and NO_x as gases absorbed by vegetation and soil. During the growing season, relatively large quantities of SO_2 and NO_x gases are taken up by plant foliage. After death and normal decomposition of the organic matter so formed, these S and N compounds contribute significantly to the acidification of natural resources (Cowling 1980).

But many ask, "What is the source of the acidic deposition on a remote Adirondack lake?" Consider the gaseous emissions from any large urban or industrial area. Emissions build up to moderately high and very reactive concentrations, and then move out over the rural landscape. Many questions remain as to distance transported, and ultimate effects. However, the technique of air parcel trajectory analysis can back-track the path of an air parcel to its original location 12, 24, and 36 hours before it deposits acid rain. Miller, Galloway and Likens (1978) found that trajectory analysis, supplemented by meteorological maps, identified the high industrial, coal-burning regions as source areas of the constituents in acid precipitation. The technique is becoming increasingly precise, and analysis of source areas requiring abatement will be a part of acid deposition management in the relatively near future.

Recent reviews have shown that, despite some questions of rates of reaction and control mechanisms, we know enough about the acidic deposition phenomenon now to describe the general relationships, the areas of impact, the mechanisms of effect, and the basis for some lags in response times. Figure 1 shows the principal ecological consequences resulting from formation and deposition of elevated hydrogen ion and sulfate anion densities (sulfate and nitrate), the consequence of atmospheric chemical reactions following release of nitrogen and sulfur

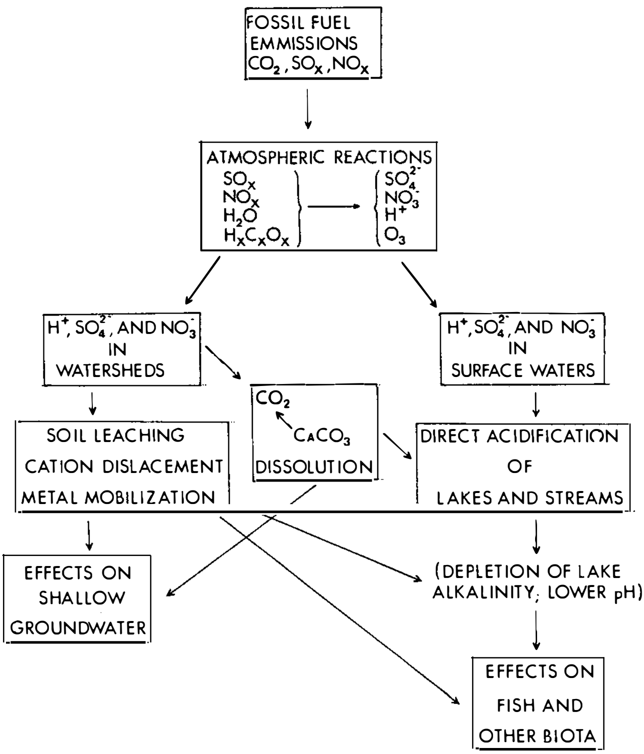

Figure 1. Flow diagram showing system linkages for acid precipitation formation, deposition, and effects as a consequence of nitrogen and sulfur oxide emissions from fossil-fuel combustion.

oxide emissions from utilities, transportation, and other industries. The ultimate effect of this deposition must be viewed as a coupled system which, for simplicity, is shown here as a flow diagram. The principal findings of Cowling (1980) in the area of emissions, transport and deposition, are shown in Table 1.

Treating the acid precipitation phenomena as a linked system (Figure 1) leads to considering effects of elevated hydrogen ion density (pH) as the consequence of inputs from anthropogenic sources. The greater part of these inputs is believed to derive from fossil fuel combustion emission by elevated stacks (Miller et al. 1978). These emissions remain in the lower atmosphere much longer than short-stack emissions, long enough for acidifying reactions to be complete.

Thus, the following analysis is developed around the known and projected data on fossil fuel emissions, transport and transformation of these products to form H^+ and related anions in precipitation; the present data on known effects; projections of trends in acid rain effects based on projected emissions; and the nature of responses and lag-times in soils, watersheds, streams, and lakes.

Present and Projected Combustion Emissions

Projections of the magnitude of acidic deposition in the future, and therefore of the management problems for wildlife, must begin with an inventory of present and projected emissions. In recent studies by The Institute of Ecology (TIE), we were asked to assess the consequences of three energy development scenarios in the Ohio River Basin. Here, we had to review not only the acid rain effects properly attributable to acid precursors emitted in the Ohio Basin, but also had to determine what part of the total downwind acidic deposition on a sensitive area is attributable to the ORBES region emissions. We were asked to make this determination for the present, for the year 2000, and through the life of facilities constructed by 2000 (i.e., until the year 2030).

Table 1. A consensus on present scientific understanding of atmospheric acid formation, sources, and deposition. (After Cowling 1980.)

Property/constituent	Responses
1. Geographic area	The eastern United States, Canada, Europe, and Japan, and locally in the western United States.
2. Sources	From elevated total emissions of SO_2 and NO_x, transformed in the atmosphere to sulfates, nitrates, and sulfuric and nitric acids.
	Contemporary acidification results from both natural (5% to 10%) and man-made emissions (90% to 95%) of gases, aerosols, and particulate matter.
3. Emission height	Tall stacks decrease ground-level concentrations of SO_2 and NO_x but increase the geographic area of acid deposition.
4. Transport	Air-mass movement and chemical transformation studies indicate acid precipitation in one state or region of the United States or Canada results in large part from emissions in other regions, up to hundreds of miles from the original source.

Projections of change in acid-forming precursors from utility development in the Ohio River Basin are shown in Figure 2. A potential 40 percent reduction in NO_x plus SO_2 appears possible under some scenarios by the year 2000, but other scenarios indicate very little reduction is possible. These estimates do not reflect the recently proposed increase in SO_2 projected to occur with conversion of oil-burning facilities to coal, and they are optimistic with respect to the rapid retirement of present large SO_2 sources during the decade of the 1990s. Automobile sources of acid deposition seem likely to move downward by the year 2000, but long-distance transport of emission products from coal development in

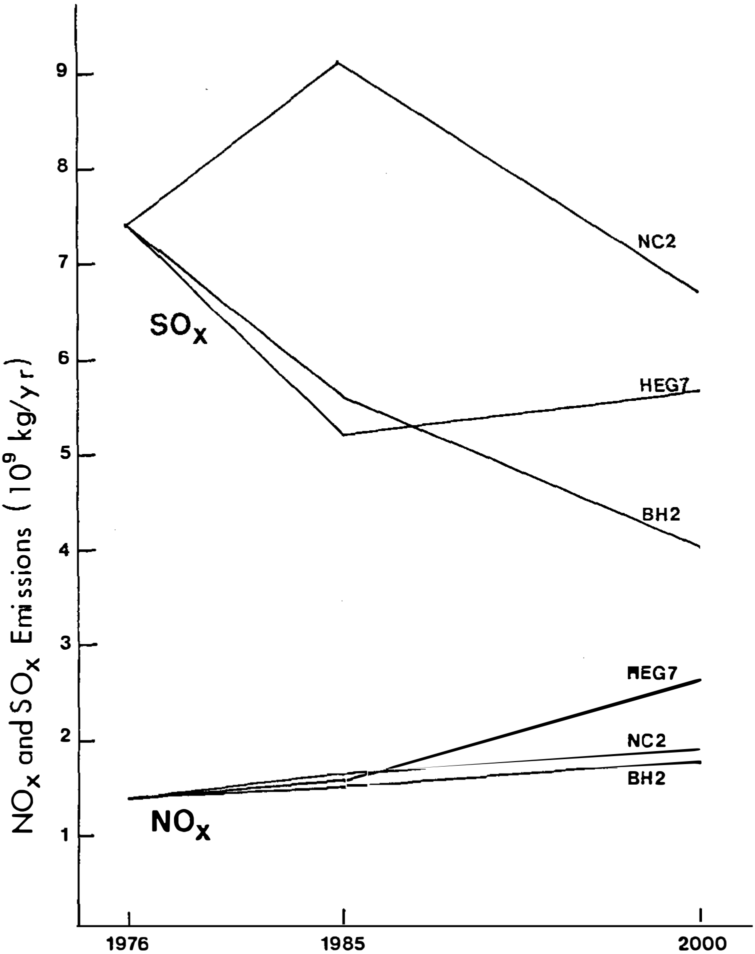

Figure 2. Projections of NO_x and SO_x emissions (1980–2000) under three scenarios of utility development in the Ohio River Basin: The NC2 scenario assumes a doubling of electricity generating capacity and non-compliance with State Implementation Plans (SIPs) by 1985; BH2 is the same but assumes compliance with SIPs; HEG7 assumes a quadrupled rate of electricity generation by 2000 and compliance with SIPs.

the central and southern Plains States is likely to add to the problem in the Northeast. Thus, depending on decisions now being made, the total precursors of acidity in precipitation could increase significantly, might increase only slightly, or could, with rapid conversion to solar energy sources, decrease as much as 30 percent between now and the year 2000. To explore the management implications for wildlife resources, we will have to consider the long-distance transport of acidic substances from all three of these scenarios as equally possible for the western United States and Canada, as well as the eastern United States.

Data Base on Recent H^+ Inputs

Evidence is available as to the long-term trends in H^+ deposition from rainfall and snowfall. The first general data base for the pH of rainfall (from Cogbill and Likens 1974) covered the 1955–56 period (Figure 3). The second data point is available for the 1972–73 period (from the same authors). More recent data are available from the newly established National Atmospheric Deposition Program. The entire sequence shows a dramatic increase in the intensity of H^+ deposition (i.e., depression of pH) from 1955 to 1976, and a very large spread in the geographic area over which H^+ density in precipitation is elevated. Recent results show a spread to western Wisconsin and Minnesota and significant decreases in precipitation pH in the Rocky Mountains and Sierra Nevada range of California, both areas with locally sensitive bedrock and soils (Lewis and Grant 1980, McColl 1980).

Consider now the prospective trends in deposition if we accept the three broad emissions scenarios (Figure 2) for the Ohio River Basin. These can be summarized in terms of total annual deposition of sulfate and nitrate anions. Data on total sulfate and nitrate deposition at the Hubbard Brook watershed in New Hampshire

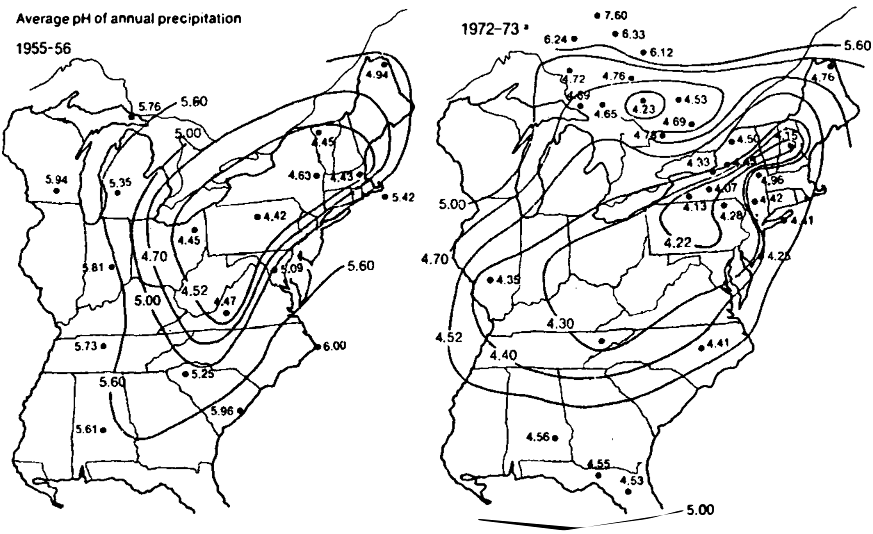

Figure 3. Precipitation pH isopleths from 1955–56 to 1972–73 showing the timecourse of change in H^+ loading for the northeastern United States (Cogbill and Likens 1974).

are summarized in Figure 4 (from Likens et al. 1977). The historical background estimate is from Glass and Loucks (1979) for a northern Minnesota site representative of northern continental (i.e., non-coastal) locations. An estimate of 5 to 10 percent natural background in the relatively polluted continental regions is now widely accepted in Europe as well as North America. The dashed lines show first a linear projection of continued increases in anion deposition, and, alternatively, a trend toward leveling off of the deposition rate (and therefore of H^+ input) by the year 2000. For the reasons considered above, however, a sharp decrease in deposition in H^+ or the anions, although possible, must be regarded as improbable.

Inventory of Present Effects on Natural Resources

The effects of acidic precipitation on plants are only one facet of complex atmospheric/plant/soil interactions. Both injurious air pollutants and required plant nutrients are readily absorbed through foliage from the atmosphere, as well as through the soil solution. The growth and productivity of plants are governed by the availability and balance among fifteen elements essential for growth. Some of the elements, although essential, can be injurious to plants at abnormally ele-

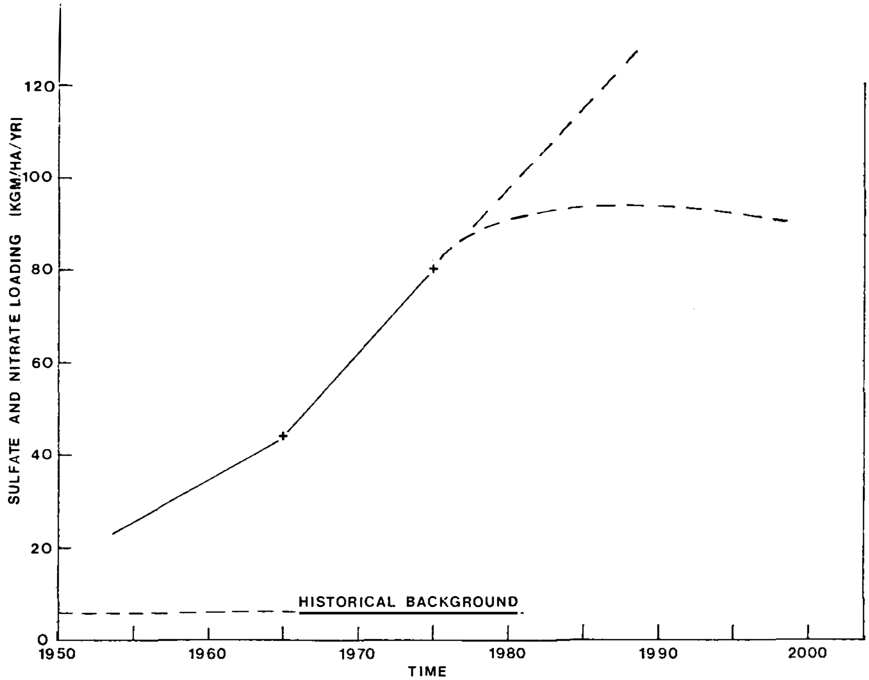

Figure 4. Historical background (ca. 1850), recent observations (1965–1977), and projections (1980–2000) of total annual deposition of sulfate plus nitrate. Recent data are from the Hubbard Brook watershed in New Hampshire (Likens et al. 1977); the historical background estimate is for northern Minnesota (Glass and Loucks 1979).

vated levels. For example, small amounts of sulfur and larger amounts of nitrogen are needed for the synthesis of protein in plants, but excess amounts of gaseous oxides of sulfur and nitrogen, and sulfuric and nitric acid aerosols, are injurious to plants at very low concentrations. In general, however, the above-ground portions of plants have rather thick protective surfaces, and few serious direct effects are observed, as summarized in Table 2.

For soils and watersheds, the potential effects of acid rain have been described by Norton (1976) as trends toward solution of clay materials, loss of nutrients and exchange capacity, increased rates of chemical denudation, mobilization of metals, and expansion of podzolization. Iron and aluminum oxides and hydroxides can be dissolved and go into soil solution, where they are toxic to some plants and animals. A number of investigators have discussed possible implications of acid rain to agricultural soils. Considerable acidification has occurred here over the past 25–50 years as a result of current fertilization practices with ammonium sulfate and ammonium nitrates, which tend to acidify soils. However, for agricultural soils, atmospheric acid deposition probably is overwhelmed by the cation

Table 2. Consensus on present scientific understanding of atmospheric acid effects on plants. (After Cowling 1980.)

Property/constituent	Response
1. Potential injurious substances	Includes not only acidic substances, but also elements such as Mn, Zn, Cu, Fe, Mo, B, F, Br, Al, Pb, I, Ni, Cd, V, Hg, As.
2. Essential nutrients	Mn, Zn, Cu, Fe, Mo, and B are needed by plants in small amounts. At higher concentrations, however, each of these (as well as S and N) can be toxic to plants and animals; the acidity of precipitation affects the solubility, mobility, and toxicity of certain of these elements.
3. Damage to plants	Most likely when a particularly sensitive life-stage, developing in poorly buffered waters or soils, coincides (in time and/or space) with major episodic acid inputs or other injurious substances.
4. Crop and forest	Direct and indirect damage reported in laboratory, greenhouse, and field experiments using synthetic rain. The biological effects include: —Induction of necrotic lesions on foliage —Loss of nutrients due to leaching from leaves —Predisposition of plants to infection by pathogens —Accelerated erosion of waxes on leaf surfaces —Reduced yield of marketable crops —Inhibition of nodulation of legumes leading to decreased nitrogen fixation —Reduced rates of decomposition of leaf litter and decreased mineralization of organically-bound nutrients
5. Economic significance	Reliable evidence of economic damage to agricultural crops and forests, and to biological processes in soil, by naturally occurring precipitation and dry deposition of aerosols has been reported only rarely.

exchange capacity inherent in good agricultural soil management. Still, serious effects of acid precipitation are known for shallow, poorly-buffered (i.e., low in calcium) natural soils (mostly in rocky or mountainous recreational areas and wilderness). In general, the results are as follows: lowered soil pH; accelerated leaching of plant nutrients and other ions; accelerated weathering of soil minerals; changes in soil biota; reduction in organic matter decay rates and associated release of plant nutrients; reduction in nitrification; reduced phosphorus availability to plants; increased aluminum mobility and associated toxicity; increased mobility of organic soil components; and changes in anion-cation balances necessary for plant growth.

The earliest identified responses of aquatic resources to acid deposition in North America are those described by Beamish and Harvey (1972) from studies in 1969–70 in the LaCloche Lakes north of Georgian Bay, Ontario. Here, by 1970, an unusually large number of lakes had pH values as low as 4.5, and a large number showed complete loss of fish populations at that time. Reproductive failure begins for some species at lake pH values of 5.5, and is serious when a lake drops below pH 5.0. The most serious drop in pH occurs as the winter accumulation of H^+ is stripped from snow during snowmelt. Not all of the lakes were reduced in pH to a biologically significant level in one year, however, indicating the responses observed in 1970 were the accumulation of an annual "addition" of lakes into an "affected state," as determined by the continuing addition of acidity. The rate of this annual addition of affected lakes is still a major unanswered question, but for the LaCloche Lakes area, it appears to have been 5 to 10 additional lakes acidified annually during the late 1960s.

Later, study of lake chemistry and fish populations in high-elevation lakes of the Adirondack region of New York showed a marked decline in the pH of the lakes compared with 40 years earlier (Figure 5). The decline in pH here also was associated with failure of fish to reproduce and maintain populations in the youngest age classes. Although some questions about response rate and time lags remain, the effects summarized here must be regarded as a cumulative phenomenon, in which some lakes annually reached a defined H^+ density threshold (e.g., in the order of pH 5.0) at which significant effects on fish reproduction can be expected. These effects may be in Ca metabolism, Na and K balance, or direct toxicity from metal ions such as Al^{3+} mobilized into water by excess H^+. Of the 218 lakes measured in 1975, approximately 50 percent are significantly acidified, having passed this threshold within the previous 10 to 15 years—an annual rate of 7 to 10 lakes per year. These will be aggregated into annual rates for larger areas in a later section. Monitoring of lakes in Ontario, Quebec, Nova Scotia, and throughout New England shows large numbers of lakes with depressed pH levels (Harvey, personal communication). Many of them are approaching the point at which fish populations will be affected. However, detailed data on biological effects in these systems are not available at this time. Table 3 provides a summary of the known effects (from Cowling 1980).

A special case is the rapid decline in pH and collapse of the salmon fishery in Nova Scotia rivers. Representative here are the pH measurements in the Tusket River of Nova Scotia between 1955 and 1975 (Thompson et al. 1979). The salmon fishery, which for over 200 years had survived so many other pressures in at least modest strength, has now disappeared entirely in all seven rivers. The mecha-

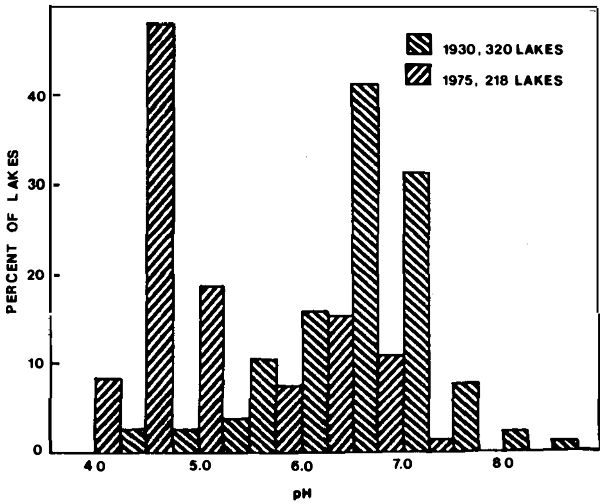

Figure 5. Frequency distribution of pH in lakes in the Adirondack Mountains, New York, in the 1930s and in 1975. (Redrawn from Schofield 1976).

Table 3. Consensus on present scientific understanding of atmospheric acid effects on aquatic organisms. (After Cowling 1980.)

Property/constituent	Response
1. Reproduction	Inhibited for many species of aquatic organisms at pH's between 6.0 and 5.0.
2. Adult mortality	Populations of many freshwater fish go to extinction at a pH below 5.0; aluminum toxicity is probably partly or largely responsible at these pH's.
3. Status of fishery	As of 1979, several hundred lakes in the Adirondack region of New York, and many hundreds of lakes in southern Ontario, Quebec, and Nova Scotia, showed acid stress in the form of diminished populations or extinction of fish populations.
4. Toxic ion effects	Acidity increases the mobility of many toxic cations, including Al, Mn, and Zn, increasing their concentrations in adjacent streams and lakes. These toxic ions are transferred from soils into surface and ground waters.
5. Ecosystem linkages	Neighboring terrestrial and aquatic ecosystems usually are so intimately linked that evaluation of effects in the aquatic system without considering effects in the terrestrial system is unrealistic.

nisms for this collapse, while not yet known in all details, are almost certainly due to interactions between elevated Al^{3+} in the low pH water and gill function, particularly O_2 uptake and ionic regulation of the bloodstream.

This lake and stream response information, taken in conjunction with earlier records from northern Europe, indicates a trend in the number of lakes affected similar to the upward trend seen earlier in total H^+ loading during the 1950s and 60s (Figure 5). The studies by Dickson (1978) show that the pH of lakes in extremely sensitive surroundings drops sharply as the annual sulfate loading reaches 15 kg/ha/yr. Lakes in slightly less sensitive surroundings become increasingly acid as deposition increases from 30 to 60 kg/ha/yr. These effects, taken in conjunction with the evidence for annual increases in the number of lakes reaching a pH of 5.0 or less, suggest the depression in lake pH values could expand now to larger watersheds and larger numbers of lakes in the years ahead, even with no increase in acid precursor emissions. This is not a conclusion at this time, but a hypothesis to be evaluated. If we follow the scenario projecting continued increase in acid-forming emissions, we do know that much larger geographic areas will be affected by the elevated levels of acid deposition.

Trends for Future Lake and Stream Responses

The first step in exploring wildlife management implications for effects on wildlife resources is to examine prospects for continuation, expansion, or abatement of acid rain threats. These scientific questions and the effects are remarkably similar to the mechanisms of DDT-induced effects on resources, summarized qualitatively by Rachel Carson in 1962 and documented in detail in the decade which followed. We know now for acid rain, as many scientists knew in 1962 for DDT, what the sources, mechanisms, and future responses are likely to be; but there are now, as then, certain differences in scientific judgments that prevent effective, but costly, control measures from being implemented. Thus, in the case of acid rain effects, we must explore as best we can what are the risks of postponing ameliorative action.

Still, let us consider, even qualitatively, what the current studies indicate. A preliminary estimate of the total number of lakes that may experience acidification by the year 2000 has been prepared by the Ontario government (Province of Ontario 1979). This estimate suggests some 48,000 lakes in Ontario will experience significant acidification within the next 20 years. An inventory of present alkalinities of lakes on the Canadian Shield in Ontario, the levels of acid inputs currently known for the area, and the general relationships for acidification were used in making this estimate. Since many aspects of the lake response to acid inputs are still unknown, this estimate does not necessarily mean all of these lakes will experience a significant failure of fish reproduction; but effects on some species are almost implicit once significant acidification has begun. The Ontario estimate suggests a total of 3,000 lakes per year (upper curve, Figure 6) will reach a significant, defined threshold of acidity during the two decades between now and the year 2000.

A more conservative view of the relationships between inputs and probable responses in lakes is suggested in Figure 6. Two different deposition response scenarios are shown, each associated with certain assumptions as to acid precursor emissions. Considering the emissions first, the probable maximum possible

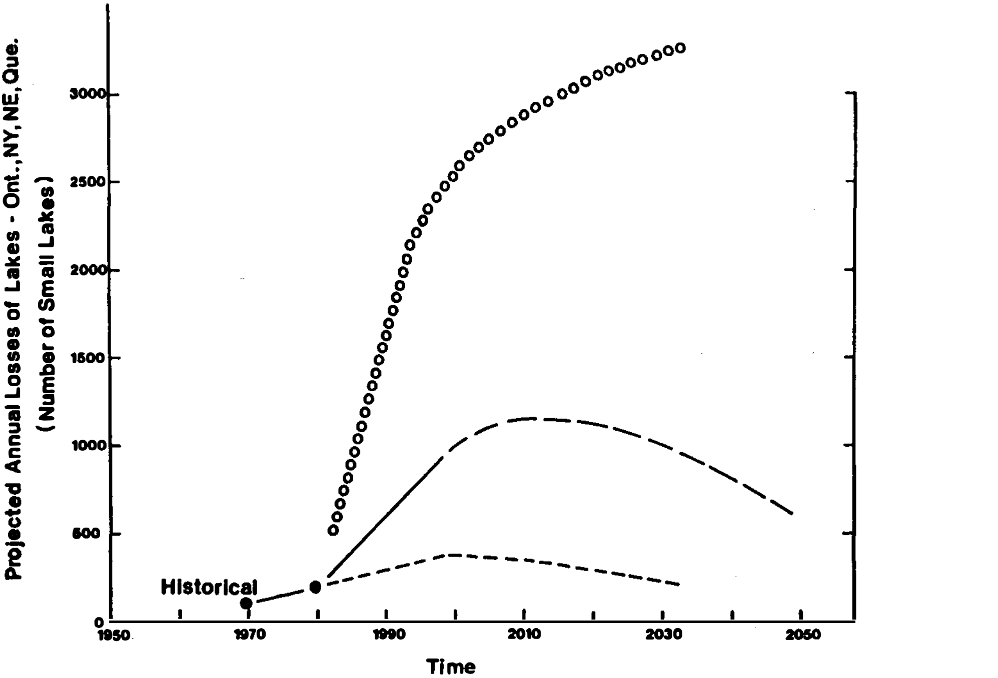

Figure 6. Relationships between sulfate and nitrate inputs and probable responses in lakes of Ontario, Quebec, New York, New England, and the Maritime Provinces. The circles represent an approximate projection of the annual rate of lake "losses" for Ontario alone; the lower dashed line represents a linear projection of the trend evident in the northeastern part of the continent, assuming no time lags; and the solid line represents an intermediate position which assumes time lags will result in higher rates of expressed acidification during the 1980s and 90s.

abatement of acid precursors shows an approach toward 20 percent of present levels by the year 2030, probably the most optimistic possible. We cannot truly estimate the recovery in lakes by this abatement. A linear upward trend in emissions, and therefore of acid loadings, also is possible for the reasons discussed previously.

Figure 6 also suggests a way to express the annual effect on lakes as a rate at which additional lakes and streams experience a depression of pH (below 5.0), and therefore, associated effects on fish populations. Extrapolating from the small area sampled by Beamish in 1970 (Beamish and Harvey 1972) to other regions of similar bedrock and similar acid deposition rate at that time, one obtains a preliminary estimate of 50 lakes annually, reaching a pH threshold significant for fish reproduction throughout Ontario, Quebec, New York, New England, and the Maritime Provinces. The later estimate of 7 to 10 lakes per year within the high-elevation Adirondacks area (Schofield 1976; see the earlier text) can be extended to about 20 other similar areas in eastern Canada and northeastern United States, suggesting an addition of 200 lakes annually at that time.

Although these two estimates of the annual addition to the inventory of affected lakes are approximate, the general upward trend during the 1970s is not in doubt. What does the future hold? Three projections are shown in Figure 6, using the preliminary results just cited. The line of circles represents a linear projection of the annual rate of lake "losses" based on the Ontario estimates of 48,468 lakes by the year 2000, *for Ontario alone*. The lower dashed line represents a linear projection of the trend evident for lakes during the past decade in the northeastern part of the continent, allowing no time lag in relation to changes in inputs. The solid line is simply an intermediate, reflecting an assumption that time lags following the high loading rates of the 1970s will be seen as higher rates of expression of lake acidification (in terms of numbers reaching a biologically significant threshold) during the 1980s and 90s.

Unfortunately, we do not have, in either Canada or the United States, any direct monitoring of these effects on our aquatic resources. Thus, the trend projections shown here must be viewed as questions desperately in need of answers. However, the present knowledge of effects is no mystery, as some have suggested. The only mysteries are how many more resources will be affected, when the effects will be expressed, and whether recovery is possible. The questions with respect to wildlife management are as much issues of how to respond to the present level of impact, as well as how to project management responses to the possible loss of 1,000 lakes per year during the decade of the 1990s and continuing until 2030. Especially important, if the dramatic decline in emissions implicit in Figure 2 could be achieved, is the determination of whether peak losses may reach no more than 300 lakes per year throughout the Northeast by the turn of the century.

Implications for Other Wildlife Resources and Wildlife Management

Although we know much about the status of atmospheric acid inputs and of aquatic resources in relation to acidity of lakes and streams, little is known yet about the response of wildlife other than fish. Certainly the pH of spring pools appears to be too low for the reproduction of many amphibians, but salamanders are the only group in which effects are well documented. Scattered observations have been made of searches by osprey in lakes that have no fish; they persist in the search for a season and are then not seen. We do not know whether the pairs relocate. Since crayfish, snails, and other species with a high calcium demand are among the earliest to disappear in acidified lakes, wading species such as the blue heron are likely to be affected, although no records are being made that I have been able to discover.

More pathetic are the observed effects on nesting pairs of loons on lakes in Ontario that have no fish. Although the adults apparently survive the season, perhaps by using other lakes in the area, it appears the nestlings do not survive. No loons return in succeeding years (H. Harvey, personal communication).

Management options range from massive additions of lime to breeding of genetically resistant strains of fish, and ultimately, to abatement of the acid precursors. Treatment of the presently acidified waters would cost on the order of \$250,000,000 annually. However, even if we had the money, it is very difficult to reach all the remote streams and lakes during the critical snowmelt period. Also, many of the effects are the result of Al^{3+} liberated to groundwater from the soil, and lime additions in the lake do not control these stream and lake-edge inputs.

Development of resistant fish strains has been an attractive option for some resource managers. However, fish live in a complex food-web, within which many other species, particularly crayfish and some mayfly species, also are sensitive to acid inputs to the lake or stream. It does not appear possible to breed resistance for the entire food chain, so such a program has serious limitations.

Control of fossil energy emissions appears likely to be the most feasible and cost-effective option. It is not an option open to resource managers immediately, but it is being considered by state regulatory agencies and by the U.S. Fish and Wildlife Service in its energy impacts assessment programs. Relative costs and magnitude of benefits are only now beginning to be evaluated for any of these options.

Conclusions

This paper must serve primarily as background for considering wildlife management implications emerging now from what we know about acid rain. Much more will be known within a year or two, and some ameliorative steps probably will be underway in certain areas. I do not aim to advocate a particular solution; ultimately that must be a broad public consensus based on the type of information I have given, as well as on implications for jobs and the economy, which I have not discussed. However, managers of living resource systems know that nature has a way of outlasting man and most of his interventions.

In time, nature repairs. Although specific wildlife populations, in some places, have been reduced to local extinction, and still more will be lost, mankind is the real loser when resource productivity is diminished. We can rebuild; I am reasonably hopeful that within the two decades remaining in this century we can create the opportunity for the repair process to begin. This challenge is no greater than many previous challenges met, and overcome, by the stewards of living resource systems.

Acknowledgements

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Implications of International Conventions on Management of Living Resources

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A rather large number of international treaties pertaining to wildlife have existed for many years. Some have proven highly successful while others remained dormant. Others placed into effect in recent years have proven to be, in certain respects, counter-productive. Some of the treaties have been bilateral involving only two nations. Some have been multilateral, while in recent years two conventions have become global in design.

The early treaties involving migratory species set forth general guidelines to be followed by the signatory nations for the protection of birds and other species moving back and forth across international boundaries. Most of these involved game and nongame birds migrating several thousand miles. The treaty provisions outlined basic wildlife management principles and concerns. There were no supervisory boards or conferences of the parties to mandate actions for an individual nation to follow.

In recent years, however, trends have developed in the creation of treaties, placing broad jurisdictional authority in the hands of international party conferees from participating nations. These delegates now meet periodically at designated locations around the globe at intervals of from one to three years. International convention authorities now have the power to mandate total prohibition against the harvest of certain species and/or prohibit or restrict the movement of birds or animals between participating nations, even though some animals may have been taken in a completely legal fashion in the country of origin. Also, according to terms and conditions of the recent treaties, the parties have the power, by simple amendment, to greatly broaden their own authority.

All of this exists without any opportunity for input from on-going, highly successful wildlife management jurisdictions that have been in existence at the local level for many years prior to the creation of such conventions. While the early treaties related to species migrating thousands of miles, the later treaties are now affecting species having a complete home range of only a few hundred acres—species unique to only one nation and which never cross an international boundary.

One of the early treaties proven highly successful is titled "Convention Between the United States and Great Britain for the Protection of Migratory Birds," placed in effect in 1916. Another treaty, of much later origin and causing major wildlife management problems in the United States, has been the CITES convention—the Convention on Trade in Endangered Species of 1973. Between these two extremes, the other treaties include the agreement between the United States and the USSR in 1976 concerning the conservation of migratory birds and their environment; the convention between the United States and the United Mexican States for the protection of migratory birds and game mammals in 1936–37; and the treaty between the United States and Japan for the protection of birds and their environment signed in Tokyo in 1972 and amended in 1974; the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere; the International Convention for the Northwest Atlantic Fisheries; and the International Convention for the High Seas Fisheries of the North Pacific Ocean. The most recent agreement placed into effect was the Convention on the Conservation of Migratory Species of Wild Animals formulated in Bonn, German Federal Republic (GFR) in June, 1979.

While some treaties have proven highly beneficial, others have caused serious problems. The CITES convention, for example, has resulted in litigation between some states and the Federal Government, on grounds that the provisions of the treaty were being administered in an overly burdensome and restrictive fashion. This placed state and federal wildlife management agencies in an adversary posture, resulting in wasteful expenditures of funds and energy. At the other extreme, law suits filed by one nongovernmental private organization charged that the CITES convention was not being properly administered. This caused the states additional expense to again enter into litigation, this time on the side of the federal agencies. In other words, once the United States becomes signatory to a treaty, the administration of its provisions becomes a requirement of a designated federal department. Interpretations of the treaty provisions differ, resulting in the initiation of legal action that may come from any one of several directions.

Because of severe problems caused by the CITES Convention in the United States, wildlife management authorities have recently become very wary when new treaties are proposed. The state-federal (Endangered Species Scientific Authority or ESSA) clash over the bobcat resulted in litigation causing a diversion of funds badly needed for other wildlife management projects. CITES also forced the closure of a state-authorized trapping season on alligators and a loss of revenue of over $1,000,000, part of which would have been funneled back into marshland habitat preservation. Further, CITES has forced some states to undertake studies and supply federal administering agencies with information on certain species needing much less attention than others. Now, from a protectionist-oriented wildlife organization comes a lawsuit saying that the federal agency has been too lenient in mandating CITES requirements.

What lies ahead with CITES remains to be seen. Like other treaties, it is, no doubt, permanent. Congress has taken recent action to reduce the autonomy of ESSA, but the results remain to be seen. Little comfort can be obtained from reviewing reports on the recent Costa Rica CITES meeting. It was obvious that persuasions by protectionist-oriented nongovernmental organizations had a profound effect on decisions by the Conference of the Parties. While large contingents of nongovernmental organization participants were present in Costa Rica, representatives from state wildlife agencies having serious problems with CITES experienced great difficulty in obtaining permission to attend. Only after making persistent effort was one state able to obtain clearance and by so doing achieve its goal of having the American alligator removed from Appendix I and placed on Appendix II. On the other hand the proposed criteria action to remove the bobcat from Appendix II, where it was originally placed for political rather than biological reasons, was not approved. From that decision it was apparent that the conference parties wished to continue to make it easy to list and virtually impossible to delist species from Appendix I or II.

These examples are but a few of the reasons why many wildlife management authorities in the United States want to look carefully before rushing blindly into another global treaty creating another autonomous international control body.

Aside from the CITES convention, the migratory species of wild animals convention treaty, formulated in Bonn, German Federal Republic during June, 1979, has attracted the most attention. In early 1978, it became known across the United States that a migratory species treaty was in the early stages of development. During the fall of 1978 a draft of the treaty was circulated to all states for review and comment. A draft had been prepared by the Federal Republic of Germany with primary input from International Union for the Conservation of Nature. In many respects it followed the pattern of the CITES convention except that the draft contained wording that would enable the Conference of the Parties to exercise control over a much wider range of species. The states offered numerous suggestions for changes in the draft in an effort to make the treaty more palatable in the event it became a reality. These suggestions were conveyed to the State Department and the Interior Department by the International Association of Fish and Wildlife Agencies. The Conference on Migratory Species convened on June 11, 1979. The basis of the convention was Recommendation 32 of the action plan adopted by the United Nations Conference on the Human Environment in Stockholm, Sweden in 1972. As a result of that action, the GFR agreed to host the Conference and IUCN prepared the original convention draft which was later revised. A total of 62 nations participated officially at the Bonn Conference, while 15 other nations had representatives present and 20 nongovernmental organizations (NGOs) sent official observers.

The United States had the largest official delegation present at the conference and also the largest NGO contingent. During the conference, which closed on June 23, 1979, substantial improvements were made in the second German draft which finally became the convention. But, nevertheless, it was so embracive that the United States, Canada and Mexico declined to become signatores. Upon conclusion of the conference, it was the United States' position to not become a party to the treaty then or at any time in the foreseeable future. The principal reason was that it included marine fish and molluscs. The United States proposal to exclude these animals was defeated by more than 30 votes. Secondly, the language of the treaty was believed to prejudice the United States' Law of the Sea position. Further the United States was soundly defeated in its attempt to include a federal clause in the treaty recognizing the division of state and federal wildlife management responsibilities in this country.

In our view there were other major problems with the treaty. Although the definitions were refined considerably, they remained much too broad and loose for future interpretation by the Conference of the Parties. In Article I, the migratory species definition was narrowed. However, it is unlikely that this will entirely control the placement of a variety of species on either Appendix I or II. In fact some relatively sedentary species were included on Appendix I, indicating that the parties may ignore the limitations of the definition when they choose to do so. The favorable or unfavorable outline criteria of the conservation status of a species as set forth in the definitions are extremely open and vague. Virtually any species could be given an unfavorable status using any of four guidelines for determining this rank.

Article II outlines some worthy fundamental principles regarding wildlife. Article III, however, pertaining to Appendix I, the Endangered Migratory Species, is so broad that it would permit the Conference of the Parties to designate a wide range of species to Appendix I if it is perceived that reliable evidence was available to justify such action. It must be remembered that the Conference of the Parties is made up of individual delegates from signatory nations. As evident from the Bonn meeting, many of these individuals are diplomats and attorneys, rather than professional wildlife managers. No doubt, the scientific committee will have input. However, this offers no guarantees that only endangered and migratory species will be placed on Appendix I or II.

Article III requires that range states prohibit the taking of Appendix I species. In the treaty, the term "state" means national federal government. Therefore, it would become the responsibility of a federal agency in the United States to enforce the provisions prohibiting the take mandated by the Conference of the Parties. Despite limited exceptions to the prohibition, hunting, fishing, or trapping for sport or commercial purposes are not included. Only through a reservation provision could such action be avoided, since the treaty provisions would have the same binding effect as domestic law, should the United States decide to become signatory at any time in the future.

Article IV relates to Appendix II species and calls for developing international agreements for species having an unfavorable conservation status, or a status benefiting from bilateral or multilateral cooperation. This is one of the most important features of the entire treaty. The need for such arrangements was recognized in North America in the early 1900s for migratory birds which resulted in the Convention between the United States and Great Britain in 1916. Such agreements certainly have merit, particularly for range nations where harvest controls and habitat protection are afforded in some countries but not others. Apparently there is a need for such agreements between northern and southern European countries and certain African nations traversed by various migratory bird species. It seems that protection against overutilization is provided by only a few countries in that particular flyway.

In Article IV the term "unfavorable" is a poor choice. The criteria set forth in Article I for unfavorable status is so poorly spelled out that the door is open for placing almost any migratory species in an unfavorable status. Such a designation would cause a serious public relations and image problem for range states should they desire to allow the utilization of a given component of a population that may have an unfavorable population status. Certainly this would apply in the United States, where organizations exist that will seize upon such descriptions of population status to oppose any form of utilization. Recognizing the need for migratory bird management agreements between European and African nations was, without a doubt, a major reason for the strong treaty support provided by those countries.

Article V outlines guidelines for agreements between range states. It is largely advisory in design and calls for the parties to take action where appropriate and feasible to restore populations of migratory species. It asks each party to designate a national authority to implement the agreement and, in the case of the United States, this would, no doubt, be the Interior and/or Commerce Departments. Here again, if a species considered to be resident and now under the jurisdiction of a state were listed in Appendix I, then jurisdiction over that animal would be transferred to a federal agency by virtue of the convention. This would be followed by rules and regulations handed down to the states in a fashion similar to those resulting from acts of Congress. Examples of this are the CITES convention rules affecting the management of resident species such as the bobcat and alligator.

Article VI calls for the Convention Secretariat to maintain a list of range states for species listed on Appendix I and II and states that the parties should inform the secretariat on implementation measures as provided in the convention for those particular animals.

Article VII outlines the authority, responsibility and formulation of the Conference of the Parties. It states that they will meet at intervals of not more than three years. When one considers the hectic day-to-day requirements of carrying out a successful wildlife management program, it is difficult to understand how the convention will function effectively and make sound decisions on a near global basis without frequent meetings—particularly when the delegates are not trained wildlife management professionals. In all likelihood, infrequent conferences will result in hasty decisions and a built-in reluctance to relax controls on listed species.

The section of Article VII specifying observers who may attend the meetings of the parties is most interesting. Specifically excluded are individuals from states and provinces of all countries even though these entities may have more wildlife management authority in their locale than the federal agencies. Specifically included are international nongovernmental bodies or national nongovernmental agencies approved by a state where they are located. These observers may participate but not vote. These inclusions and exclusions are, no doubt, a measure of the influence that the NGO groups exercised at the Bonn meeting as well as the formative meeting for CITES. This means that the convention, with its national voting delegates and NGO observers, may readily take actions which would supersede state and provincial authority over resident species that may be placed on Appendix I or II. This would happen without allowing states or provinces input into the meeting of the parties except through a national delegate. Here again, this system, which is being employed in managing the CITES Convention, has proven most unsatisfactory.

Article VIII pertains to the scientific council, composed of a qualified expert (not defined) from each party. Being an advisory board to the Conference of the Parties, it will provide scientific advice to members, recommend research on migratory species, and suggest management measures for such animals. It is not clear how these suggestions will be implemented in those countries not having a day-to-day wildlife management program. Perhaps, if wishful thinking is permitted, this may provide a stimuli for the creation of a viable wildlife department in those countries where none exists. The lofty goals of the convention will mean very little unless someone is in the field carrying out the enforcement, biological, and habitat management work necessary for a successful wildlife management program.

Article IX defines the duties and functions of the secretariat, the primary working arm of the convention. Article X pertains to amendments to the convention, another matter of considerable concern. Any party may propose amendments to the treaty. These are adopted only after a two-thirds majority vote of the parties present. For those accepting the amendments, they become effective and part of the treaty. This opens the door to making the agreement much more restrictive at future conferences. There were many comments made by delegates at the Bonn meeting suggesting that the wording of the present treaty is just the beginning, and that many changes will be made at future meetings by amendments.

Article XI provides for amending the Appendices, utilizing an arrangement similar to Article X. Adding species to Appendix I or II will be made by amendment, and only by a reservation may a party avoid applying the amendment to his country. Many delegates at the Bonn meeting spoke of adding large numbers of species to both appendices, some being highly sedentary and not within the Article I definition of migratory.

Articles XII through XX pertain to the effect of this treaty on other international conventions, other legislation, settlement of disputes, reservations, signatures to the treaty, ratification, acceptance, approval, accession, entry into force, denunciation and the depository.

In essence there may be advantages to wildlife in some countries through acceptance of the treaty. However, it poses many potential disadvantages for wildlife management in the United States and strong support should be provided to maintain this country's independence of such agreements. Existing bilateral agreements meet the needs for the proper management of migratory species on the North American continent, but adding an extra layer of international jurisdiction over these time-proven arrangements would be counter productive. The present state-federal system for managing North American wildlife is the most sophisticated and successful arrangement found today. As previously pointed out, the state-federal clause was not included in the migratory species convention, as strongly recommended by the United States at the Bonn meeting. Therefore, the treaty would have the potential for seriously disrupting existing management authority on this continent.

Wildlife treaties should complement rather than hold the potential for suppressing successful on-going wildlife management programs. Treaties should be positive, not negative, in design. International conventions should pave the way for the creation and implementation of wildlife management programs in countries where none exist. Rhetoric and lofty international goals are meaningless without trained professionals working in the field at the local level on a year-round basis in behalf of wildlife. New treaties should recognize the division of authority between state and federal jurisdictions in federated states. If nongovernmental organization participation is to be allowed at meetings of the parties, then why exclude provisions for direct state and provincial input?

Treaties not meeting some of these concerns should be avoided, as in the example of the United States position with the Migratory Species Convention. No doubt new treaties will be proposed in the future. Adequate time for early study and careful consideration, as well as active participation in all meetings, is necessary before involving the United States in any agreement.

Not only are new strategies now being discussed, but major amendments to existing treaties are surfacing. Some of these are being viewed with much apprehension on the part of those who may be affected. Some proposed changes are being justified on the grounds that uniformity is needed between conventions. As yet the rationale for this has not been explained. Since treaties are permanent in nature, extremely difficult to change, and have the same binding effect as domestic law, the best course of action would be to proceed with caution.

Academic Education Needed by Resource Managers

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Introduction

In the past decade fisheries and wildlife management challenges became increasingly complex. Biological knowledge and competence in managing populations and habitats, though still necessary, are no longer sufficient without complementary skills in environmental, economic, and sociological analysis and the ability to serve a better informed and more critical public (Donaldson 1979, Eastmond and Kadlec 1977, Hester 1979). In a 1977 report of the Professional Improvement Committee of the International Association of Fish and Wildlife Agencies, agency administrators questioned the adequacy of the formal education of young professionals. The administrators wondered if university program directors were sensitive to agency needs, receptive to suggested changes in curricula, and willing to participate in an accreditation program. The Professional Improvement Committee, which I have been chairing for the past several years, recognized a need to improve cooperation and communication between the universities who educate professionals and the agencies who employ graduates. To further this objective and determine the receptivity of the universities to suggested changes, the committee surveyed department heads in 1978. The results of the 1978 survey were tabulated and analyzed in a report to the committee by Bromley and Beattie (1979)[1]. This paper combines the findings of the 1977 survey of agencies with the results of 1978 survey of universities and presents the recommendations to both entities by the Professional Improvement Committee.

Methods of Conducting This Study

In 1977, the views of agency administrators on the adequacy of young professionals and on the relationships between their agencies and academic institutions were surveyed with a written questionnaire prepared by the Professional Improvement Committee. The results of that survey were distilled into a second questionnaire. After pretesting of the questionnaire by several academic department heads, the instrument was modified and mailed to 151 university and college department heads in the United States and Canada. Staff personnel of The Wildlife Society and the American Fisheries Society selected the institutions. Along with the questionnaire, department heads received a cover letter urging cooperation and a copy of the 1977 report, which pointed out the concerns of agency leaders.

[1]These reports are available in limited quantities from the New Jersey Department of Environmental Protection, Division of Fish, Game and Shellfisheries, P.O. Box 1809, Trenton, N.J., 08625.

Usable responses were received from 67 (44 percent) of the institutions. Follow-up mailings to increase the response rate were not made. The sample was large and diverse enough to permit descriptive analysis. Open-ended questions prohibited all but descriptive statistical analysis.

Results and Discussion

Adequacy of Student Education

Are new graduates adequately educated in relevant disciplines and well-oriented to the realities of the profession they seek to enter? Of 53 responding agencies to the 1977 questionnaire, 29 percent reported partial satisfaction or dissatisfaction with new employees. Half stated that their new employees were not well oriented to the working world. The agency heads questioned if professors had administrative, management or even field experience. Additional courses in the areas of public relations, wildlife law, business management and administration, social sciences and the humanities were suggested. Only one respondent expressed dissatisfaction with the scientific background of new graduates.

The results of the 1978 survey of academic administrators paralleled the results of the agency survey. At the undergraduate level, academic heads rated their students adequate in biology (87 percent) and humanities (80 percent) but inadequate in law enforcement (83 percent) and administration and business (80 percent). About one-third were considered adequate in research, communication and political science. At masters and doctoral levels, academic heads rated their graduates as adequate in research (97 percent), biology (94 percent), and fisheries and wildlife management (88 percent). One-third or fewer graduate students were perceived as well educated in administration (17 percent), law enforcement (17 percent), business skills (20 percent), and political science (34 percent).

Given that a substantial majority of academic heads recognize weaknesses in their graduates, would these leaders be willing or able to adjust their course programs? Twenty-six stated they were planning to change their curricula, but 42 said changes were not planned. Unspecified administrative constraints were cited by 11 respondents as reasons why no changes were planned. Time was a problem too, with four departments reporting a full curriculum and two reporting full loads for professors. Resistance to external suggestions was suggested by some replies. Nine departments reported that courses were available in most or all the categories suggested, but that their students simply did not have enough time to broaden out that far. Four said their program was sufficient. Four others said other departments had responsibility to produce professionals in business, law, political science and so on. Another four said that they would not compromise the integrity of their programs by teaching inappropriate topics such as law enforcement and on-the-job techniques. There were four responses that the academic program was either general purpose or not a fish and wildlife program.

The approximate summation of academic head responses to changes in curricula was one-third favorable and willing, one-third apparently unable to change due to constraints in money, time and talent, and one-third unfavorable for fundamental reasons, stemming from differences in goals between the university and the agency and perhaps a resistance to external intervention in academic programming.

Accreditation

Should college and university departments offering programs in fisheries and/or wildlife management be accredited according to guidelines and review by the American Fisheries Society and/or The Wildlife Society? Accreditation is under active review by both professional societies. It is considered by agency heads as a way to assure minimum academic training in the professions plus as a way to simplify civil service hiring procedures. However, academic responses to accreditation ranged from extreme support to extreme opposition. About one-half of 65 responding institutions favored accreditation, 37 percent were opposed, 6 percent were undecided and 5 percent were neutral. The most frequent reason for opposing accreditation was that it would inhibit curriculum development. One wrote "Accreditation leads to standardization which leads to stagnation." Contrarily, the most frequently cited reason in support of accreditation was that the process would eliminate substandard programs. Several institutions favoring accreditation cautioned that the accreditation process should be based on objective standards, be fairly administered and performed by a committee of professionals from a variety of backgrounds.

Academic department heads were asked if accreditation, once installed, would improve the quality of undergraduate and graduate students. About half of the respondents said no, claiming that their program was already strong. Others said yes, with some suggesting that an accreditation program would be used for leverage to increase departmental resources from supporting institutions.

Professional Education Beyond the Degree

University educators strive to instill in their students a thirst for knowledge that will drive them to educate themselves throughout their lives. In times when technological and social change are so rapid as to make the ways of solving problems in the 70s obsolete in the 80s, should not the agencies and the universities work together to offer working professionals opportunities to expand their horizons and to improve their skills? The survey of institutions indicated that 41 percent provided at least some form of in-service training. Programs in 12 specific areas were cited, including fish diseases, pesticide pollution, aquaculture, computer operations, and habitat evaluation. Of the 26 programs reported, 9 were originated by the university, 8 by agency request, 9 by joint agreement, and one with varying initiators. Agencies funded 15 programs, joint funding accounted for 9 and one school carried the full cost.

Institutions not offering in-service programs were asked why not. Eighteen claimed they were not asked by appropriate agencies. Another 11 claimed they lacked funds or manpower to offer programs.

Comparison of the nature of existing in-service courses to comments made by agency heads on the adequacy of new professionals reveals significant opportunities. Apparently, in-service training in business management and administration, law enforcement, public relations, communication, and political science would be important additions to the education of practicing professionals. Such courses would be particularly appropriate for the professional who is promoted from the basic field-level position to the first supervisory level. Upon passage of appropriation bills to implement P.L. 95–306, the Renewable Resources Extension Act of

1978, there may be new sources of funds available through USDA-SEA Extension Committee on Policy (ECOP) for expanded opportunities in continuing education for resource managers at land grant institutions.

Improving Liaison Between Agencies and Institutions

Is there a substantial communication gap between the management agencies and the academic institutions? If so, what is and what should be done to improve relations? These questions were asked of both agency directors and academic department heads. According to the 1977 report, an overwhelming majority of agencies felt their liaison with universities was good, but that there was a clear need to improve relations through institution of formal agreements. Similarly, 80 percent of academic heads reported good relations in 1978. In many instances the presence of Cooperative Wildlife Research Units and Cooperative Fisheries Research Units makes liaison formal and routine. About 30 types of formal and informal linkages were cited by agencies and academic departments including guest lecturing, co-authorships, cooperative research grants and contracts training exchanges and student intern programs. Of these various liaison activities, academic heads reported the greatest satisfaction from cooperative grants and research and from guest lectures by agency professionals.

When queried on the desirability of practical work experience during the undergraduate and graduate years, both agency and academic leaders were in strong support. Some states and federal agencies have substantial programs for students as interns through the year or as summer employees, while others offer little or no opportunities. This area is particularly amenable to cooperative agreement between agencies and university departments, as is agreement on the nature and funding of inservice programs.

Conclusion and Recommendations

The turmoil of the environmental management arena is placing new and difficult strains on fisheries and wildlife managers. Consequently, traditional programs in fisheries and wildlife management at universities may no longer be adequate educational backgrounds for starting professionals. Furthermore, the notion that professional education is complete upon attainment of the terminal degree is untenable. Improved liaison between the employing agencies and the academic institutions is essential to prevent excessive time lags between changing needs in the working world of the professional and innovations in the educational opportunities provided at the universities. Therefore, the Professional Improvement Committee of the International Association of Fish and Wildlife Agencies proposes the following recommendations.

1. University and college departments offering professional education in fisheries and wildlife management should be accredited. Accreditation standards should be developed and applied under the auspices of The Wildlife Society and the American Fisheries Society.
2. In-service training programs should be offered at universities. Programs should be available on new technology in the fields of fisheries and wildlife management as well as in fields relating to the broader challenges of resource management.

3. A formal body comprised of university and college administrators and agency directors should form to expedite improvements in professional education. Cooperation of the professional societies and the International Association of Fish and Wildlife Agencies is imperative. University administrators should form an organization. This body should meet annually in conjunction with the North American Wildlife and Natural Resources Conference.

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National Wildlife and Fisheries Policy

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A National Fish and Wildlife Policy

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I consider our panel today to be one of the most important ever presented before the North American Wildlife and Natural Resources Conference, and also a very historic one. There is no doubt that the time has arrived for a National Fish and Wildlife Policy. This Administration is aware of this, and Secretary Andrus has directed me to prepare and implement a policy with the full input and support of all factions with an interest in this nation's fish and wildlife resources. *I* intend to carry out this mandate.

Today, I will discuss the purpose and the outline of the National Fish and Wildlife Policy, which will be published before long. My colleague and personal friend, Assistant Secretary M. Rupert Cutler will discuss policy germain to the responsibilities of the Department of Agriculture.

Developing this policy is a task that I have not taken lightly. Interest, to say the least, has been at a high level. The proposal of a National Fish and Wildlife Policy has been speculated about and, in some instances, challenged inside and out of government.

I believe that, today, this subject is particularly pertinent to the North American Conference where conservationists, protectionists—collectively called environmentalists—gather together once a year to address the problems and opportunities that we all mutually share.

In that sense, I ask you to react to this policy, not so much in what I say in brief summary, but to what it sets forth overall for the benefit of America's fish and wildlife resources. Attempting to reconcile what some consider irreconcilable points of view has been neither easy nor fun, but something *had to be done*.

I will detail some of our efforts shortly, but first, let me tell you how it all began. My hope, when I set this effort in motion, the hope of Lynn Greenwalt, the hope of our entire department, and I expect the hope of you and many other conservationists was that a formal enunciation of a national fish and wildlife policy would do several important things.

It should help focus our efforts, which are almost always parallel and complementary, but occasionally are in apparent or real conflict. By describing present relationships, authorities, and responsibilities, it may diminish needless friction and suspicion. By defining goals, it may attract new support, confirm and coalesce old support, and increase the chances—particularly in a time of government austerity and budget cuts—of reaching our stated goals! Simply, we felt it was not only worth the struggle, but imperative that we try. Energy wasted in conflict and misunderstanding was more than we could afford.

Further, the idea of a policy statement is not something strange or new. It is a periodic necessity—indeed, the obligation of each new generation of conservationists. From Gifford Pinchot through Aldo Leopold, to the contemporary efforts of many of you in this room and various conservation organizations, we have reached repeatedly for definition. Truly, every one of us in this room is directly involved with defining fish and wildlife policy either in word or in deed, often through a career of caring about the resources of our states, this continent, and even the world. Many of us have written about public policy and are, thus, partial authors of continuing, changing, evolving policy as it actually is.

In a sense, fish and wildlife policy is an organic creature. Itself, the transitory end-product of papers written and papers delivered, of research, of formal meetings like this and informal conversations in the halls and the fields, and the end-products of discussions, disagreements, arguments, reconciliations, lawsuits, legislation and, sometimes, even consensus.

But wildlife policy has never been chipped in stone, and for good reason. If nature has remained relatively constant in our personal lifetimes and even in our nation's life; social, economic, political and demographic conditions have not. Even specific parts of nature, obviously, have not.

Less than 400 years ago, 103 Pilgrims disembarked at Plymouth Rock and settled a couple acres on a vast continent where possibly a million Indians already lived, north of present-day Mexico, in scattered tribes. Our concept of "conservation" is less than 75 years old. If the word itself was unknown to those Pilgrims 360 years ago, the concept would have been even more foreign. In their small and lonely enclave, surrounded by natural abundance, survival of the human species was the first order of the day. Early settlers in this land struggled to survive by *using* wildlife, and *consuming* it.

These were religious folk who saw themselves stewards of God's work and His blessed land. Yet, they hunted without question, without permission, and without doubt. When they were successful, they praised the Lord for his Providence and shot again—no bag limits, no possession limits, no in-season or out-of-season regulations, and "no restrictions on lead shot."

For the Indians, life was even more stark, more impossible without the sustenance of native plants and wildlife. Food, clothing, artifacts of transport, hunting, even medicine necessarily came from nature. In the intervening years, at the time of our revolution and as we moved westward, even as the frontier closed, this land changed slowly and the relationship between man and wildlife changed slowly.

Then came the 20th century, a century of accelerating change, of species created over millenia disappearing in a moment, of habitat destroyed in the name of progress or as the result of ignorance or indifference. We created a century of steel and concrete, of asphalt, of dams and reservoirs, and of highways. Abundance of nature, of fish and wildlife seemed less important than other material measures.

For most of us today, if we fish or hunt, wildlife is no longer sustenance but wholesome recreation. For those who don't hunt or fish, but care about the out-of-doors, it is a thing of beauty, a remembrance of things and times past, a precious piece of natural mosaic.

In a time of dead lakes, polluted streams and coastal marshes, of poisonous wastes, of long-term miseries and overnight disasters, *we must act in concert*. Our legions are too small for any other choice. We do not have the luxury of needlessly continuing what have become traditional forms of controversy among us. There are major and divisive issues of substance which concern us as state or federal officials, or as private conservation advocates. No one denies that! There are serious differences between hunters and anti-hunters, differences even between hunters and just non-hunters. These differences are also real and no one denies that either.

But we are weakened by internal warfare, by hostility and distrust, by the inordinate desire to protect our own turf. So I hope we can suspend—if not permanently set aside—our various adversary positions. I speak to you obviously as a federal official—one deeply interested in making as explicitly as possible a realistic, useful statement of national fish and wildlife policy. But I also speak to you as a former state director of natural resources, and as a former director of a national outdoor organization. No matter where you're coming from, I've probably been there.

Believe me, I intend to work for and encourage a policy that *we* will always be proud of. I seek in our work to define a *national* fish and wildlife policy, *not a federal* fish and wildlife policy. If the policy is not cooperative, does not advance equity for all interested parties, does not protect useful historic traditions and roles; it can be nothing more than empty words—the babblings of bureaucracy. I say to you: We have labored too long to bring forth an empty, fatuous, quickly and deservedly forgotten statement.

If we intended to dodge conflicting points of view and the companion tough questions, we would never have started in the first place. The power of this policy statement will ultimately come, not from the force of an executive order of the President, which I will pursue as the vehicle for adoption, but from its acceptance and implementation by *all* of you. A policy statement is, in a sense, like a river. Its power is greater when its tributaries flow strong into it. A wholesome policy, like a healthy river, is stronger than the sum of its parts.

I am presenting to you today the outline of those elements of a National Fish and Wildlife Policy which describes the present institutional relationships—the relationships on which the administrative aspects of the policy will be built. Months ago, we reached outside the department to ask Dr. Jay Hair of North Carolina State University to assist us in the development of a national fish and wildlife policy statement. A continuation of his field inquiries, his first draft on state-federal relationships was completed last November and sent to various agencies, conservations groups and individuals for comment. Virtually everyone responded. While many approved, many also had questions about the draft. Some were basic, some were not. All were considered.

A second draft has not been written. We in the department are continuing to work on it, and in a few days we will print it in the *Federal Register* and ask for public comment. Everyone will have a crack at it, though the final responsibility for it will rest with me. *I* expect to hear every criticism. *I* expect to work to reconcile every argument. *I* have been told that a camel is a horse designed by a committee. *I* do not intend to produce a camel.

We are determined to clearly describe state or territorial and federal roles. That this is our core consideration will come as no surprise to you. We are attempting, in developing our policy statement, to reason together on many matters, hoping to replace conflict with conciliation. The goal of the section to be published will be to identify the respective missions and responsibilities of state, territorial and federal agencies responsible for fish and wildlife resources and their habitats, I quote "as the basis of enhanced cooperation in the attainment of scientifically based resource management programs, and of further development of a national policy."

The sources, nature and interaction of jurisdictional authorities will be described. A plain statement of habitat management responsibilities on federal lands and the related roles of state and territorial agencies will be set forth. Authorities for, and limitations on public activities on federal lands and the integral state and territorial powers over those uses will be described. Further, the scope of, and the need for, interagency agreements on a variety of cooperative activities will be examined. I firmly believe that the keystone of the conservation structure of the future is cooperation. Therein lies the conceptual framework that we are pursuing in the development of this policy.

The maintenance of existing obligations and authorities durng the further development of a National Fish and Wildlife Policy will be prescribed. As it evolves, a National Fish and Wildlife Policy should address a wide range of topics, including but not limited to the following:

1. Ecological, economic, esthetic, and other fish and wildlife values;
2. Human activities, such as land use practices and environmental pollution that affect fish and wildlife resources;
3. Human attitudes toward fish and wildlife resources and their management;
4. Education, extension, research and public affairs programs;
5. Subsistence uses and native claims;
6. Habitats: including ecosystems, communities and individual habitat types;
7. Federal land systems;
8. Management strategies for the maintenance of ecosystems, populations, biological diversity, and yield;
9. Enforcement of fish and wildlife laws and regulations;
10. International programs;
11. Endangered species of fauna and flora;
12. Exotic species; and
13. Animal damage management.

Clearly, in virtually all of this, the complexity of fish and wildlife jurisdiction cries out for generalities that offend no one. We are trying to do much better than that.

Though litigation has increased, with more cases reaching the Supreme Court, and thus more decisions being handed down, it is conceivable that jurisdictional definitions will never be universally accepted. Maybe it is inevitable in the law that it be so.

Perhaps, for us, the most important point is that while in a fundamental sense, fish and wildlife are the property of no one until and unless legally taken, they are the responsibility of us all. The most critical matter is *not* a question of what level of government shall have the basic authority, but rather how a *shared authority* can be made most beneficial for fish and wildlife resources and their habitats. An effective and working partnership between all levels of government is essential for maintaining our natural heritage for the enjoyment of present and future generations. Let us join together to make it so.

Today, I have given you the rationale, the outline and the highlights of this policy. Advance copies of the policy are available at the back of the room. This document will appear in the *Federal Register* shortly. You'll note that this segment of the National Fish and Wildlife Policy is not very long. It is not a 300-page bureaucratic dissertation. It is a concise statement whose words represent a great effort by many people.

Many of you may remember that somewhat lighthearted, but most informative book on organization management called *Up The Organization* by Robert Townsend. It was published some years ago and became a popular best-seller—a strange fate for a book on management.

Townsend was president of a rental car organization that found itself "number 2." It is reported that he asked his senior staff to write a statement of mission or purpose. It took many months of effort and when it was finally agreed upon, it contained only a few dozen words clearly outlining why the corporation was in business and what the business was to be. Short, simple and representing very hard work, but important.

The National Fish and Wildlife Policy may not in the long run be short or simple, but it will be hard work—and it will continue to grow in importance. I view this first draft of overwhelming importance and I commend it to your close attention.

I can think of no more important occasion than the North American Wildlife and Natural Resources Conference in which to annouce this significant beginning which, when successful, can only benefit America's fish and wildlife resources.

I will conclude my remarks by saying simply, we have done much but there is much left to do. In the words of Robert Frost, "We have promises to keep and miles to go before we sleep."

A Wildlife Policy for the U.S. Department of Agriculture

M. Rupert Cutler
Assistant Secretary of Agriculture
for Natural Resources and Environment, Washington, D.C.

The U.S. Department of Agriculture (USDA) supports efforts to redefine the roles of the many states and federal agencies responsible for programs affecting fish and wildlife. And we are prepared to stipulate how USDA plans to do its share to assure implementation of a national fish and wildlife policy.

The department administers lands and programs that affect the use and welfare of fish and wildlife resources on hundreds of millions of acres of lands and waters across rural America. Six USDA agencies—the Agricultural Stabilization and Conservation Service; the Animal and Plant Health Inspection Service; the Economics, Statistics, and Cooperatives Service; the Forest Service; the Science and Education Administration; and the Soil Conservation Service—have important fish and wildlife programs and responsibilities. Through financial assistance, still other programs of the department influence land and water management and, thus, affect wildlife populations and habitats.

Obviously, it's important that USDA develop explicit policies regarding fish and wildlife and provide for coordinated implementation of those policies. We will do this in several ways:

1. In managing the 188 million-acre (76 million ha) national forest system and the other lands we administer directly.
2. Through our educational, technical assistance, and financial assistance programs affecting practices on 1.5 billion acres (600 million ha) of private and other non-federal lands.
3. By improving the status of threatened and endangered species.
4. By alleviating the economic losses to agricultural crops, livestock, and forage and range resources caused by vertebrate animals.
5. Through integrated pest management.
6. Through research.

Our proposed USDA wildlife policy has cleared all but the last few hurdles before it can be signed by Secretary Bergland and published. We wanted to have it ready for this meeting, but this policy is too important and too sensitive to be rushed. We want to make sure it is right. Our lawyers keep finding new wrinkles to iron out. But it will be adopted soon. Meanwhile, the current working draft has been reproduced in quantity for public review.

The essential elements of this statement are as follows:

We will develop and carry out programs, policies, and actions that will support fish and wildlife and improve habitats. At the same time, we will fully consider other department missions, resources, and services. Our policies will direct activities of the department that relate to both federal and non-federal lands. Federal lands administered by the department include the farm, range, and woodlands administered by the Science and Education Administration and the Soil Conservation Service, as well as those managed by the Forest Service.

Fish and wildlife habitats on national forest system lands will be managed to maintain viable populations of all existing native vertebrate species, and to maintain and improve habitats of so-called "management indicator species." Activities and standards for doing this are spelled out in land management planning and other Forest Service regulations. All land management plans for Forest Service regions and individual national forests will state the desired future condition of fish and wildlife in terms of both animal population trends and the quality of the habitat. "Management indicator species," vertebrate and invertebrate, will be identified. Reasons will be given as to why those species were selected. The effects of changes in vegetation type, timber age classes, community composition, rotation age, and year-long suitability of habitat related to the mobility of "management indicator species" of wildlife will be estimated. Where appropriate, measures to mitigate adverse effects will be prescribed. Population trends of the "management indicator species" will be monitored, and the meanings of these trends will be determined.

Range condition and trend studies will estimate the actual use of key forage species by "management indicator species" of wildlife. The capability of rangelands to produce suitable food and cover for these "management indicator species" will be determined.

The national forest system will be managed to protect streambanks, shorelines, lakes, wetlands, and other bodies of water. The national forests and grasslands also will be managed to provide and maintain diversity of plant and animal communities. That means, among other things, that we will monitor fuelwood cutting to prevent the loss of valuable snags and den trees; that we will preserve adequate stands of old-growth forest for species which need it, with or without wilderness designation; and that we will do our best to justify and maintain enough water for aquatic ecosystems despite competing demands for water for other uses.

The Forest Service will fully consider how road construction on lands it administers affects fish and wildlife habitats, and will take advantage of opportunities to improve that habitat or to effectively mitigate adverse effects.

On research and demonstration lands administered by our Science and Education Administration and Soil Conservation Service, consideration will be given to protecting fish and wildlife and their habitats in the development of area management plans. Management alternatives that protect or improve fish and wildlife habitat on these lands will be selected when they are compatible with the primary use for which the area was established.

Of course, federally administered lands contain only part of the nation's fish and wildlife habitats. Most of the existing and potential wildlife habitat in the United States is in private ownership. Two-thirds of all hunting, two-fifths of all sport fishing, and three-fourths of all commercial trapping occur on private lands. There are all kinds of uses for those lands, however, and demands for nearly every use are on the rise. If current land use trends continue, it will become increasingly difficult to save a place for wildlife. For example, 3 million acres (1.2 million ha) of rural America are being lost to other uses, and 300,000 acres (121,410 ha) of U.S. wetlands are being drained every year.

We in the USDA have no intention of increasing "the federal presence" on private lands and waters in regard to fish and wildlife. We firmly believe that the function of our department is to help increase the capability of state and local agencies, private organizations, and individuals to meet wildlife needs. USDA agencies will provide research and technical and financial assistance to encourage landowners to protect and improve fish and wildlife habitats. All of our agencies will recognize fish and wildlife as valuable products of agricultural and forestry operations on private lands.

We will not duck controversial issues, such as how to perpetuate wet meadows for wildlife—created by inefficient irrigation—while at the same time conserving water through more efficient irrigation. We will seek equitable solutions.

The Department of Agriculture and our university-based cooperative extension partners will provide leadership, and will help improve opportunities, for hunting, fishing, trapping, and viewing of wildlife for recreational, economic, and ecological purposes on private lands. These activities will be consistent with landowners' objectives, and will be in accordance with state, federal, and local laws.

The department, within its authorities, will assist the states, territories, and other federal agencies in conducting resource inventories and evaluations of the status and potential of fish and wildlife habitat on private and other non-federal land. We will help the states develop minimum habitat standards for designated species of fish and wildlife. In accomplishing these objectives, the department will review its current statutory authorities, regulations, policies, and directives, and adopt program changes to meet the needs of fish and wildlife habitat management on private and non-federal lands. Our agencies will be given a tight deadline date by which this review must be accomplished.

Our proposed policy will make explicit current policies to improve the status of threatened or endangered species. In consultation with the secretaries of Interior and Commerce, USDA will actively promote and conduct programs to improve the status of important and vulnerable species.

On lands administered by the department, the responsible agencies will identify species whose habitats are particularly sensitive to management activities. They will develop the quantity and quality of habitat required to sustain these species in viable numbers. We will see to it that this key habitat is sustained.

Then there's the issue of predators. Within their authorities, USDA agencies will develop and implement programs to alleviate damage caused by vertebrate animals to agricultural crops, cattle, sheep, poultry, forest and urban trees, and valuable populations of other wildlife species. These agencies also will implement research programs to develop new techniques to prevent animal damage and to control individual predators. This will be done in coordination with other institutions receiving wildlife research support. Such new techniques will be incorporated as promptly as possible into appropriate management and educational programs.

Implementation of the Department of Agriculture's fish and wildlife policy will be in accord with processes established by the Forest and Rangelands Renewable Resources Planning Act; the Soil and Water Resources Conservation Act; and the Renewable Resources Extension Act.

To carry out our new policy, the Secretary of Agriculture will establish an interagency departmental coordinating committee at the national level. This committee will facilitate compliance with the goals and objectives outlined in the policy. It will provide liaison between departmental agencies on all matters related to the policy. This new USDA interagency wildlife committee will recommend and coordinate department actions regarding habitats for threatened and endangered species. It will coordinate a department-wide review of legislation, regulations, policies, and directives. It will ensure that compliance with the policy also will be in compliance with the requirements of the National Environmental Policy Act.

Our new committee will help the department's agencies in obtaining needed data on the habitat characteristics of fish and wildlife populations. The group also will coordinate procedures for developing quantitative goals for wildlife populations and habitat acreage.

In addition, it will be recommended that state coordination committees be formed to implement this policy in each state. Ideally, committee membership will include the state-level heads or wildlife representatives of USDA agencies, their primary state cooperators, and other state and local interest groups. The purpose of these state-level committees will be to coordinate wildlife-related USDA activities and promote cooperation with agencies and persons outside the department.

These, then, are the essential elements of our proposed policy. Many outside the department have participated in their development. We appreciate the candor and the constructive nature of their suggestions. We will make every effort to complete the review of this policy promptly, so that it soon can become a visible part of the department's goals and activities.

Of course, we have not been sitting idly by, waiting for the policy to be adopted. In response to public comments on the draft Resource Planning Act program for the Forest Service, the recommended Forest Service programs for 1981-1985 will place greater emphasis on fish and wildlife programs in the national forests. This will include specifying national population trend targets for production of some species. When those targets are disaggregated to the national forests, as part of the land management planning process, they will ensure that fish and wildlife values are incorporated in national forest land management.

The 1981 budget proposed for the Forest Service contains a significantly enlarged program to rehabilitate and manage salmon and other anadromous fish on the national forest system. Most of you know we also are moving toward third party-enforceable regulations for our channel modification guidelines. Buffer strips along drainage ditches will be provided for wildlife where possible.

The number of fish and wildlife biologists employed by the Soil Conservation Service has been well over 100 for some time now, and the number of biologists employed by the Forest Service has grown from 180 to 368 since January 1977 . . . . in other words, more than doubled in 3 years. These professional habitat managers, working as members of interdisciplinary teams, will assure that fish and wildlife interests are considered and provided for in every small watershed plan and national forest plan.

In the preparation of the Renewable Resources Extension Act National Plan, careful and extensive consideration has been given to fish and wildlife needs. And in the current effort to develop a national program under the Soil and Water Resources Conservation Act, fish and wildlife needs—particularly wetlands-preservation concerns—are being given full consideration.

We believe our proposed policy and our actions on the ground reflect the fact that the USDA has assumed greater responsibility for the habitat of some 3,000 species of fish and wildlife found on America's more than 2 billion acres (800 million ha) of crop, forage, and rangelands and associated water.

We will make every effort to complete the policy review promptly and make its implementation a very visible part of the USDA's goals and activities. With the help of all interested persons in making sure our implementation of that policy lives up to our expectations, and in cooperation with the Department of the Interior, other federal and state agencies, and private organizations and individuals, we can meet fish and wildlife needs in this country.

Note

Subsequent to the 45th North American Wildlife and Natural Resources Conference, the U.S. Department of Agriculture officially adopted a Policy On Fish and Wildlife (Secretary's Memorandum No. 2019). The full text, as approved by Secretary Bob Bergland on 8 July 1980, is presented here.

Secretary's Memorandum No. 2019
Policy on Fish and Wildlife

1. SCOPE AND PURPOSE: America's more than 2 billion acres of crop, forest, and range lands, and associated water, provide habitat for 3,000 species of birds, mammals, fishes, reptiles, and amphibians. Fish and wildlife are important economic, esthetic, ecological, recreational, and scientific resources. They are the object of recreational hunting, fishing, trapping, and viewing and are important culturally and for subsistence purposes to Native Americans. Unusual changes in the numbers of fish and wildlife are often indicators of the general health of the environment and the quality of life for people.

The Agricultural Stabilization and Conservation Service (ASCS); Animal and Plant Health Inspection Service (APHIS); Economics, Statistics, and Cooperatives Service (ESCS); Forest Service (FS); Science and Education Administration (SEA); and Soil Conservation Service (SCS) have important fish and wildlife programs and responsibilities. Other programs of the Department affect land and water management through financial assistance. These also affect habitats and populations of fish and wildlife. Increasing competition for the use of habitats supporting fish and wildlife requires strong policies, beneficial programs, and effective actions to sustain and enhance fish and wildlife in places and numbers that will satisfy human demands.

The purposes of this Memorandum are (1) to state the goal and policies of the Department with respect to the management of fish and wildlife and their habitats and (2) to outline specific actions that will be taken to implement the policies and achieve the goal.

The term ''fish and wildlife'' as used in this Policy Memorandum includes birds, mammals, fishes, and all other wild vertebrate animals.

2. GOAL: The fish and wildlife goal of the Department is to develop and implement authorized program policies and actions that will support the economic, esthetic, ecological, recreational, and scientific values of fish and wildlife, improve their habitats, and insure the presence of viable diverse naturally occurring wildlife populations, while fully considering other Department missions, resources, and services. This will be accomplished through: (1) management actions on lands administered by the Department; (2) educational, technical, and financial assistance programs for private and other non-Federal lands; (3) programs to improve the status of threatened and endangered species; (4) alleviating economic losses to agricultural crops, livestock, and forest and range resources caused by vertebrate animals (birds, rodents, predators, and other mammals); (5) support and encouragement of biological controls to regulate insects, diseases, and pest vegetation; and (6) research providing the necessary technology to accomplish the foregoing.

3. POLICY

A. Lands Administered by the Department

Federal areas administered by the Department include National Forest System lands managed by the FS, and relatively small experimental or research areas administered by SEA and SCS.

1. *Forest Service—National Forest System:* Land management planning and all natural resource management activities and standards for the National Forest System are guided by rules and regulations in Sections 6 and 15, 90 Stat. 2949, 2952, 2958 (16 U.S.C. 1604 and 1613), and 5 U.S.C. 301. A summary of these guidelines as they relate to fish and wildlife follow:

> Fish and wildlife habitats on National Forest System lands will be managed to maintain viable populations of all existing native vertebrate species and to maintain and improve habitats of management indicator species.
>
> All land management plans for National Forest and/or FS Regions will state the desired future condition of fish and wildlife, where possible, in terms of both animal population trends and of amount and quality of habitat. Management indicator species, vertebrate and/or invertebrate, will be identified and reasons given why they were selected. The effects of changes in vegetation type, timber age classes, community composition, rotation age, and year-long suitability of habitat related to mobility of mangement indicator species of wildlife will be estimated. Where appropriate, measures to mitigate adverse effects will be prescribed. Population trends of the management indicator species will be monitored and relationships to habitat changes determined.
>
> Range condition and trend studies will estimate the actual use of key forage species by management indicator species of wildlife and will estimate the capability of rangelands to produce suitable food and cover for these management indicator species.
>
> The effects of pest and fire management on fish and wildlife populations will be considered as well as problems of access and dispersal associated with hunting, fishing, and other visitor uses.

Specific requirements of all management practices for National Forest system lands, to be met in accomplishing goals and objectives, will protect streams, streambanks, shorelines, lakes, wetlands, and other bodies of water. Management practices also will provide for and maintain diversity of plant and animal communities to meet overall multiple-use objectives. Practices will be monitored and evaluated to assure that they protect fish, wildlife, watersheds, soils, recreation, esthetic values, and vegetation productivity. Assurance will be provided in all land management activities that fish and wildlife habitats are managed to maintain viable populations of all existing native vertebrate species and to improve habitats of selected species. This will be coordinated with appropriate State fish and wildlife agencies.

Management prescriptions that involve vegetation manipulation of tree cover will be best suited to the multiple-use goals established for the area. Such prescriptions will provide the desired effects on wildlife and fish habitat and recreation uses. Blocks or strips cut will be shaped and blended with the natural terrain to achieve esthetic and wildlife habitat objectives to the extent practicable. In determining size limits of cuts effects on fish and wildlife habitat will be considered. Timber cuts designed to regenerate an even-aged stand of timber will be carried out in a manner consistent with the protection of fish and wildlife and other resources.

All management practices on National Forest System lands will give special attention to land and vegetation for approximately 100 feet from the edges of all perennial streams, lakes, and other bodies of water. No management practices will be permitted within the riparian vegetative zone that causes detrimental changes in water temperature or chemical composition, blockages of water courses, and deposits of sediment, or deposits of sediment that seriously and adversely affect water conditions or fish habitat. These practices are not meant to preclude or interfere with statutorily permissible activities (for example, a hydroelectric power license issued by the Federal Energy Regulatory Commission under Part I of the Federal Power Act).

The Forest Service will ensure that road construction on lands it administers fully considers the effects on fish and wildlife habitats and takes advantage of opportunities to improve or mitigate adverse effects. If land management planning, or other circumstances determine that certain roads ought to be closed to the public for purposes of protecting fish and wildlife such closures will be put into effect and enforced.

Research needs to accomplish the foregoing will be identified in the land management planning process, and will be established and budgeted at the research stations and at national levels.

2. *Science and Education Administration and Soil Conservation Service:* On research and experimental lands administered by SEA and SCS, consideration will be given to fish and wildlife and their habitats in developing management activites. Management alternatives that protect or improve fish and wildlife habitat on these lands will be selected when they are compatible with the primary use for which the areas were established.

All of the foregoing actions will be carried out within the framework of primary missions, goals, and authorities and will be compatible with action and research programs of SCS, SEA, and the FS.

B. Private and Other Non-Federal Lands

To the extent authorized and subject to budget constraints, agencies will provide research and technical, educational, and financial assistance to inform and encourage landowners to protect and improve fish and wildlife habitats on private and other non-Federal forest, range, and agricultural lands. They will recognize fish and wildlife as valuable products of agricultural and forestry operations on private lands and will work to develop that appreciation in private landowners and landusers.

Within its authorities, the Department will provide leadership and will assist with the improvement of opportunities for hunting, fishing, trapping, and viewing of wildlife for recreational, economic, and ecological purposes on private lands when these activities are in keeping with the landowners' objectives and are in accordance with State, Federal, and other local laws and ordinances.

Agencies in the Department that have authority to do so will assist the States, Territories, and other Federal agencies in conducting resource inventories and evaluations on the status and potential of fish and wildlife habitat on private and other non-Federal lands. Assistance will be provided to the States in developing minimum habitat standards for designated species of fish and wildlife.

Within 12 months of the date of this memorandum, the Department will review pertinent legislation, regulations, policies, and directives and prepare an analysis of its role in fish and wildlife habitat management on private and other non-Federal lands. The analysis will include specific recommendations on need for changes in technical, educational, financial, and incentive programs to encourage the protection and improvement of fish and wildlife habitats by private landowners.

C. Threatened or Endangered Species

The Department will promote and conduct its activities and programs in a manner that will improve the status of threatened or endangered species. Objectives will be determined for threatened and endangered species that will provide for, where possible, their removal from listing as threatened and endangered. On National Forest System lands critical habitat for threatened and endangered species will be determined and measures prescribed to prevent the destruction or adverse modification of such habitat. A management concern that should be considered in FS regional and forest planning are needs to improve critical and essential habitats of threatened or endangered plant and animal species.

The Department will consult with the Secretary of the Interior or the Secretary of Commerce on activities that may affect threatened or endangered species except where counterpart regulations provide otherwise.

Agencies of the Department will take no action that is likely to jeopardize the continued existence of any threatened or endangered species or destroy or degrade their critical habitats except for situations involving conflict with animal and plant quarantine laws as provide by the Endangered Species Act of 1973 (16 U.S.C. 1536 § (7h)) or unless exemption is granted pursuant to subsection 7(h) of the Act. The Department will coordinate with Federal and State agencies in determining the occurrence and distribution of threatened or endangered species; describing the use, condition, trend, and location of critical habitats; prescribing and implementing management to maintain or improve these habitats; and otherwise assisting cooperating agencies or groups in carrying out recovery efforts.

The Department will enforce, to the fullest extent possible, the regulations, provisions, goals, and objectives of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere involving the importation and exportation of terrestrial plants.

On lands administered by the Department, the responsible agencies will, in cooperation with the States, identify species whose habitats may be influenced significantly by planned management activities and define the quantity and quality of habitat required to sustain these species in viable numbers.

D. Economic Losses by Wild Animals

To the extent authorized and subject to budget constraints, agencies of the Department will develop and implement programs to alleviate damage by vertebrate animals to agricultural crops, cattle, sheep, poultry, forest and urban trees, and valuable populations of wildlife. These agencies also will implement research programs, in coordination with other institutions receiving wildlife research support, for the purpose of developing new techniques for the prevention of animal damage and for defining the ecological role of those vertebrate animals that are causing damage. Such techniques and considerations will be effectively incorporated into appropriate management and education programs.

The Department reaffirms the President's 1977 policy on predatory animals. The goal is to reduce damage from predators by preventing conflicts between predators and livestock as far as possible. When control is necessary, it will focus on the offending animals causing the problem—not the species as a whole.

On lands administered by the Department, direct predator damage control programs will be coordinated with the Department of the Interior and the States. The Department also will coordinate with Interior, and with the separate States, on predator-livestock research, extension-education programs, and on damage control activities involving birds, rodents, and mammals other than predators.

A Memorandum of Understanding will be developed with the Department of the Interior to define responsibilities, guidelines, and procedures for the two Departments and their agencies on research and action programs involving animal damage control.

In accordance with Executive Order 11987 on the introduction of exotic species, the Department will work with the Department of the Interior in development and implementation of appropriate procedures.

The Department will promote the concept of integrated pest management practices in the control of economic losses caused by vertebrate animals and plants to agricultural, forest, and range resources.

E. Implementation and Coordination

Within 12 months of the effective date of this Policy Memorandum, agencies in the Department whose programs influence fish and wildlife or their habitats will amend their programs, policies, and procedures as needed to comply with the policies of this Memorandum, to the extent permitted by their authorities. In completing this assignment, each agency will ensure compliance with the National Environmental Policy Act.

Implementation of this Memorandum will be developed in accordance with the processes established by the Forest and Rangelands Renewable Resources Planning Act of 1974, as amended (P.L. 93–378); the Soil and Water Resources Conservation Act of 1977, as amended (P.L. 95–192); the Renewable Resources Extension Act of 1978 (P.l. 95–306); and other appropriate authorities.

The Secretary will establish an interagency Departmental coordinating committee to: (1) facilitate compliance with the goals and objectives outlined in this Policy Memorandum; (2) provide liaison between Departmental agencies on all matters related to this Policy Memorandum and develop procedures for establishing working relationships with cooperating and other interested organizations, groups, and individuals; (3) recommend procedures for designating species for which habitats are to be protected, maintained, and/or improved; (4) recommend and coordinate Department actions regarding habitats for threatened and endangered species; (5) coordinate the Departmentwide review of legislation, regulations, policies, and directives as required by this Memorandum; (6) develop coordinated assistance to agencies in obtaining needed data on habitat characteristics and fish and wildlife populations; and (7) coordinate procedures for developing quantitative goals for wildlife populations and habitat acreages. At least every 3 years the committee will review this Policy Memorandum and recommend changes as appropriate.

The Coordinating Committee will include one representative from each of the following agencies: Agricultural Stabilization and Conservation Service; Animal and Plant Health Inspection Service; Economics, Statistics, and Cooperatives Service; Farmers Home Administration; Forest Service; Office of Budget, Planning, and Evaluation; Rural Electrification Administration; Science and Education Administration; Soil Conservation Service; and the Office of Environmental Quality. Minutes of Committee meetings shall be made available to the top management of each of the respective agencies.

The State Coordination and Administration Committees will promote and help establish an effective fish and wildlife operating committee in each State. The purpose will be to coordinate fish and wildlife planning, budget proposals, and agency roles in education, technical assistance, technology transfer, and incentives programs. The committee should include, as a minimum, the State heads or wildlife representatives of USDA agencies and their primary State-level cooperators, including university and research interests. Other State and local interests should be involved at the discretion of the committee. Some States may choose to have major policy meetings of all interested parties as needed, on a formal or informal basis, to help guide a smaller "core" committee.

Coordination of the policy, programs, and committees established in accordance with this Memorandum will be the responsibility of the Office of the Assistant Secretary for Natural Resources and the Environment.

Establishing Common Ground for Resource Allocation and Management

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Introductory Remarks—Establishing Common Ground

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My remarks are intended to provide an overview to our discussion and a framework for approaches to "establishing common ground for resource allocation and management." The papers and discussion which follow will explore in detail the specific "steps" and concerns in situations where the common ground was, in fact, discovered.

We have seen, and I am sure we all accept, that reasonable persons will have legitimate and often widely divergent differences in values, perceptions and goals as they relate to the allocation and use of our natural resources. Unfortunately, procedures based on existing legislation, regulation and tradition too often operate to emphasize and, indeed, exacerbate the differences, rather than to seek the common ground and mutually acceptable solutions. Our nation is frequently referred to as a "melting pot." However, this simile is flawed. We have not had a melting pot where our several traditions were melded into a single broth, but a structure of government and society which encouraged mutual coexistence: a sense that we could find ways to accept and "live with" our differences even though they would continue to exist.

The papers you will hear today, along with the film and discussions which follow, are based on a recognition of this historic reality: even if we don't agree we can and must find some means of living with differences.

One of the approaches to finding the common ground which is presently receiving a great deal of public notice in the environmental and natural resources arena, is "mediation." Unfortunately, there is also a great deal of confusion over what mediation entails and what it can and cannot achieve. The Office of Environmental Mediation has defined mediation as:

> . . . a voluntary process in which those involved in a dispute jointly explore and reconcile their differences. The mediator has no authority to impose a settlement.

> His or her strength lies in the ability to assist the parties in resolving their own differences. The mediated dispute is settled when the parties themselves reach what they consider to be a workable solution.

Mediation, therefore, is nothing more than the use of a trusted and independent third party to assist in the negotiation process.

To understand the potentials and limitations of mediation it is, first, necessary to understand negotiations. Negotiation is the face-to-face exchange of views and discussion of positions with the good-faith intention of seeking to resolve differences. While it is, perhaps, the best means of finding the common ground, there are some critical prerequisites which must be met if negotiations are to occur.

First, *recognition* by all parties of the necessity of other parties participating in the decision-making process as co-equals is necessary. This is more than the right-to-be-heard espoused in public participation models. A decade ago, Sherry R. Arnstein (1969) in her classic article "A Ladder of Citizen Participation," identified two basic types of citizen participation in governmental decision making: "tokenism" and "citizen power." Processes which fell in the category of tokenism were "informing," "consultation" and "placation." Processes which indicated the presence of citizen power were "partnership," "delegated power" and "citizen control." In any dispute, negotiations occur where some level of partnership has been achieved between the parties—a recognition that whatever one's preference, it is necessary to work together to find some mutually acceptable and agreed upon approach to the decision-making issues in conflict. This is not "advising," but decision making.

The second prerequisite to effective negotiation is that each of the parties involved have *sufficient power or influence* to exercise some control over the ability of the other parties to take unilateral action. Effective negotiators are realists: they may prefer to do it "their way" but know they can't. The power of a party challenging some proposed action may be based on threats of delay through challenges in the courts and administrative arenas, on unfavorable public notice, on such direct economic action as a boycott or even on such political action as an initiative campaign. However, unless there is a sufficient credible power on all sides, it is unlikely that the most powerful parties will have reason to consider negotiations.

A third prerequisite to effective negotiations is that the parties *be able to commit* themselves and their constituencies to the implementation and support of any agreement reached: That is, not only must we find the common ground, but we must secure it. This, in turn, requires that interest groups have opportunity to mobilize support and viable constituencies for their positions. On the one hand, this mobilization is empowering, providing access to the decision-making process. On the other, identifiable, cohesive constituencies with secure leadership provide negotiators with whom to reach agreements and who can make meaningful commitments to abide by and support those agreements.

Finally, there must be some *sense of urgency*. Where any party can achieve its objective by delay or by "waiting out" the opposition, meaningful negotiations will not occur. The negotiation process will become a sham at best and another strategy for delay at worst. This sense of urgency is unlikely to be present until the opposing parties have had some chance to confront one another and the issues. Negotiation, therefore, is not a tool for *avoiding* conflict, but for settling it.

Unless these four basic criteria are present in a particular conflict situation, negotiations are unlikely to be successful. Not only may they fail, but they may heighten the mistrust and misinformation existing between the parties.

As I mentioned above, mediation is merely the assistance of an independent third party in the negotiation process. Negotiations can occur without a mediator, but mediation can never occur in the absence of negotiation.

Most of us are familiar with the use of mediation in labor–management disputes. There, mediators enter a dispute when negotiations have broken off. In the environmental and natural resources controversies, however, the first task which the mediator usually faces is to help the parties define and develop a negotiating relationship. To do this, parties considering entering into a negotiation/mediation process must be given some basis for making an informed decision. Recently, our Office worked with a group of persons experienced as parties to environmental mediation to identify the kinds of determinations that need to be made before entering into the process. Briefly, it was concluded that at least the following questions should be addressed by any party considering such a step:

1. Are all parties who have a stake in the outcome or the ability to influence implementation involved?
2. Have all parties reached general agreement on the scope of the issues to be addressed?
3. Are the negotiators for each party able to speak for their constituency? Is there reason to believe that, if the negotiators reach an agreement, that agreement will be honored by the groups they represent?
4. Has there been a public commitment by the immediate parties and/or the eventual decision makers to a good faith effort to reach a consensual agreement?
5. Has a realistic deadline been set for the negotiations?
6. Are there reasonable assurances that affected government agencies will implement an agreement if it is reached?
7. Does the mediator operate from a base which is independent of the ultimate decision makers involved in the conflict?
8. Do you trust the mediator to carry messages when appropriate and to honor confidential remarks?

The first six questions are, or course, relevant whether or not a mediator is involved in the negotiations.[1]

In conclusion, let me provide a brief description of our Office and its experience: Our efforts to explore the possible application of the mediation process to environmental conflict were initiated in 1972 with a grant from the Ford Foundation. Based at the time at Washington University in St. Louis, Missouri, we began by discussing the concept with leaders from environmental organizations, private industry and public agencies. In late 1973 my colleague Jane McCarthy and I entered our first dispute, a 15-year old controversy over flood control, recreation, land use, and related issues, symbolized by the proposed construction of a flood dam near Seattle, Washington. An agreement was achieved in late 1974 and in mid-1975 we were re-established as the Office of Environmental Mediation in the Institute for Environmental Studies at the University of Washington.

[1]*See* Office of Environmental Mediation. 1978. So you are considering mediation.

Since that time we have successfully mediated about a dozen major disputes involving such diverse issues as highway construction and transit priorities; port development and estuary protection; automobile racing facilities and attendant noise issues; airport expansion and operation in a growing suburban area; management of a sports fishery involving tribal, state, and sports interests; siting of a major ferry terminal; and the establishment of a public park on lands surrounded by a major Indian reservation.

We are funded in roughly equal amounts by three major sources: (1) the Ford Foundation; (2) the Pacific Northwest Regional Commission, an organization formed by the states of Idaho, Oregon and Washington; and (3) the Federal Regional Council in Region X (Alaska, Idaho, Oregon and Washington) through the cooperation of five federal agencies concerned with environmental and natural resources issues (Department of Agriculture, Environmental Protection Agency, Department of Energy, Department of the Interior, Department of Health, Education and Welfare).

Disputes come to our attention in a variety of ways. Typically, we informally explore the possibility of mediation in a particular dispute at the invitation of one or more of the parties, at the suggestion of some interested third party such as the courts, a governor or other political leader, or even at our own initiative. However, we will mediate the issues in dispute only with the informed concurrence of all of the major interests or parties involved.

Our present funding enables us to make our mediation services available to parties in the western United States without direct charge.

Our staff of six full-time mediators, including myself, are currently involved in either mediating or working with the parties to consider mediation of disputes in five western and midwestern states. In addition, my Assistant Director, Leah Patton, coordinates the activities and deliberations of the Western Forest Environment Discussion Group, a group of industry and environmental spokespersons exploring a range of issues of common concern on which they are often divided. We also offer a limited number of seminars and training sessions to acquaint parties with the negotiation process and negotiation skills. These are usually offered in settings and under circumstances which ensure the joint participation of persons from divergent perspectives who are mutually concerned about specific sets of issues. Not only does this approach ensure a high level of involvement, but participants often find they can clear up areas of misunderstanding and misinformation and even explore mutual agendas under the rubric of training.

We believe that mediation can have an important role in fostering and helping to find and secure the common ground through negotiation *if* it is applied carefully in situations where the parties have made a realistic assessment of their options.

The papers that follow address some specific experience in negotiating environmental conflicts which will, I believe, illustrate both the potential and the limitations of environmental mediation.

Reference Cited

Arnstein, S. R. 1969. A ladder of citizen participation. American Institute of Planning Journal (July): 216-24.

Resolving Conflicts in Natural Resource Priorities: Some Experiences from Developing Countries

R. Michael Wright
World Wildlife Fund-U.S., Washington, D. C.

Synopses of Several Resource Conflicts

"We are very proud to believe that in spite of the economic situation in the world, *conservation is a very important tool for development*. This is the principle on which we base our actions . . . " [emphasis added] (from a letter to the Nature Conservancy and World Wildlife Fund-U.S. dated 1 March 1976 from Costa Rican President, Daniel Oduber).

Corcovado National Park, Costa Rica

The project referred to by President Oduber, the 89,000 acre (36,000 ha) Corcovado National Park on Costa Rica's south west coast, provides insight into the reasoning which can lead a developing country to resolve a conflict over resource use in favor of conservation.

The Corcovado's wet tropical forest is the largest such system now protected in Central America. Arguments over the best potential use of these unique natural resources had raged for a number of years without resolution. The Costa Rican decision to forgo substantial immediate foreign exchange which, it was claimed, might result from exploitation of this forest was followed by an additional commitment of up to $2 million in order to relocate squatters and take other protective measures to actually secure the park. In some ways, the most critical factor to the resolution of the dispute was President Oduber's choice of a time perspective substantially beyond his own term in office. Thus he did not discount the future public benefits to be derived from stewardship of these resources, but rather recognized the increased future value of areas such as Corcovado which can arise as comparable areas disappear. On the other hand, President Oduber was able to discount the apparent immediate economic profit from conversion of the Corcovado's rain forest for forestry, cattle or even subsistence farming by applying the ecological realities which are likely to render such conversion futile within a very brief time span.[1]

The reason for the negative assessment of economic potential from conversion is because the luxurious rain forest of the Corcovado basin is a deceptive resource. The area's apparent fertility is not the result of rich soils, for the system's nutrients are locked up in the vegetation and once these are cut, the soil can quickly become leached, compacted, unable to sustain man or animal. This ecological reality was critical in forcing a reassessment of the apparent resource conflict between permanent agriculture or sustained forestry and preservation.

In addition, when considering competing values, it must be stressed that preservation is not necessarily non-use. Through protection, the essential ecological

[1]*See* Myers, N. 1977. Discounting and depletion: the case of tropical moist forests. Futures 9 (6): 502-509; and also Dasman, R., J. Milton and P. Freeman, 1973. Ecological principles for economic development. John Wiley & Sons, London.

processes are maintained as is the prospect that research and high quality nature tourism may actually support more people over time than alternative economic uses. As Dr. Joseph Tosi of Costa Rica's Tropical Science Center observed in his important report to President Oduber:

> Although the growing pressure to "colonize" the Corcovado Basin has some popular emotional appeal with an uninformed urban populace, it has little economic or social rationale due, as has been suggested in this survey, to the area's insurmountable geographical inaccessibility and a largely unfavorable physical environment for all agrarian pursuits. Thus, the declaration and subsequent operation of a managed nature reserve or national park would be not only a most rational step from the cultural and educational point-of-view but also an essentially economic one. A well organized and administered reserve of international fame would, in addition to providing permanent social and cultural benefits to the nation's citizenry, result in large and continuing revenues, direct and indirect, from international scientific and touristic visitation and use. These revenues would be many times greater and be dispersed to a far greater number of people than the essentially short-term income that could be realized from immediate exploitive logging of the old-growth timber, mineral extraction, or the establishment of a few hundred poor families living in isolation from the mainstream of Costa Rican society on marginal, subsistence farms of declining productivity. (Tosi 1976: 11-12)

While unlikely to match east Africa's mass tourism, the Corcovado contains the natural attributes to fulfill Dr. Tosi's prediction and President Oduber's publicly stated goal of sufficient conservation-oriented tourism to underwrite the basic cost of preserving a natural treasure for the people of Costa Rica.

The biotic diversity of Corcovado is due in part to its 13 distinct ecosystems. In the upper basin forest, shallowly rooted trees, draped in vines, rise unbranched to 115 feet (35.7 m) and reach 213 feet (64.9 m) with plant buttresses over 7 feet (2.1 m) tall. The forest has four distinct vertical layers, each differing dramatically from the other, having its own separate species and contrasting microclimates. The gallery forest further down is dominated by great espavel trees, which have cylindrical trunks up to 10 feet (3 m) in diameter. In adapting to a waterlogged existence of the basin itself, some plants rise from stilts, others float, and many abandon the ground altogether and—as epiphytes—move into trees.

Among the 297 bird species listed for the Osa Peninsula are five found only in this region—a wren, a tanager, an antbird, a toucan, and a trogan. The Corcovado contains numerous varieties of hawks, falcons, hummingbirds and gaudy toucans with their oversized bills. Raucous parrots are heard throughout the forest. The swamps provide habitat for ibis, jabiru storks, cormorants, roseate spoonbills, and boat-billed herons; while the coast harbors magnificent frigate birds, boobies, pelicans, and an occasional osprey. In addition, the park shelters populations of endangered harpy eagles and flocks of striking scarlet macaws, a species that is rapidly disappearing elsewhere in the hemisphere.

The tropical forest's major consumers are the ever-present leaf-cutter ants, foraging brigades of carnivorous army ants, and other varieties. All sustain such highly specialized species as the Corcovado's endangered giant anteater.

Threatened American crocodiles and caimans share the marshes and lagoons with some of the Osa Peninsula's 42 species of frogs and 19 species of lizards. The fer de lance, the coral snake, and many nonpoisonous snake species—including the boa constrictor—populate the various forest systems. Endangered hawksbill and Pacific green turtles share the nesting beaches with pelagic leatherbacks and Pacific ridleys. Sperm whales have been sighted in the offshore waters.

All of Corcovado's six species of cats—jaguar, ocelot, puma, margay, jaguarundi, and tiger cat are endangered elsewhere in Central America. However, in the Park they find ample food among the bands of collared and white-lipped peccaries, the ungainly browsing tapir, and the small rodents and reptiles. Over 30 species of bats—including at least one vampire bat—fill niches in the rain forest, along with coatimundis, armadillos, and masked tayras (one of the largest of the weasels). Several of Corcovado's mammals sport prehensile tails: anteaters, kinkajous, a porcupine, and, of course, monkeys. In contrast, two sloths have evolved a sedentary arboreal lifestyle.

Despite the attraction of the Corcovado's wildlife, tourism is rarely sufficient justification by itself to resolve natural resource disputes in favor of conservation. However, it can be one of a combination of factors in the decision process. In Corcovado, the primary motivation was preservation of a unique natural treasure, especially when contrasted to the economically minimal alternative uses. The importance of such trade-offs should not be underestimated. Similar arguments were relied upon in our own country where "supporters of the bill for the creation of Yellowstone assured their colleagues that the Yellowstone country was too high and cold to be cultivated; consequently its reservation would do no harm to the material interests of the people" (Wetterberg 1974: 22).

Morne Trois Pitons National Park, Dominica

In the case of Morne Trois Pitons National Park on the island of Dominica (the "nature island of the Caribbean") some limited tourist potential was combined with watershed protection in resolving a dispute which had smoldered for many years over use of major portion of the island's forest resources. Scientists were interested in protecting these resources while government desired income from them. Initiation of timbering by a Canadian concern brought this long-standing conflict into the light. Although development of the forest resource was the major immediate government objective, the foresighted decision was made in 1970 to integrate conservation issues into the resource equation in order to maintain the island's essential ecological processes. Such processes are in the IUCN's *World Conservation Strategy* defined as "those processes that are governed, supported, or strongly moderated by ecosystems and are essential for food production, health and other aspects of human survival and sustainable development" (IUCN 1980).[2] The resulting report, *Dominica, A Chance for a Choice*, revealed that the island's soil, like the Corcovado's, was characterized by impeded drainage, saturated, highly leached, acidic and poorly aerated. This in turn meant agricultural use was

[2]*See also* a popular version: Allen, R. 1980. How to save the World—strategy for world conservation. Kogan Page London.

limited to two to three years. Natural recovery of soil or vegetation on the island is slow, with disturbed areas often lying fallow in tree fern and razor grass for years.

Contrasting this negative potential were the positive benefits resulting from preventive planning and management within the watershed forest of Dominica's capital city. Besides supplying timber and other products, if managed carefully, these watershed forests influence local and regional climates—parts of the nearby island of Montserrat have become arid and unfit for man following removal of what had previously supported rain forest cover. The forests mitigate the impact of Dominica's average 100 inches of rain (up to 400 inches in places) on steep slopes with poor drainage. Tragically, the negative consequences of forest destruction are now being demonstrated in the aftermath of Hurricane David.

This is not to say all of Dominica's essential timber resource must be protected as inviolate. On an island as in need of development, such a posture is unlikely to even reach the negotiating phase. Some of the island's forestry resources must be used to provide selective cutting of desirable hardwood for employment and export earnings. Although drawn up by conservationists, the report recognized the economic need but observed: "In Dominica a new industry of tropical hardwood seed and seedling production may very well be economically more desirable and of greater long range export potential than the existing lumber industry . . . " (Eddy et al. 1970: 25).

Dominica's conflict was not between use or waste of the resources but between, on the one hand, unplanned cutting for charcoal, clear cutting for cultivation, cordwood and commercial logging and, on the other hand, the free goods which the forest provided: soil protection, flood prevention—protecting life and property both personal and agriculturally valuable lands downstream and the capital's water supply for both human consumption and hydroelectricity.

The accommodation proposed was termed a "conservation composite" which sought to reconcile the present and future needs of the people with the island's basic resources which are limited, intertwined and easily disrupted to a point beyond recovery. The proposal recommended protection of an area (now, Morne Trois Pitons Park) which consisted of five water catchment basins (found necessary by a report of the World Health Organization Water Supply Development Report), one hydroelectric drainage basin, and a southern forest reserve. Beyond meeting these basic human needs, the area included a private estate which the Nature Conservancy, via a gift of an American citizen, was prepared to add as additional immediate benefit of park creation. As noted previously, the pragmatic benefits were complemented by the park's tourist potential. These attractions include rain forest dominated by trees rising to 100 feet (30.5 m) from broad buttresses. Fifty feet (15.2 m) above the forest floor the branches are draped in cable-like lianas and epiphytes, or air plants, The most common trees of the park's rain forest are the giant red-buttressed chataignier and the unbuttressed pillar-like gommier, thriving amid a scattering of other species, such as the aerial prop-rooted mangle blanc. In contrast to North American forests, which are dominated by only a few species, the diverse forest of Dominica contains as many as 60 different tree species within a 10-acre (4 ha) plot.

Dominica's wildlife reflects the isolated island environment and can never compete with the African or even Costa Rican spectacle, but it does include two endangered parrots, a blue-headed hummingbird and two species each of snakes, lizards, and bats all of which are endemic to Dominica. One other island shares the crapaud (a large wood frog known locally as "mountain chicken") with Dominica. The island's 135 species of native birds include the trembler, a thrush whose courtship and territorial display involves a rapid, quivering movement.

The tourist is attracted to Dominica's precipitous, forested peaks which plunge steeply to cliffs, black sand, and cobbled beaches. Torrential rivers, sparkling streams and waterfalls, deep valleys, tall trees, and lush vegetation characterize the recently independent country. The island's undisturbed flora, until its recent devastation by Hurricane David, was the last large expanse remaining in the Lesser Antilles.

The 16,000-acre (6,475 ha) Trois Pitons National Park covers 10 percent of the island's land area, encompasses four forest types, mountains ranging from 3,683 to 4,400 feet (1122.8 to 1341.7 m), and three strikingly different lakes—including one of the world's largest boiling lakes. The barren Valley of Desolation within the park contains sulfur springs, steam belching fumaroles, and streams of black, white, red, gray and orange water. While all this may attract people seeking a different Caribbean experience, the report was careful to note that the park was unlikely to lead to a dramatic growth in tourism and stated that the park's primary purpose should be the protection of those natural resources which directly affect the physical welfare of the people of Dominica.

The Corcovado and Trois Pitons Parks demonstrate some of the mixture of risks and benefits which form the materials from which a resolution of resource disputes in developing countries must be formulated. Prior to generalizing about such considerations, several other examples can be mentioned very briefly.

La Libertad National Park, Panama

Watershed protection, which was so important for Dominica, was doubly important in Panama. The Rio Chagres watershed provides hydroelectric power and water for the country's two major population centers—centers that by the year 2000 will contain some 1.7 million people—but also is essential for the economic operation of the Panama Canal itself. The canal depends upon the supply for passage of ships and siltation, following deforestation, could render this engineering masterpiece inoperative. Nevertheless, in a country with limited land and high population concentrations near the capital, the political and human pressure to convert the former canal's rain forest were intense. These human and economic concerns to protect the forest water and soil found common interest with conservationists interested in the canal's rain forest with its 285 species of birds, 650 species of vertebrate animals (including 17 endangered species) and more than 1,500 different plant species. Ironically, recognition of this common ground arose in 1977 during negotiations over the Panama Canal Treaties and implementation now involves both Panamanian and U. S. government agencies, scientists, and private conservation organizations seeking workable solutions which accommodate use and maintenance of these unique natural resources.

Living Marine Resources of Carriacou and Grenada

The Corcovado, Trois Pitons and Panama's proposed La Libertad Park each involved foregoing conversion of resources in particular areas in favor of the benefits to be derived from protection. In each case the decision makers were high-level government officials. However, in a developing country, disputes centering on overutilization through direct consumption, of wildlife, for example, by a subsistence society can be especially intractable. For a society dependent upon such natural resources, sustainable use is essential for survival. However, such societies are often compelled by the very lack of sufficient resources to progressively destroy the few resources available to them. Any conservationist proposing to protect such overutilized resources must reflect not the degree of endangerment of species in question, but rather the real consequences of the solution as perceived by the subsistence users themselves.

> Considerable resistance to innovations and improvements can be expected from most . . . peasants. . . . They must be totally convinced that no appreciable risk is involved. "Low risk—not high yield—is the name of the game in subsistence agriculture," Ewel says. "Low inputs, diverse crops, multiple plots, dooryard gardens, nearly self-sustaining poultry and livestock, and low but certain-to-get-something yields: these are all reflections of the harsh fact that the subsistence farmer cannot absorb a single failure." (Conservation Foundation 1977: 7)

There are a few precedents for mediating subsistence needs and ecological limits, however, World Wildlife Fund has just become involved indirectly with such an effort in the Caribbean. Initiated by the Carriacou Seamen's Rescue and Support Team in the Grenadines and the Woburn Fisheries Development Group on the island of Grenada, the project entitled "Management of Living Marine Resources by Artisanal Fishing Communities in Grenada" was brought to us by Environmental Research Projects of New York. The nine-part effort includes education, self help projects, determination of the productive capacity of over-exploited marine resources (spiny lobster, queen conch and sea turtles), and evaluation of the commercial potential of new resources (which could diversify their resource base and perhaps provide the future flexibility to allow reduction of take of turtles and other resources to sustainable levels).

Traditional conservation concern for the preservation of endangered marine species, such as the hawksbill turtles, could have led to direct conflict with local human needs. In a developing country setting (in Carriacou for example, one hawksbill can equal a third of a fisherman's annual income) the result of such a direct conflict is unlikely to result in protection of the species, but rather in the conviction that conservation is not merely irrelevant but actually harmful and antisocial. It is too early to know if this particular conflict over use of a living resource can be resolved, but we have reason for hope because it was the fishermen of Carriacou and Grenada who recognized the stocks were being depleted. They are seeking ways to accomodate the conflict between their needs and that of the species, between the demands of the present and the prospects for the future. We have reason to hope because how they, the fishermen, feel about the decision which must be made is more important than how we, the conservationists, feel about them. Most importantly, we have reason to hope because the fishermen apparently perceive that they have a choice which is essential if we are to fulfill what is essentially an ethical belief that "we have not inherited the earth from our parents, we have borrowed it from our children."

Tentative Observations on Conflict Resolution

While the examples cited have involved resolution of conflicts over resource allocation, it must be stressed that none have specifically involved use of the environmental mediation process described by Dr. Cormick in his introductory remarks. Nevertheless, some of the characteristics of mediation can provide insight into the decision process on an international setting. They contain lessons for those hoping to influence conservation decisions in other countries.

Definitions

Mediation has been described as: "a voluntary process in which those involved in a dispute jointly explore and reconcile their differences. The mediator has no authority to impose a settlement. . . . The mediated dispute is settled when the parties themselves reach what they consider to be a workable solution." (Cormick and Patton 1977: 4). By way of comparison, international conflict resolution has been characterized: "My premise is that most international objectives can be achieved only by something more than our own actions: by having other governments make decisions. If this is so, both we and our adversaries must prefer the decision we want them to make to its alternatives. If only we prefer it, they will not make it; if only they prefer it and want to make it, then it would not be a goal of our policy. Unless there is some common ground there is no hope for influence." (Fisher 1969: 52)

Functions of the Conservationist as Mediator

The role of a conservationist working internationally is not totally akin to that of a neutral mediator but the function has similarities: the task is not to adopt high-sounding moral principles, but rather to obtain the best results possible under the circumstances, results which are all, or substantially, the province of foreign governments over whom the conservationist has no power to impose a decision. A mediator seeks to assist the parties resolve their differences. The international conservationist seeks to promote agreement. In a real sense the conservationist is an involved party, but lacking power or authority his strength lies in the ability to alter another party's perception of that party's choice in order to resolve differences between himself and the decision maker. Both the mediator and conservationist must have the ability to anticipate how another party will consider a particular decision in order to exert influence, however, marginal, and if they are effective, both deal in the realm of compromise. On the other hand, the conservationist, unlike the mediator, does have an ultimate decision which he would prefer.

Interestingly, it is the lack of one of the basic prerequisites of mediation, the relative ability of the parties—in this case the conservationist—to exercise sanctions over one another, which transforms the international conservationist into something of a mediator. Pressed with immediate and visible human needs in a developing country setting, conservationists rarely have the power, legal tools, or moral suasion to deny the objectives of more development-minded parties. This is even more the case for conservationists coming from outside the country.

However, a conservationist, even from outside the country, can facilitate a decision by articulating the resource choice which the government must make in the most readily decidable form—what Roger Fisher terms "a yesable proposition." The goal is not to stress broad general virtues or principles of environmentally sound action, but to present the choice in simple form in a specific case and in a way to encourage evaluation of the real costs and benefits of each decision. Posturing for one's domestic constituency or selfrighteous accusations are unlikely to result in any mutal agreements. Both *Dominica: A Chance For a Choice* and Tosi's report on the Corcovado presented the decision makers with the resource issue in such a readily decidable form. Both reports defined the issues to be resolved in a form which facilitated their resolution. Thus, an important aspect of the mediator and international conservationist's role can be his or her ability to structure the issues into an explicit form conducive to decision by another party and in terms of principles accepted by that party.

In addition to articulating the form of the decision, the conservationist, like the mediator, must be certain the critical range of issues is included. In this role the conservationist seeks to accommodate the common preference of governments for immediate benefits with the reality of future costs and long term benefits. The conservationist, in a sense, mediates between the present and future generations.

The Power of the Environment

Given the pressure to use all available resources and the lack of basic conservation power, one must still wonder why any developing country would choose to resolve a conflict over resource use (land, timber, water, soil, wildlife) by both setting aside some of those resources and expending additional resources for protection and management of these "non-used" resources. Yet Dominica, Costa Rica, Panama, and an increasing number of governments are recognizing the necessity of such mediation between development needs and ecological limitations.

> A common factor linking virtually every region of acute poverty, virtually every rural homeland abandoned by destitute urban squatters, is a deteriorating natural environment. Ecological degradation is to a great extent the result of the economic, social, and political inadequacies . . . it is also, and with growing force, a principal cause of poverty. If the environmental balance is disrupted, and the ecosystem's capacity to meet human needs is crippled, the plight of those living directly off the land worsens, and recovery and development efforts—whatever their political and financial backing—become all the more difficult . . . . (Eckholm 1976: 21).

In the developing countries it is the environment, not the environmentalists, which provides sufficient power to exercise control over the ability of the developer (acting through or with acquiescence of government) to take unilateral action. The sanctions which a delicate and highly stressed environment can apply to any development project are of two types—those directly related to the project objectives and those external to such goals. For example, to a decision maker considering a hydroelectric dam these include the threats of high costs which are unrelated to the project goal itself (such as increased schistosomiasis and other health problems resulting from irrigation provided by the dam) and the threats of lack of success of the project itself leading to failure of expected benefits (such as siltation of the dam through mismanagement of the watershed resulting in cutting its power potential or useful life). Roger Fisher argues that failure to attain expected benefits is more likely to alter a project than the threat of high but unrelated costs.

In seeking to resolve a natural resource conflict, such as management related to the dam, one must first consider who it is one seeks to influence. The threat that mismanagement of the watershed will frustrate the project goals will have more influence on the energy department than the secondary health impacts which affect a distant group in a different section of government outside the mandate or reponsibility of the energy department. One may not agree that health considerations are secondary, but if such is the view of those planning the hydroelectric project, the health impacts should not be the primary thrust of one's argument. In seeking to resolve the health problems related to the dam, conservation influence should not focus on the energy department, but pick a different decision maker—logically the health department. Alternatively, if it is the energy department with whom one seeks to negotiate, then one should articulate the impacts or benefits in terms recognized as legitimate by the group who is resolving the conflict, for example, in terms of power outputs and useful life of the project. One of the difficulties in making environmental threats credible is their distance in time and their tendency to fall on groups or in sectors other than the decision maker one seeks to influence.

Conflict Settlement or Conflict Avoidance

Another prerequisite of mediation is altered in the international setting. As Dr. Cormick has stated, mediation builds from perceived impasse which can sharpen the focus and clarify the issues at stake—it is not conflict avoidance but conflict settlement. In an international setting the conservationist is less likely to be successful in settling an ongoing resource conflict when one must attempt to change governments' minds or stop some action already underway. Conservationists rather seek to become involved in potential conflicts often requiring prevention of a decision which has not yet been made. Thus, it attempts to be conflict avoidance. An ecosystem evaluation (EE) which assesses the general characteristics of ecosystems and matches them with appropriate uses far in advance of any project proposal may have more influence in a developing country than a later environmental impact assessment (EIS) which verifies negative impacts, but far into the project cycle: "A decision to start doing something which takes into account certain risks will be confused with a decision to proceed even though the risks materialize" (Fisher 1969: 35).

Lacking the power to themselves stop projects when environmental risks do materialize, the role of the conservationist internationally has been not to create impasse or delay, but to clarify issues, whenever possible ahead of time, and to formulate and reformulate the decision in terms acceptable to those charged with resolving the issue. Having learned from the U.S. experience, developing countries are unlikely to adopt EIS processes capable of giving conservationists the power to stop projects . . . a power upon which mediation depends. Rather, our goal should be to develop environmental evaluation or assessment procedures which improve our ability to predict the likelihood of risks materializing before the initial decision is made.

The Benefits of Conservation

In addition to all the negative consequences from an environmentally unsound decision—the costs one pays and the project benefits frustrated—there has been growing appreciation for the taken-for-granted benefits to be derived from resources which are "not, or only partially, used." These resources include such things as the watersheds for the world's rivers, the source of hydroelectric power, irrigation, industrial and urban waters, wood products and considerable foreign exchange:

> Less obvious benefits include the collection of plant and animal species from which come new medicines, materials for food and industrial commodities. From wild places come fish, meat, seeds and fruits for the diets of rural dwellers. Wild animals contribute to medical research . . . wildlands are an intimate and unseparate part of the "life support system" of the human habitat. The examples are of processes rather than species, habitats or things: rivers flow, evolution continues, nutrients are transformed, energy is converted, genetic materials are conserved, and wastes are filtered and absorbed. (Miller 1978: 13).

Over the last few years there has been a growing change of perception in the developing countries about the value of the benefits to be derived from resolving a resource conflict in favor of conservation. Nevertheless, just as the threats of environmental disruption are distant in time and impact on individuals other than the decision maker, conservationists have a long way to go in demonstrating the direct connection between the benefits of conservation and the decision maker. Take, for example,

> . . . the case of tropical rain forests, perhaps the most paradoxical of resources. Ecologists find themselves explaining that although their luxuriance gives the impression that tropical rain forests are rich, in fact they (or at least their soils) are generally poor. They then add that although in that sense they are poor, in another sense they are rich—in their genetic diversity, for example. If areas are conserved for this genetic diversity, they must be kept safe from logging, agriculture, pastoralism, in short most activities likely to yield an economic return. Yet even when some of that cherished genetic diversity is eventually used—as the source material of new products—it will not necessarily bring any economic return to the country concerned. For example, a medicine derived from a forest plant is likely to be manufactured in an industrial country. (Allen 1975).

Paradoxically to promote conservation, therefore, conservationists would do well to encourage creation within the developing countries of the capability to utilize and benefit from the resources available in their reserve areas. An example of the potential is seen in the use of a Mexican yam which provides the key ingredient for contraceptive pills and which has become so valuable the Mexican government was able to increase export prices over 1000 percent between 1970 and 1976 (from \$5/lb. to \$70/lb.) (Myers 1978).[3]

[3]The most exhaustive analysis of the value and uses of species can be found in Myers, N. 1979. The sinking ark: a new look at the problem of disappearing species. Pergamon Press, N.Y.

Actions which increase capability to exploit natural resources, albeit on a sustainable basis, make preservation more attractive to a developing country and conservationists' urgings more credible. Unfortunately, conservationists have not equipped themselves to promote such economic use of natural resources and have tended to shun schemes which promoted exploitation, especially of wildlife. Given the nature of their constituency, this situation is not likely to change dramatically in the near future.

Short of such major sustainable development reorientation, conservationists can still provide short term benefits in order to encourage and support conservation initiatives. These can take the form of financial assistance as was done in Corcovado, it may involve technical or scientific advice or, as in Dominica, a donation of land. The offer by The Nature Conservancy, World Wildlife Fund and RARE in the case of Corcovado was highly credible due to the irrevocable nature of the commitment, the specificity of the offer, the initiation of fund raising (putting our commitments into effect), the high reputation of the organizations, and their willingness to provide the benefits immediately upon establishment of the park. While not equaling the ultimate costs of the projects, these benefits were seen as proper and appropriate in both our and the government's eyes in light of the needs imposed by the conservation decision. The support also helped legitimatize the decision and importantly, allowed us to share the risk with the decision maker. On the other hand, the amounts were not so great that the country could not sustain the effort once the parks were established. An international aid program to compensate for loss of exploitation revenues called "World Ecological Areas Programme" has even been proposed by the *Ecologist Magazine* (Goldsmith and Allen, pers. comm., 1978).

Finally, adding to the growing recognition of the negative consequences of environmental abuse and benefits of positive conservation actions, there is an increased sense in many countries that conservation is a symbol of political maturity. Governments are more likely to act if the action is seen as legitimate and consistent with their own principles, therefore this recognition of legitimacy is encouraging.

Despite all the rationale described here, disputes over allocation of resources will occur and, as in the U.S., will continue to create animosity and mistrust—one group characterized as destroyers of the nature while their opponents are anti-people. If one is to work on conservation in developing countries, it is essential to adopt one basic insight from mediation: that such conflicts are not over right or wrong, but over different, but, nevertheless, legitimate, priorities and objectives. "To attempt to accommodate these differences, therefore, is not a 'compromise' in the sense of doing something less than what is 'best': it is determining what *is* best" (Cormick 1976: 217).

To conclude, in terms of resolving resource conflicts in developing countries, an important step was taken on March 5 of this year with the launch, in 33 world capitals, of the World Conservation Strategy, produced by the International Union for the Conservation of Nature, with Robert Allen as principal author and financial support from World Wildlife Fund and the U.N. Environment Programme. This document seeks to accommodate legitimate differences, seeks in broad terms to articulate what is "best." Therefore it may be instructive to close with the Strategy's definition of the natural resources' erstwhile adversaries, conservation and development, for a fully implemented Strategy may help or resolve many new potential resource conflicts during our next environmental decade.

> Development is defined here as: the modification of the biosphere and the application of human, financial, living and non-living resources to satisfy human needs and improve the quality of human life. For development to be sustainable it must take account of social and ecological factors, as well as economic ones; of the living and non-living resource base; and of the long term as well as the short term advantages and disadvantages of alternative actions.
>
> Conservation is defined here as: the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment. Living resource conservation is specifically concerned with plants, animals and microorganisms, and with those non living elements of the environment on which they depend. Living resources have two important properties the combination of which distinguishes them from non-living resources: they are renewable if conserved; and they are destructable if not.
>
> Conservation, like development, is for people; development aims to achieve human goals largely through use of the biosphere, conservation aims to achieve them by ensuring that such use can continue. . . . (IUCN 1980).

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Mediation: A "Sell-out" for Conservation Advocates? or a Bargain?

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As a lawyer involved in environmental advocacy, I often describe myself as an "environmental litigator." That reflects the expectation of having to take my fights, and solving my problems, in the courthouse. That's the convention; it's what I am trained to do, and it is therefore "comfortable" (though not completely).

Over time I have made a discovery that most before me, and many after, will have made: trial by fire (i.e., litigation) is the most costly, the most time consuming, and generally the least effective way to solve an environmental problem and most others, as well.

I remember the first case I became involved in when I became an "environmental litigator" back in late 1974. It involved a federal highway bridge going over a lake and an important (indeed, the *only*) inland beach on Lake Worth, Florida. Our Florida affiliate (the Florida Wildlife Federation) argued that the Federal Highway Administration had an obligation under a federal transportation statute to mitigate the damage to the aquatic and recreational resources being destroyed. We claimed, in particular, that the beach destroyed by the highway bridge should be replaced.

The highway folks thought they were doing everybody a favor by providing a nice umbrella for the otherwise sun-struck sand.

Well, there were preliminary skirmishes in court, a blizzard of paper, and finally a "shotgun" settlement of sort when the parties started running out of gas and the judge began banging heads. The deal, in effect, was that the Highway Administration would do whatever was "feasible and prudent" to mitigate the loss of the beach and the damage to the lake.

Result: nothing ever happened. Though there was another blizzard of paper.

That was my first shot.

The second was the famous, or maybe not-so-famous, Sandhill Crane case down in Jackson County, Mississippi. Again, the Federal Highway Administration had the black hat. This time the agency was planning a stretch of Interstate 10 right across the last remaining habitat of the Mississippi Sandhill Crane, an endangered subspecies—only 40 birds were still extant, and they were all in the area traversed by this new stretch of highway. This was in early 1975, and there hadn't yet been any litigation under the Endangered Species Act. (The Tellico Dam case—more about that later—had yet to hit the launching pad.)

Right at the edge of this habitat, the Federal Highway Administration programmed a giant new interchange. That meant a flowering of fast-food franchises, motels, miniature golf courses, drive-in movies, and truck stops. And, no doubt, new sub-developments would come soon after. Result: The end of the Crane's habitat. The end of the Crane.

We tried to reason with the roadbuilders. They didn't want to talk, and down went the gauntlet. Off to court.

By the time the dust settled, and we had "won," several years had passed. The case had ultimately gone to the Supreme Court and was remanded back to the lower court to make additional findings. Letters to the editor of the *Pascagoula Times* had prescribed new recipes for Sandhill Crane soup, and the Fish and Wildlife Service had to assign law enforcement officials to the area to protect the birds against outraged citizens. A compromise was finally reached in which the land all around the proposed interchange was purchased for an extension of the Mississippi Sandhill Crane refuge being created by the U.S. Fish and Wildlife Service. An additional $10 million of the taxpayers' money was spent for the acquisition. Also, "borrow pits" were relocated, the alignment of the highway was modified somewhat, and an additional $25,000 of the taxpayers' money was stuffed into our pockets for attorneys' fees.

If we had sat down *before* the feathers had started flying, we could have worked out that (or an equally satisfactory) resolution—with a lot less bloodshed, in a lot less time, and with a lot less money spent.

After a couple more doses of "trial" by error, it occurred to me that there might be a better way to solve these kinds of problems. My first attempt at another way came in early 1976.

Jay Shuler is a self-trained naturalist who lives in McClellanville, South Carolina. McClellanville is on the edge of the Francis Marion National Forest. In the forest there is a marshy area of several thousand acres called Ion Swamp.

There is (or was) a small bird called the Bachman's Warbler. That Warbler was discovered in the mid-1800s by a preacher named John Bachman. The last absolutely verified sighting of the bird was sometime in the 1960s. Many of the sightings of the bird over the 140 years that Bachman's Warbler had been known, and most observations of its nests, had been in or around Ion Swamp.

The Forest Service decided to let new timber contracts in Ion Swamp in the mid-1970s. Shuler was outraged. He thought the tiny bird still lived, and he thought Ion Swamp was critical to its survival. So when the Forest Service decided to permit logging there, Shuler readied for war. All he needed was an army—or a lawyer, with time, energy, and a combative nature.

He called me.

Down to McClellanville. I listened to Schuler's argument. He and I walked around the Ion Swamp one warm spring day, at a time when the Warbler (if it still relied on Ion Swamp) would have been there. We looked. No luck.

I asked Shuler for permission to negotiate with the Forest Service. He was reluctant, but willing to think about it. He didn't have a lot of maneuvering room. He had no army. I was the only lawyer in sight.

So I went down to the Forest Service District Ranger's office and met with the planners and biologists. A big meeting. It lasted two hours. Not two years. Two hours.

What I proposed was putting the issue (logging versus the Warbler) to a panel of three biologists—one to be chosen by each contestant, the third chosen by the first two. These "experts" would listen to each side's arguments, make a field trip, read the ornithological literature, and then hold a hearing at which both sides would make their last pitch in the presence of each other. Then the panel would render a non-binding "advisory" opinion—which either side would be able (at its peril) to disregard.

The Forest Service agreed. I took the proposal back to Schuler. He bought it. Then we rounded up the panel. Shuler picked Dave Marshall, a biologist with the U.S. Fish and Wildlife Service's Office of Endangered Species in Washington. The Forest Service picked its Endangered Species coordinator, Bill Zeedyk, also then in Washington. Both of those fellows picked Fred Evenden, Executive Vice-President of The Wildlife Society.

The bonus was that the government (for Marshall and Zeedyk) and The Wildlife Society (for Evenden) picked up the tab. What a bargain.

There ensued several months of dialogue, field trips, and research. The panel came up with a draft advisory opinion. Both parties took shots at it, an oral hearing was held, and the panel issued its final opinion. They recommended, as you might expect, a compromise. No cutting of the bottomland hardwood, some cutting in the upland pine area, and modest thinning in the ecotone. Both parties accepted the recommendations. Q.E.D.

When I last looked, there was still some minor dispute as to the boundaries of the *forbidden* versus the *permitted* cutting area. But, in effect, the dispute was solved with a minimum of sound and fury, not too much expense, no protracted delay. When it was all over the parties were still speaking to each other—if not in harmony, at least with civility.[1]

I liked it.

So we tried it again. The next time was a dispute in Idaho—in the drainage of the South Fork of the Salmon River. Once again, the antagonists were the Forest Service and conservationists. My clients (members of the Idaho Wildlife Federation) were concerned about new timber cutting and roadbuilding and its impact on a fragile watershed, and in particular on rare summer-spawning chinook salmon.

The South Fork of the Salmon had been all but wiped out in the mid-1960s by a combination of excessive logging, roadbuilding, and severe storm events. Finally, a moratorium had been placed on any further timber harvest or roadbuilding until the resource recovered. The Forest Service thought there had been sufficient recovery in the mid-1970s. The Service started planning for renewed, albeit modest, timber production and road construction. Some of our folks in Idaho were, understandably, concerned. They were more than concerned—they were furious. Like Shuler, they were ready for battle, and wanted us lawyers at NWF to lead the charge.

I was off to Idaho. I recall arriving in Boise at about midnight, and going immediately to the home of the vice-president of the Idaho Wildlife Federation and sitting down with the ringleaders of the opposition. The last thing those guys wanted to talk about was "mediating" this dispute. They were looking for blood—not milk and honey. Like Shuler, their maneuvering room was limited. No army of experts. No clear victory in court.[2]

All they had was one carpetbagging, lonely lawyer. And he didn't like the idea of going to court with the case with which he had been presented.

Forest Service personnel had done extensive modeling, with the most sophisticated "technology." They had written one impact statement which had been

[1]Alas, at last word the Warbler had still not been sighted—in Ion Swamp or elswhere. Be it understood, however, that this miniature bird is extremely difficult to sight.

[2]Victories are rarely "clear"—even after they're won (*see* Tellico Dam case, below).

rejected by their Chief. The Service wrote a second impact statement, bigger and better than the first. Forest Service folks, including a highly respected fisheries biologist, Bill Platts, were honestly convinced that they could permit a modest amount of cutting and road construction without increasing sediment levels, or in any way jeopardizing the fishery. My clients were equally convinced it couldn't be done.

We hammered out a compromise, in which the Forest Supervisor agreed to very close monitoring of sediment levels, with my clients participating in the monitoring process, and agreeing to cease all timber activity if sedimentation levels showed any appreciable increase (we defined "increase" quite specifically).

We tried it on, and it fit—until we got it to the Regional Forester for approval. He had not been a party to the negotiations. He didn't think that the Forest Service should be bowing to that kind of outside pressure—or have outsiders working on the "monitoring" committee. So we had to take administrative appeals. Finally, we got most, but not all, of what we wanted.

After all the bickering, neither side was happy. And when the Forest Service prepared their management plans for some contiguous management units in the forest, the war started all over again. When I last checked, there was another administrative appeal pending decision by the Chief of the Forest Service regarding two other management units in the same Boise-Payette Forests.

I cite that example as a case where "mediation," or conciliation, showed promise, but ultimately failed, partly because not all the decisional parties were at the bargaining table. That is a pitfall of dealing with the government, where it is often difficult to get all, or the right, decision makers in the same room.

One more war story. One without an ending. We are currently engaged in still a third fight with the Forest Service. This one concerns a huge open-pit mine in a national forest in Colorado. My clients—and they represent a broad spectrum of interests—claim that the Forest Service and the state have betrayed their statutory and public trust obligations by permitting this mine to operate without requiring backfilling of the pit (which will be a mile long, one-third mile wide, and 700 feet deep in places). Our contention is that only by backfilling can the mining company adequately restore the landscape and protect the watershed.

The folks opposing the mine are of various stripe. Some are concerned about big game migration routes disrupted by the pit. Others are concerned about the chanciness of revegetation at high altitudes and on fairly steep slopes. Others are worried about radiation contamination of the ground-water system and tributaries of the Gunnison River. Still others are concerned that uranium is being mined, with the potential for use in nuclear war, or in unsafe energy production.

The mining company has talked to us about the possibility of mediating this dispute. They would match their experts on reclamation, hydrology, wildlife and outdoor recreation against ours, at a negotiation table. And we would try to reason to a result.

I like that idea, and *some* of my clients like it, also, but not all of them. The ones who don't like it are, by and large, "anti-nuclear" folks. Their main concern is not how good the reclamation or how restructured the hydrologic system will be. They simply don't want any contribution to the nuclear fuel cycle being made by our public land managers.

Right now we're on dead center. We (the lawyers) are at the option of either dropping some of our clients, and helping them find other counsel; or forsaking the chance to resolve this dispute without litigation.

It's "no win." If we agree to mediate (and have to drop some clients in so doing), it's a "sell out" to some of our people. It we go to court, we may be taking the most expensive, and least satisfactory, path to resolution. One thing for sure: litigation will be no bargain.

Let me try to generalize from these few experiences just recounted. Mediation, as an alternative method of environmental problem-solving, is useful and holds promise under the following set of circumstances:

1. The parties on both sides must be "reasonable"—that is, each must be willing to listen to reason and to make choices based on rational debate.
2. The decisional parties must be brought to the mediation table. If the government is on one side of the fight, the right government officials must be participating, or have endorsed the negotiation.
3. The dispute has to be one that centers on *fact* (Does the Bachman's Warbler still exist? What kind of habitat does it depend on? Is it possible to contain sediment increases given new roadbuilding and timber harvest? Can high altitude revegetation be achieved on steep slopes?), rather than philosophy or values (Will uranium production increase the likelihood of nuclear war?).
4. There must be a balance of power on both sides. The government or industry has power, by definition—a "deep pocket" with which to pay lawyers and experts. Somehow equivalent, or at the least respectable and responsible, power on the other ("public interest") side has to be demonstrated.
5. Each side must have an incentive to solve the problem outside the courthouse.

Often both sides, regardless of the depth of their pocket or the number of lawyers and experts in their corner will have a natural incentive to avoid a lengthy, expensive and publicity-ridden lawsuit. The government, and/or industry, though it can generally afford the time and the money, usually wants to avoid the bad public image that goes with litigation—and the delay. Further, there is always the risk of losing. Enough of these courtroom wars have been lost so that government and industry have to be sensitive to that risk.

As for the "public interest" disputants, the cost of litigation is always a deterrent. Even if the lawyers (like me) come free, depositions, transcripts, filing fees, expert witnesses and the like will still run up the tab. And often the lawyers are *not* free.

Further, the time-and-energy drain is enormous. And we, too, know the risk of loss is high. Even if we've got a winning case, the risk of loss is still high.

Take the Tellico Dam (snail darter) case. Zyg Plater and his small but courageous band of warriors put up the good fight, reached way down to their shoetops to finance *Hill v. TVA*, ran it from a federal trial court in Tennessee (where they lost) to the Supreme Court of the United States—where they won.

And they still lost.

An environmental victory, if it doesn't have solid political appeal, is at the mercy of the Congress. The Supreme Court says the dam ought *not* to be built. The Endangered Species exemption ("God") Committee—created by the Congress, in response to the snail darter's victory—also says that the dam ought not to be built (for *economic* more than environmental reasons). Still the legislature, by hook and crook, makes sure that the dam gets built.[3]

We just finished losing a court fight up in South Dakota. Again, we were battling the Forest Service, and what appeared to us to be excessive road construction in the Black Hills National Forest. Roadbuilding which the area residents, the South Dakota Game, Fish and Parks Department, and local and statewide conservationists opposed. Roadbuilding which threatened important deer and elk habitat with new intrusions of people, automobiles, and noise. We claimed that the right environmental impact statement had not been written. Our case seemed solid.

After a ton of time, lots of money and enormous energy, and with a good case—we lost, in the Court of Appeals in St. Louis. I cannot, given ethical constraints, give you my assessment of how that happened. (I'd like to think it wasn't because our lawyers hadn't produced.) Suffice to say that even with a really good case, any litigant runs the risk of losing in the courthouse. In our South Dakota case, one panel of three judges on the Court of Appeals apparently found that we had a "meritorious" case, and issued a *temporary* injunction against further roadbuilding. Their decision wasn't final, however. The *final* decision was rendered by *another* panel of judges, and (without writing any opinion) those fellows found that our case was *not* meritorious and undid the injunction.

Litigation, then, is often like rolling dice. So I think there is always an incentive on both sides—if both sides are "thinking" and have their eyes open—to take their fight somewhere else. That brings me to my last point.

What is that "somewhere else?" Is there a ready alternative to litigation? Is there a readily-available forum where "mediators" (rather than judges) can help resolve disputes? Are there "mediators?" The short answer seems to be "no." At least right now.

If the parties in an environmental fight are amenable to resolving their dispute in a way more civilized, less costly, and quicker than litigation, chances are they're going to have to create their own mechanism for doing so. To my knowledge, there are no "institutionalized" mediation forums for resolving environmental disputes.

While a few organizations—the Office of Environmental Mediation in Seattle, RESOLVE in California, and ROMCOE in Colorado—exist to help parties resolve their disputes in a non-confrontational way, not many disputes have been taken to those organizations or resolved by them. They seem not to have the person-power, the track record, and/or the credibility to attract disputants.[4]

There is, in my judgment, a need to more broadly, and with better funding, institutionalize mediation as an alternative to litigation. Establish some place, or places, where there exists a pool of trained mediators who can help two warring factions intelligently address the issues and reach a resolution—an organization that attracts government and/or foundation money, then goes out and enlists a cadre of highly regarded, unbiased expert biologists, hydrologists, botanists,

[3]*See, similarly, Named Individual Members of San Antonio v. Volpe*, 446 F.2d 1013 (5th Cir. 1971). A court victory there was also followed by a Congressional exemption for a center-city highway.

[4]The Office of Environmental Mediation in Seattle may be an exception. It has become increasingly active in mediating live disputes, especially in the northwest part of the country.

physicists, chemists, engineers, whatever. Teach them the tools (such as they are) of mediation, and make them available on an *ad hoc*, remunerated consultancy basis to contestants in a conservation confrontation. Thus, in my mining dispute, if my clients and the mining company and the Forest Service and the State Mined Land Reclamation Division are all willing to sit down and work out our differences, this mythical organization would make available some expert who has some understanding of reclamation, hydrology, and wildlife, and knows mediation technique.

With the advent of massive energy development (coal, uranium, synfuels, *and* hydroelectric) in the part of the country in which I live (the West), we can expect continuing conflict between the resource developers and the resource conservators. If those conflicts have to be taken to court and await judicial resolution, shame on us.

There is a better way. The challenge is to find that way. Then bottle it, and put it on the market. The sooner, the better.

Founding a Center for Environmental Mediation in New England

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Introduction

In New England, there are three obstacles to the establishment of an effective environmental mediation service:

1. Many who might choose to bring a dispute to mediation are not aware that mediators are available or how they might be of help.
2. Cases are mediated in isolation from one another rather than as single instances of a systematic approach to environmental dispute resolution.
3. Mediation is frequently thought of as a high pressure, "last ditch" effort to get a solution, rather than a form of negotiation assistance helpful throughout the course of a difficult dispute.

Those who can find mediation services helpful include business organizations, environmental groups, and government regulators. Each is involved in environmental disputes for different reasons, and each requires somewhat different forms of help.

Business and industrial developers tend to be familiar with and skillful at negotiation. However, business leaders may resist negotiating directly with concerned environmental and citizen groups for several reasons. One complaint is that these groups are unable to understand complex technical matters and are not truly "representative." Another is the fear that the information provided to explain and justify a position will be used against them later on.

Environmental groups are equally apprehensive about negotiating with industry—in part because of their limited experience with negotiation outside of a legislative and political context, and also because they often mistrust the technical and economic sophistication of "business types." Environmentalists prefer the familiar pace and ground rules of a regulatory proceeding.

And the regulatory official is wary of any process which seems to circumnavigate "estalished procedures." If the regulator encourages parties to negotiate on their own, it looks as if he is abdicating his administrative responsibilities and encouraging parties to play fast and loose with the rules.

For mediation to work, participants must believe that, in the course of the negotiation, all parties will respect the opinions of the others even if they do not agree with them; all parties will be able to present information to support their case without fear it will be used against them; all parties will have sufficient time and information to make decisions—agreements will not be binding until all parties understand and approve of them; all parties will be able to participate in the process without prejudice to their legal rights and regulatory responsibilities; and all parties will be free to halt the negotiations at any time of their own volition.

Examples of Environmental Mediation

Let me describe two cases from my experience in New England to illustrate, first why negotiation is often the best way to resolve an environmental dispute and, then, how mediation structures and encourages negotiation.

Hydroelectric Development at Swan Lake

Swanville, Maine is a quiet town which wraps around the shores of Swan Lake, a deep, clear body of water a few miles north of Belfast at the northern end of Penobscot Bay. If if were not for Swan Lake, Swanville would probably not exist.

At the center of town, just across from the general store, is a long, low, concrete and stone dam which releases water from the lake to the Goose River. From the dam at Swan Lake, the river meanders across a wide meadow and then drops rather sharply to the northern end of the bay. Along the way, it passes over five more small dams.

It is hard to believe that this inconspicuous dam, the scene of picnicking, swimming and fishing on any late summer afternoon, was recently the focal point of anger and violence that shattered the peace of this tiny community in a controversy which reflects our national dilemma over energy development and environmental protection.

For years the people of Swanville had felt victimized by the operation of the dam at Swan Lake. When the water in the lake rose too high, it washed away beaches and lawns and damaged homes. When it fell too low, it inhibited boating, swimming and fishing; left water intake pipes dry; and increased concentrations of human and agricultural wastes in the water. Extremes of either sort eroded property values and decreased the local tax base. Uncontrolled fluctuations in the lake level jeopardized waterfowl nesting and the year's fish hatch.

For many years, the dams on the Goose River had been used to generate mechanical power to run the small mills downstream. Operation of the mills meant the dams were in "beneficial" use and gave the owner of the water rights complete freedom to manage the ebb and flow as needed to further that "beneficial" use. But in 1976, the last mill burned down. The dams fell into disrepair. This meant that, under Maine law, the state could regulate the owner's operation of the dam at Swan Lake to manage the levels of the lake. In 1977, the Maine Soil and Water Conservation Commission reported that "high water has resulted in significant flooding of property, undermining of foundations, septic field failures and shore erosion" and established minimum and maximum levels for allowable lake fluctuation. In this way, the residents of Swanville had finally been able to gain influence over how the dams were operated.

However, in the summer of 1977, the Maine Hydroelectric Development Corporation announced that it would apply for a license from the Federal Energy Regulatory Commission to generate hydroelectric power using the five dams on the Goose River and assumed responsibility for operation of all the dams. Authority to regulate operation of the dam and therefore management of the lake levels passed from the state to the Federal Commission.

The dam at Swan Lake was the key to Maine Hydroelectric's project, for with it the developer could store water in the lake when he wished and release it when he needed it downstream.

The residents felt sure this meant the level of Swan Lake would rise and fall, not according to their needs or in harmony with nature's patterns, but according to the needs of downstream industry.

The president of Maine Hydro knew that he would need the cooperation of the town of Swanville for his project to be a success. But resentment of the company's initiatives led unexpectedly to violence after Main Hydro announced plans to renovate all five Goose River dams. Vandals tore rocks from the dam at Swan Lake and used them to block the gates. In January of 1979, a crude fire bomb exploded on the dam, starting a fire and causing minor damage. No one could predict what would happen next.

The town's selectmen wanted to stop the escalating violence, but not without protecting Swanville's interests. They petitioned the Commission to allow them to intervene in Maine Hydro's license application process and asked that the license be denied on the grounds that it would severely damage the environment at the lake.

The Commission granted the town status as a intervenor, but strongly recommended that the parties try to work out their differences. The Commission staff was confident that a long battle over licensing would exhaust everyone and the resolution might please no one.

The Maine Office of Energy Resources, with the support of the Commission, suggested to the parties that they work with a mediator. With some reluctance, they agreed. The parties met together in the presence of a mediator for the first time on May 3, 1979. Three months and five meetings later, on August 2, 1979, the town and Maine Hydro signed a Memorandum of Agreement which covers water rights, recreational opportunities, measurement of water levels, flood control, summer lake levels, release of spring run-off, maintenance and repair of the dam, legal rights and responsibilities of the parties, and management of the area around the Swan Lake dam. The area management provision is important because it designates the area as a public park even though the park remains privately owned. The agreement created a committee to oversee the management of the park and empowered the committee to monitor all aspects of the operation of the dam.

The Federal Energy Regulatory Commission is now reviewing Maine Hydro's license application and plans to incorporate as much of the agreement as possible into its own final ruling. Both parties feel that the agreement provides for responsible management of the dam and will result in an improved environment at the lake and downstream.

Resolution of the controversy over the Swan Lake dam is not the first or only time mediation has successfully resolved environmental disputes in New England. Nor is mediation only appropriate in simple cases involving merely two parties.

Conversion to Coal at Brayton Point

In the spring of 1977, I was asked by the Federal Regional Council of New England to mediate a dispute over conversion of the largest fossil fuel generating station in New England from oil to coal. The case involved two federal agencies, two state agencies, and the New England Power Company (NEPCO) which owns the 1400 megawatt Brayton Point Station.

The Brayton Point Station is located in Somerset, Massachusetts on a wide, flat peninsula at the confluence of the Taunton and the Lees rivers. The plant consists of four electric power generating units, each exhausting to a separate stack. Three of the boilers, totalling 1150 megawatts of capacity, are able to burn either oil or coal. The plant is highly efficient and, except for routine outages for maintenance and repair, operates continuously. Until recently, these units burned 15 million barrels of oil a year, most of it imported from foreign countries.

Because the plant had the ability to burn coal, yet burned oil, it had been, for years, the focal point of arguments over the most efficient and environmentally acceptable way to reduce dependence on imported oil in New England. In June, 1974, Congress passed the Energy Supply and Environmental Coordination Act (ESECA). This Act required the Federal Energy Administration (now the Department of Energy) to identify those power plants with the greatest potential for conversion to coal. Brayton Point was one of five New England power plants identified by the Department.

The Department knew that New England Power Company had burned coal at Brayton Point before. During 1974 and 1975, the Arab oil embargo caused the Company to seek and obtain permission to use coal with sulfur and ash contents higher than existing emission limits would have allowed. Several million dollars in new pollution control equipment would have been required for Brayton Point to meet existing emission limits burning coal and these investments were not considered a practical option for a temporary conversion under emergency conditions.

The company burned 1.2 million tons of coal between May, 1974 and June, 1975, when the variance to burn coal ended and the three units were returned to oil. Nonetheless, in June, 1977, New England Power Company received notice that the Department of Energy (DOE) intended to prohibit the burning of oil in units one, two and three at Brayton Point. Under the provision of ESECA, the Department found that a permanent conversion to coal was "practicable."

The company, the Massachusetts' Department of Environmental Quality Engineering (DEQE) and the U.S. Environmental Protection Agency (EPA) did not agree. In fact, the EPA had declared, in March, 1977, that the area around the plant did not meet National Ambient Air Quality Standards for particulate matter during 1976. The EPA and DEQE insisted that this eliminated any chance for conversion at Brayton Point since coal produces a great deal more particulate matter than oil.

For six months prior to my appointment, I had met with the parties on an informal basis to assess the nature of their dispute and the degree to which a mediator might be helpful. I found that New England Power was not unalterably opposed to conversion, but argued that the change would be economically impossible given the strict limits on air pollution in Massachusetts. Officials of the Environmental Protection Agency and the Massachusetts Department of Environmental Quality Engineering (DEQE) were not anxious to see the facility convert to coal. They were deeply concerned with the effect that conversion might have on air quality in the vicinity of the plant and seemed unlikely to consider any change in limits on plant emissions. The positions of each group left little room for compromise. Yet, one year from the appointment of a mediator, an agreement had been reached that was as simple as it was elegant.

Since the environmental regulators were most concerned about additional sulfate formation following conversion due to increased particulate concentrations, the company agreed to double its capacity to control particulate matter (at a cost of $40 million). To control sulfur emissions, the company would purchase a long-term supply of coal of less than 1.5 percent sulfur content. This would minimize sulfur emissions, but still avoid the enormous cost and serious waste disposal problems of a fuel-gas desulfurization system and create the opportunity to obtain significant fuel cost savings. The company could use these savings to offset the capital costs of adding precipitator capacity. The state agreed to set new emission limits for the facility that were good for a period of at least ten years, sufficient to allow the company to recover the cost of investment.

Thanks to the improvements in pollution control capacity, the particulate emission limit could be reduced 30 percent below what it had been when the plant was burning oil, and the sulfur emissions would be limited to their equivalent when the plant was burning 2.2 percent sulfur oil.[1]

The parties formalized their agreement by signing a Memorandum of Understanding, in the office of the Governor, in August, 1978. In May, 1979 the EPA gave final approval to the proposed conversion plan. The Brayton Point station is now burning coal and saving 15 million barrels of oil each year. The initial fuel cost savings to consumers of 12 million dollars annually will grow in value in the years to come.

The Role of Mediation

During the past year I have investigated the propects for "independent" mediation, in part with the help of a grant from the Ford Foundation. I have found that successful mediation by independent individuals tends to create the impression that it is an extraordinary process, the product of a mediator's "special" personality. Mediation seems ephemeral and unreliable to many, even those who might find it helpful. The activity does not always draw the careful scrutiny of professionals in the field. For these reasons, parties to a dispute tend to be wary of mediators and unconvinced that the work done on a given case, though successful, can be reliably transferred to other cases. Yet, those who mediate know that the process is usually predictable and manageable.

The Mediation Process

In the course of a formal mediation process, the mediator proceeds through four stages to assist the parties in dispute. He first undertakes a "fact-finding consultation" which has two objectives: to assess the physical dimensions of the problem and determine why the parties have not been able to reach agreement on their own. This culminates in a recommendation on how to proceed, either with or without the assistance of a mediator.

If the parties and the mediator decide to continue working together, there follows a period during which the mediator meets separately with the parties and explores with them the interests they most want to protect. He then helps them clarify what they want the other party to do to protect these interests.

[1]For a more detailed discussion of technical issues and their relation to the mediation process used in the Brayton Point case, see *Conversion to Coal at Brayton Point*, a report to the New England Energy Task Force, October, 1978. (published by the U.S. Department of Energy, Region I)

Next, there is an "inventing phase," a series of separate and joint meetings during which as many solutions as possible for each aspect of the problem are discussed and evaluated. None is formally selected or rejected until every possible alternative has been thoroughly considered.

Finally, the mediator begins to offer draft agreements to each party for review and revision. After receiving suggested changes, the mediator submits an amended version for review. This revision process is repeated as many times as is necessary to reach a final agreement.[2]

The Analogy to Mediation of International Disputes

In labor mediation, the mediator's role is to guide and catalyze the *final* stages of negotiation. This approach assumes that negotiation has already gone on for some time and only needs to be re-oriented. With this image in mind, it is not surprising that parties to environmental disputes associate mediation with extreme pressure, difficult decisions, hard bargaining, and painful concessions. It is no wonder that they are reluctant to retain a mediator.

Yet, environmental disputes are much more like international disputes than labor disputes. Often, there are more than two parties with a direct interest in the outcome. Questions of social and political importance compete with economic and technical issues. And, in some cases, delays in decision making work to the advantage of one or more parties. As in international disputes, environmental disputants can make use of a mediator's help from the moment a serious conflict can be identified. Even if a formal mediation process is not established, a mediator can help the parties clarify their complaints and demands, see that all the parties have heard and understood the concerns and proposals of the others, and establish a framework within which the parties can continue negotiation without the mediator.

Yet, in New England only a fragment of the total mediation work that is needed with respect to environmental disputes is being carried out. Nor has there been a concerted effort to inform the many public and private sector organizations involved in environmental disputes that mediation assistance is available to them or to explain how it might be of help. Without an organization to spearhead, guide and sustain such efforts, a consistent demand for mediation assistance will not develop and mediation will have no solid constituency in a region where it has the potential to become a vital and familiar component of environmental dispute resolution.

A New England Center

In early April [1980], the trustees of the New England Natural Resources Center will assemble at Yale to consider launching a Center for Environmental Mediation in New England. Drawing on the experience of organizations like the University of Washington's Office of Environmental Mediation in Seattle, the Wisconsin Center for Public Policy in Madison, the Rocky Mountain Center on the Environ-

[2]For further discussion of the role of the mediator in environmental disputes as well as illustrative case studies, see the author's article "Environmental Mediation: The State-of-the-Art," in the EIA Review No. 2. October 1978 (published by the Laboratory of Architecture and Planning, M.I.T.)

ment (ROMCOE) in Boulder, and RESOLVE in Palo Alto, California, the New England Center is expected to offer a broad range of environmental dispute counselling services to business, government and citizen organizations.

These services will include advisory consultation, conflict assessment, multiparty meeting facilitation, mediation assistance, and preparation of agreements. Only a small portion of the Center's cases will require the appointment of a mediator and a commitment on the part of the parties to enter formal mediation. The great majority of its time will be spent counselling parties in environmental disputes. Because of the region's town meeting tradition, special attention will be given to providing short-term assistance to communities struggling to solve environmental problems of immediate, local concern.

The Planning Period

If financial support is forthcoming, a six month planning period will be initiated and followed by at least two years of staffed, professional mediation services. During the first few months, the Center's founders will meet with the environmental community, the business community, and regulatory officials throughout New England. The planning phase will have three principal objectives:

1. to learn from each of these three sectors how a Center for Environmental Mediation could be most helpful;
2. develop a full-scale plan of operation and complete work on a trial run of the "Mediation Assistance Program"; and
3. to locate support for the organization and additional clients for the first year of operation.

A feature of the planning period will be a trial run of a "Mediation Assistance Program" for a state agency in New England responsible for enforcing that state's wetland protection statutes. Each year there are hundreds of appeals to the state by developers, abuttors or municipal conservation commissions from local permit application decisions. The program will work in conjunction with the agency's appeals process. As soon as a party declares its intention to appeal, the agency will provide a mediator to meet the parties and investigate the potential to resolve their differences through informal negotiation.

The mediator may find that many appellants are forced to use the appeals process to air grievances or to obtain concessions not directly related to the statutes. The Mediation Assistance Program will allow these issues to be addressed and resolved amicably, without recourse to the adversarial tone and procedural restrictions of the appeals process. This will allow the permitting process to accomplish its intended purpose: protect wetlands from harmful development. If this approach furthers the responsible and efficient enforcement of the wetland protection statutes, it can be applied to other areas of environmental concern: hazardous and solid waste disposal, coastal zone protection, and subdivision regulation are but a few.

During the planning period, a host of questions will be addressed, including:

1. What kinds of cases and regulatory programs are the most likely candidates for mediation services?
2. What criteria should the Center use for accepting or rejecting cases?
3. Will the parties be able and willing to pay for mediation services?
4. How should mediation success be measured?

Financing the Center's Operations

A sizeable portion of the Center's income during its first few years will need to come from foundation grants—possibly as much as 85 percent of the Center's first year operating budget. However, the portion of foundation support should decrease as a percent of each year's operating budget.

In the long run, the Center will be financed by fees for mediation services. These will come from the parties involved in actual cases or from regulatory agencies which contract for the use of the Center's services.

Conclusion

This paper suggests that New England and, indeed, every major region of the country is in need of an organization to encourage and assist in the negotiated resolution of environmental disputes—in effect, a center which specializes in environmental mediation. Why mediation? My experience as a mediator of environmental disputes in the Northeast suggests two reasons: the process seems to work and it is infinitely adaptable.

Every environmental dispute is, in some ways, unique. Whether the general problem is air pollution or energy development, transportation control or wetlands protection, its solution involves a different set of concerned parties, different controlling laws and regulations, different proposed solutions, and a different set of physical and financial constraints. What better resolution could there be than one designed by those who "own" the problem and must live with the solution. Professional mediation services can help parties in environmental disputes accomplish that end.

Strengthening Authorities and Procedures for Natural Resources Management

Chairman:
HERBERT DOIG
Assistant Commissioner for Natural Resources
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Environmental and Natural Resource Issues: Press Sensationalism

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Recently, natural resource managers have had to develop new perspectives on their management chores. What was once viewed as a job of managing a physical resource only is now viewed as a job of "managing" public perceptions of that resource as well (Grunig and Stamm 1973). Because most resource agencies have little or no control over press treatment of environmental and natural resource issues, managing public perceptions may often seem like an impossible task.

Journalists assigned to cover resource issues may have backgrounds in science, outdoor recreation, government, or simply general assignment reporting. Such diverse orientations can foster a compartmentalized rather than a comprehensive approach to environmental issues. "Environmental" reporters must also overcome political and economic pressures that accompany environmental disputes, the biases of public agencies and private experts as sources, and their own biases. Yet they are still expected to write news objectively and provide readers with fair and accurate coverage of essential information (Pryor 1972).

As a practical matter, reporters must cater to the pressures and expectations of the news organization. Although professional norms constrain editors and publishers from blatantly encouraging reporters to slant their articles in any particular way, organizational control may take a more covert and indirect form (Johnstone 1976). Such controls are present not only at the assignment stage, when it must be decided which topics will be covered and who will cover them, but also at the stage when the stories must go through an editor, frequently termed a "gatekeeper."

The public, and particularly scientists, often criticize mass media for inaccuracies in reporting scientific issues (Tichenor et al. 1970). For example, the following editorial appeared in *Science:* "It is not an exaggeration to say that many scientists view science reporters with suspicion and a few with outright hostility." (Masic 1976: 136).

One of the main problems cited by these critics is the tendency for reporters to "sensationalize." Yet news personnel must rely on excitement and color in many of their news stories in order to capture "reader interest." Therefore, in the mere act of trying to sell newspapers, the professional newsperson flirts daily with annoying if not scandalizing the scientific community. Wildlife managers are abundantly familiar with this problem. For example, gunshot fatalities during a deer season are *news*, regardless of their scope in comparison with "routine" accidents.

Tannenbaum (1963), studying relationships among editors, science writers, scientists and mass media audiences, found that media personnel, rather than serving as mediators between scientists and the public, "introduced an apparently dissonant element, featuring the more bizarre, sordid, and frivolous aspects . . . ." Whereas the scientist, science writer, and science reader considered a story valuable whether or not they considered it exciting, the editors thought of a valuable article as being synonymous with an exciting one. It seems that with editors, what is exciting is good, "almost by definition" (Tannenbaum 1963).

Tichenor et al. (1970) found that "overemphasis upon the unique" was what scientists perceived as the greatest problem with science reporting, followed by "omission of relevant information," "misleading headlines" and "misstatement of facts." Pulford (1976) found that 32.2 percent of scientists said headline style was the greatest problem. Pulford (1976) also found that scientists believed a large portion of errors dealt with misstatement of facts (28 percent) and omission of relevant information from stories (24.5 percent).

If such charges are true, impact upon natural resource management communication efforts could be significant. A case in point, analyzed in this paper, concerns coverage of the Tellico Dam issue, one of the more curious environmental battles in recent history.

Background: The Tellico Dam/Snail Darter Controversy

The Tennessee Valley Authority (TVA) first considered a dam on the Little Tennessee River in 1936 (TVA 1978). However, Congressional appropriations were not forthcoming until 1966. In 1967 land acquisition and a small amount of dam construction began on the 38,000 acres (15,380 ha) involved.

Tellico's supporters said the dam would provide recreational facilities in a new lake, promote economic activity, supplement the capacity of the area's electrical generating plants, enhance barge navigation, and assist in flood control.

Opponents said that energy production would be only a "peripheral benefit"; that any flood the dam was to control would probably happen only once every 250 years, with the dam affecting the crest at Chattanooga by only two inches. Particularly, critics said, an historic, productive valley would be destroyed—the dam would flood numerous, largely unexplored archaeological sites and valuable farmland (TVA 1978). The ancient Cherokee Indian capital, Chota, ancestral home of the Cherokee Chief Sequoyah, was located in the flowage. Belatedly, conservationists wanted to protect a three-inch fish known as the snail darter *(Percina* *tanasi).* The rare snail darter was not discovered until 1973 and was not put on the endangered Species list until 1975, yet it may be one of the most publicized fish in the country—much more publicized than any other issue relating to the Tellico Dam.

After earlier injunctions on other grounds had been thrown out of court, *Hill vs. Tennessee Valley Authority* was filed in February, 1976, enjoining the Tellico Project as a violation of the Endangered Species Act. Trial was held in April; the case was dismissed a month later. In July, the Sixth Circuit Court of Appeals issued an injunction permitting TVA to continue construction of the project, but enjoining closure of the dam. The Department of the Interior then issued an opinion stating that continued existence of the snail darter would be jeopardized and its habitat destroyed if the gates of the Tellico Dam were to be closed. Yet TVA was permitted to continue work on the project. In January, 1977, the Sixth Circuit Court of Appeals prohibited TVA from performing any construction activity that would destroy or modify the fish's critical habitat. In May of that same year, TVA petitioned the U.S. Supreme Court to review the appeals, but the Supreme Court affirmed the lower court decision by a vote of six to three.

Pressured in part by the implications of the Tellico Case, Congress amended the Endangered Species Act in fall, 1978, creating a cabinet-level Endangered Species Committee. Although the Committee was empowered to exempt projects like the Tellico Dam from the Endangered Species Act, the committee refused to exempt the project.

However, in the fall of 1979 Tellico funds were quietly attached by the Congress to an energy appropriation bill, and the President acquiesced that dam completion could be funded. Cherokee Indians continued their own battle against the project, but the flowage was filled at the end of the year.

Purpose of Study

It is evident that the significance of the Tellico case lay not simply in the trade-off between a multi-million-dollar dam and a small fish. Many important factors—social, economic, political—were involved. Yet it is uncertain whether the public perceived the struggle as anything more than a dispute over a three-inch "insignificant" fish that was blocking a 90-percent-complete dam.

The present study was designed to provide an empirical assessment of the manner in which the press handled a controversial environmental issue. The paper addresses several key questions:

1. What issues are covered during a controversy? Is press coverage fair and balanced with regard to various issues, or does the press "overplay" some issues at the expense of others?
2. How does press coverage correspond with on-going legal, political, and environmental events? What events generate greatest press reaction (both locally and nationally)?
3. How much "sensationalism" is present in local and national press stories? Are some topics more prone to "sensationalism" than others? To the extent that "sensationalism" is found in news stories, can it be attributed to the newspaper itself or to quotes from various sources?

Methods

The present study consisted of a content analysis[1] of all articles on the Tellico Dam, the snail darter, and the Endangered Species Act appearing in the local *Knoxville News Sentinel* and the national *New York Times* between January 1973 and December 1979. An article was defined broadly as either a news story, editorial, or letter-to-the-editor. The content of each article was coded for major and secondary theme, evidence of "sensationalism," and the source of "sensationalism," if present. If an article dealt with issues that overlapped topic themes, it was coded for each theme. Article topic themes were categorized into five major areas:

1. *Dam Impact*—Articles dealing with the impact of the dam on local agriculture, employment, recreation, flood control, electric power, economic prosperity, and local cultures.
2. *Dam Construction-Economics-Alternatives*—Articles dealing with dam construction, funding, cost over-runs, delays, alternative projects, supporters and opponents.
3. *Legal and Political Issues*—Articles dealing with court rulings, injunctions, legal suits, government agency actions and statements, political actions and statements, non-governmental organization actions and statements.
4. *Snail Darter Issues*—Articles dealing with the characteristics, habitat, transplanting, environmental importance, or protection of the fish.
5. *Endangered Species Act*—Articles dealing with the enactment, characteristics, implications, and amendments to the act.

Drawing from previous research (Tannenbaum 1963, Tichenor 1970), "sensationalism" was considered to be statements appearing in the body[2] of articles which met one or more of the following five criteria:

1. Seemed to be an obvious overstatment of fact;
2. Placed exceptional emphasis on unique aspects of the situation;
3. Introduced apparent bias based on value judgments;
4. Associated the subject of the story with an irrelevant issue;
5. Treated the story in a frivolous manner.

Articles containing statements defined as "sensational" were also coded to indicate whether the sensationalism was due to the actual writing of the story or to statements quoted by the newspaper.

Coder Reliability

A systematic sample of 10 percent of all the articles included in the analysis were check-coded. This process reproduced the original coding of "theme" and "sensationalism" with 95 percent accuracy.

Results

A total of 511 articles concerning the Tellico Dam controversy appeared in the *Knoxville News Sentinel* between January 1973 and December 1979. Eighty-four

[1]A quantitative procedure which provides an objective measure of the importance and emphasis of explicitly defined content.
[2]Analysis of "sensationalism" in the headline and lead sentence was also performed, but presentation of these findings is beyond the scope of the present paper.

articles appeared in the *New York Times* during the same period. As shown in Figure 1, coverage was neither uniform nor building at a steady rate. Rather it tended to rise and fall with the flow of various local and national events. For example, in the second half of 1976 a total of 21 articles appeared in the *Knoxville News Sentinel*, in the following six months the number was 93 articles, and by the second half of 1977 the number was 39. The local press seemed to be responding to

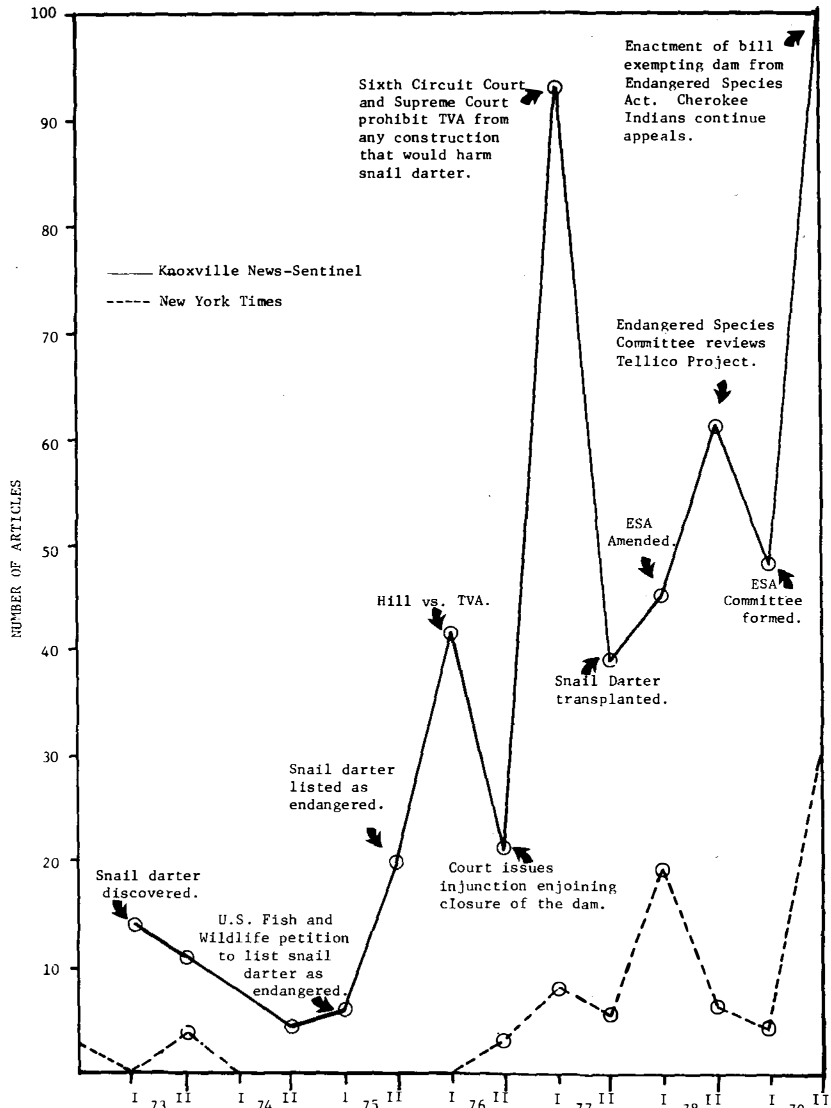

Figure 1. Major developments in the Tellico Dam/snail darter controversy by national and local newspaper coverage.

the court battles which were reaching their climax with the Supreme Court ruling in May 1977. In 1978, when most of the controversy centered around the Endangered Species Act, local coverage fell away sharply, only to surge again in 1979 when completion of the dam was authorized.

In the *New York Times*, coverage of the Tellico controversy did not begin to build until the first half of 1977—somewhat later than in the local press. And while the amendment of the Endangered Species Act and the formation of the Endangered Species Committee were associated with a relative decline in local coverage, those events coincided with a large increase in *New York Times* coverage. Apparently the national press was responding to a different set of issue priorities than the local press, although both papers showed a dramatic increase in coverage during the second half of 1979 when the President signed legislation authorizing completion of the dam.

Issue Coverage

Figure 1 illustrates the way in which the local paper and the national paper responded to the events evolving in the Tellico controversy, but it can only suggest what the press was focusing on in its coverage. Figures 2 and 3 show the

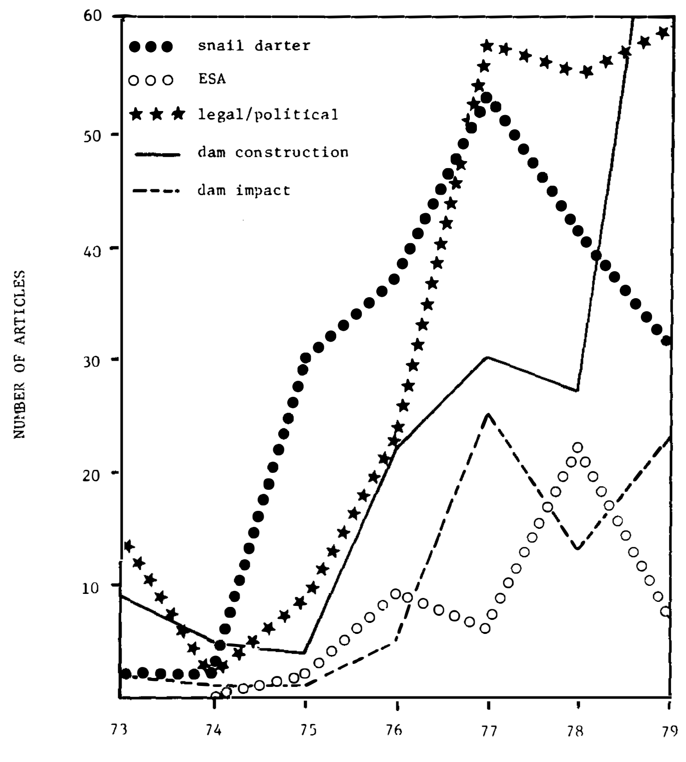

Figure 2. Profile of *Knoxville News Sentinel* coverage between 1973 and 1979 in five major topic areas.

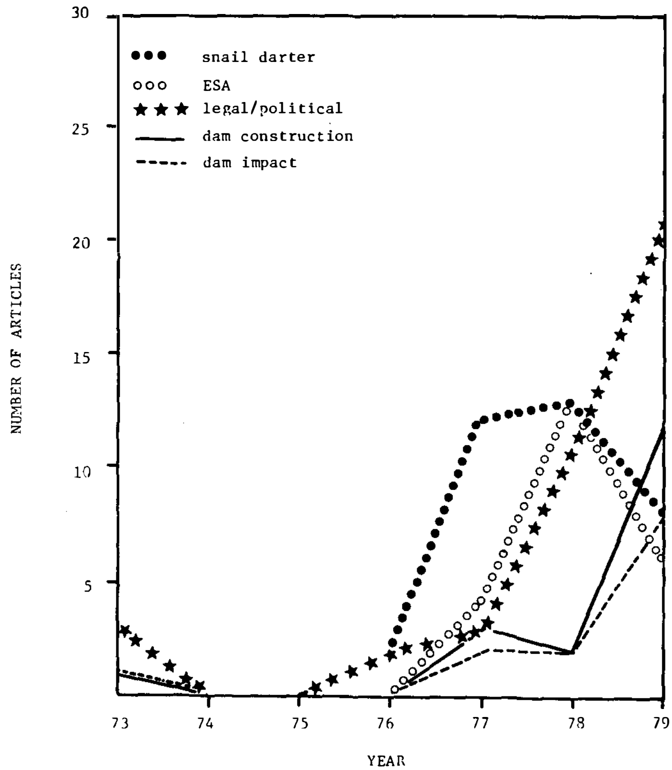

Figure 3. Profile of *New York Times* coverage between 1973 and 1979 in five major topic areas.

profile of coverage between 1973 and 1979 in five major topic areas.[3] Figure 4 shows the topics being discussed in letters-to-the-editor printed in the Knoxville paper. Analysis of coverage (see Figures 2 and 3) shows that the Endangered Species Act was not a subject of attention until 1978 and that articles focusing on the *impact* of the Tellico Dam did not appear in significant numbers until 1977. In contrast, the snail darter became a subject of considerable attention in 1975 and remained a prominent topic even during the peak periods of legal and political controversy. For example, 36 percent of the topics covered in the *Knoxville News Sentinel* dealt with the snail darter as compared to 18 percent of the topics in the *New York Times*. In contrast, only 8 percent of the *Knoxville News Sentinel's* topics dealt with the Endangered Species Act while 16 percent of the *New York Times* topics dealt with that issue. These patterns provide considerable insight into what the local and national press considered "newsworthy."

Issues emerged somewhat later in the national press (see Figure 3) and with a different emphasis. In 1976 more than 20 articles focusing on legal and political issues appeared in the Knoxville paper, while only two such articles appeared in the *New York Times*. It was not until 1977, when the controversy surrounding

[3]See METHODS section for a description of these topics.

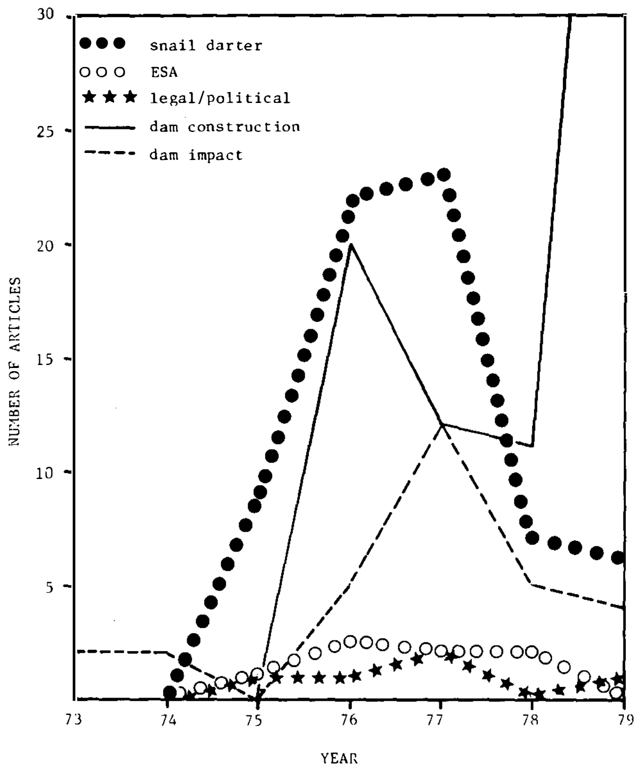

Figure 4. Letters-to-the-editor in the *Knoxville News Sentinel* dealing with the Tellico Dam/snail darter controversy by topic and year.

amendments to the Endangered Species Act became heated, that legal and political issues received increased attention in the *New York Times*. Also evident was an increase in attention given to the Endangered Species Act itself. The national paper paid almost no attention to dam impact or construction issues until 1979.

Figure 4 provides an interesting contrast to the patterns depicted in Figures 2 and 3. Letters-to-the-editor in the Knoxville paper revealed little public concern about the legal and political issues or the Endangered Species Act. Rather, public interest centered on the dam construction, dam impact, and the snail darter. By 1979 public interest in the snail darter had fallen sharply with nearly all of the public's interest focusing on dam construction issues.

Sensationalism

Based on the five criteria of "sensationalism" defined in this study, 91 percent of the letters-to-the-editor ($N=154$), 90 percent of the editorials ($N = 20$) and 23 percent of the news stories ($N = 287$) in the *Knoxville News Sentinel* were judged to contain sensational statements. In the *New York Times* five of the seven letters-to-the-editor, five of the nine editorials, and 10 percent of the news stories ($N=62$) were judged to contain sensational statements.

When sensationalism was found, it was in large measure attributable to statements being quoted or printed by the newspaper, rather than to the newspaper itself.[4] For example, of 65 news stories appearing in the Knoxville paper that were judged sensational, 54 (83 percent) were so judged because of quotations, 8 (12 percent) because of the newspaper, and 3 (5 percent) because of a combination of the two. In the *New York Times*, five of the six news stories judged sensational were attributed to source statements rather than the newspaper.

Table 1 breaks down the article topics covered[5] in the local and national papers by "sensationalism" and the source of sensationalism. It is clear that in the local paper more than three-quarters (77 percent) of the sensationalism introduced by the newspaper itself regarded one specific issue—the "newsy" snail darter. In contrast, the largest percentage of the sensationalism attributed to quotations or statements (36 percent) dealt with dam construction issues.

Even though the number of topics treated in a sensational manner by the *New York Times* is rather small (N=31), their distribution is instructive. Only 18 percent of the topics covered by the *New York Times* dealt with the snail darter, yet 35 percent of the sensationalism attributable to the newspaper dealt with that topic. Sensationalism introduced by source statements, however, was primarily associated with legal and political issues (43 percent).

Discussion

With respect to issue coverage, the data indicate that the *New York Times* paid relatively more attention to the environmental issues associated with the controversy. The local Knoxville paper kept the story alive by focusing heavily on the more "newsy" snail darter. However, both newspapers covered the snail darter issue to a greater extent than they covered the Endangered Species Act or the dam impact. Perhaps this form of issue control can be viewed as sensational to the extent that the press assumes dam impact is not as newsworthy as controversy over a small fish.

Press coverage did not correspond to public concern. Letters-to-the-editor were largely concerned with more parochial attitudes toward the controversy such as supporting or opposing the dam or the snail darter, but the press placed greatest emphasis on legal and political aspects of the controversy. It is noteworthy that public concern was not focused much on dam impact or broader environmental issues.

Grunig and Stamm (1973) note that in regard to a flood control project, members of a community had different perceptions of the Army Corps of Engineers than the Corps' own perceptions. They indicate that this result was attributable to a tendency for community members to be "undecided about the Corps' position on disadvantageous effects of the project" (Grunig and Stamm 1973).

The Corps had been effective in communicating only beneficial project effects to the community. Corps publicity and local media coverage were "blatantly one-sided" (Grunig and Stamm 1973). Grunig and Stamm further point out that the Corps had "overestimated" enthusiasm for a multiple-use recreational proposal

[4]This does not hold true for editorials.

[5]The total number of topics covered is greater than the number of articles because some articles dealt equally with more than one topic.

Table 1. Distribution of article themes appearing in the *New York Times* and the *Knoxville News-Sentinel* between 1973 and 1979 by sensationalism and source of sensationalism.

Topic	Source of sensationalism: Newspaper	Source of sensationalism: Quotation	Not judged sensational	Total	(N)
Local paper					
Dam impact	0%	13%	6%	7%	(46)
Endangered Species Act	6	7	6	8	(59)
Legal & political issues	3	17	44	32	(220)
Dam construction	13	36	19	26	(181)
Snail darter	77	27	24	28	(196)
Total	100%	100%	100%	100%	
Row percentage	4	41	54%	100%	
(N)	(31)	(287)	(380)		(698)
National paper					
Dam impact	0%	7%	13%	10%	(14)
Endangered Species Act	29	7	15	16	(22)
Legal & political issues	24	43	33	33	(44)
Dam construction	12	14	15	15	(20)
Snail darter	35	29	24	18	(35)
Total	100%	100%	100%	100%	
Row percentage	13%	10%	77%	100%	
(N)	(17)	(14)	(104)		(135)

and had been ignorant of public objections to such effects as "inundation of farms and timberlands, wildlife habitat destruction, and possible tax increases." Data in the present study imply similar problems.

With respect to sensationalism, there are several broad implications in this study. While a significant portion of some news articles and most editorials and letters-to-the-editor dealing with Tellico contained statements judged to be "sensational," most of these statements were attributed to sources such as public or private officials involved in the controversy, rather than to the newspapers themselves.

Nevertheless, the press does make active decisions when deliberating on which quotes to use for articles. For example, Zygmunt Plater, attorney for the environmentalists, recounted that reporters covering the issue voiced frustration that the story had "lost its entertainment value" (Plater, pers. comm.: 1980).

The press can neither be condemned nor absolved of responsibility for the sensationalism that existed in the articles. To the extent that sensationalism was found in news stories, there was a strong tendency for it to be associated with more "newsy" or appealing issues such as the snail darter. It seems that the more unique an issue, the more likely it will be treated in a sensational fashion.

The press is event-oriented. Give it a moon landing and it does an accomplished job. Ask it to cover the slow evolution and convolution of a typical resource issue and it has problems. An event for the press must have inherent news value—a "quickening urgency" befitting newsroom codes. Consequently, what is newsworthy to a resource manager may have little reader appeal from the newsperson's point of view.

Part of the problem is due to the fact that there is more to the newspaper organization than a reporter who takes notes and delivers an article to be printed. Frequently the article will go through several editors. Since news space is limited, these individuals decide what is "newsworthy" and what is "extraneous" in headlines, leads, and major parts of news articles.

Given such organizational constraints, one can better understand why the snail darter captured the attention of both the local and national press, and why the less "newsy" long-term issues, such as the dam's impact on the economy, environment, and culture, did not.

Resource managers are caught in the middle. If an issue is not perceived to be exciting by newspaper standards, the likelihood of it making the front page is minimal. If the issue does have "news appeal," it is more likely that the press will cover the issue in a "sensational" manner.

To cope with the situation, the resource manager can attempt to present a balanced appraisal of the issue. The more resource managers understand public concerns and perceptions of resource issues, the better able they will be to present these concerns to the press, and the more likely the press will pick up the substantive issues and cover them adequately and fairly.

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Americans' Attitudes and Knowledge of Animals

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A number of results from a three-year study of American attitudes, knowledge and behaviors toward wildlife are reviewed here. This study was organized around five primary focus areas, including: (1) public perceptions of critical wildlife issues (for example, endangered species, animal damage control, wildlife habitat protection, consumptive use); (2) public knowledge and attitudes toward animals, and species preferences; (3) characteristics of various activities involving animals (for example, hunting, birdwatching, conservation organization membership, wildlife television viewing); (4) historical trends in wildlife use and perception during the twentieth century; and (5) children's attitudes, knowledge and behaviors toward animals. This paper will cover results pertaining to areas one, two and three only.

The main data collection procedure was a national survey of 3,107 randomly selected Americans and 433 members of the National Cattlemen's, American Sheep Producers' and National Trappers' Associations. In developing the national survey, five pretests were conducted and over 1,500 questions reviewed. The final questionnaire included 290 items covering five areas: attitudes (both basic attitudes and specific issues), species preferences, knowledge of wildlife, activities relating to animals, and demographic characteristics. The knowledge and attitudes questions were also used to develop a number of scales. A knowledge-of-animals scale was based on 33 true–false and multiple choice questions scored on a 0 to 100 basis. Knowledge questions covered all vertebrate classes, and six dealt with invertebrates. Scores were roughly normally distributed with a mean of 52.8.

Based on a typology of basic attitudes toward animals, eight attitude-toward-animal scales were developed. Cluster and other multivariate statistics were used in the scale construction process, and relatively small scale intercorrelations indicated the independence of the scales.

The national sample included only persons 18 years of age and older. An oversampling of Alaska and the Rocky Mountain states ensured sufficient numbers in these important regions. This oversampling was accounted for by appropriate weighting in analyses referring to the entire American population, thereby reducing the sample size to 2,455. Probability random selection methods were used to ensure that every individual in the population had a roughly equal chance of being included in the sample. An initial contact and three callbacks were required before any designated respondent could be dropped from the study. Thirteen percent of the designated respondents could not be located after the fourth interview attempt, 22 percent refused an interview, and 4 percent terminated the interview prior to its completion.[1] As previously indicated, 433 members of the National Trappers', American Sheep Producers' and National Cattlemen's Associations

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[1] A comparison with the national census indicated the sample was a relatively good representation of the American population.

were also surveyed. These respondents completed the questionnaire by mail and were randomly selected from organization lists.

Critical Wildlife Issues

This section will review public attitudes toward the following issues: endangered species, predator control, wildlife habitat protection, hunting, species population control, trapping, harvesting of furbearers and marine mammals, and funding wildlife management. These results are described only briefly, and findings on a number of additional issues are not included. (A more thorough presentation of all the issue findings can be found in another paper, Kellert 1979a).

The *endangered species* issue was explored in the context of impacts on diverse commercial activities resulting from the protection of different species. One question projected a substantial increase in the cost of an energy development project, relating the acceptability of this economic sacrifice to the protection of eight different endangered species. A significant majority was willing to incur this impact in order to protect the bald eagle (89 percent in favor), eastern mountain lion (73 percent), Agassiz trout (71 percent), American crocodile (70 percent), and silverspot butterfly (64 percent). On the other hand, less than a majority would protect an endangered plant, the Furbish lousewort (48 percent in favor), the eastern indigo snake (43 percent) or the Kauai wolf spider (24 percent).

A question reminiscent of the Tellico Dam/snail darter controversy weighed the protection of a little known, rare fish species against a variety of water uses. In water use situations involving relatively "essential" human benefits, most approved of the projects despite their adverse impact on the fish species—87 percent favored water diversions to increase human drinking supplies and 83 percent to irrigate agricultural crops, and 72 percent damming to produce hydroelectric power. On the other hand, less than a majority approved of water projects involving relatively "nonessential" benefits if they threatened the fish species—48 percent approved of diverting water to cool industrial plant machinery and 39 percent damming to make a lake for recreational purposes.

A moderate, but significant, 56 percent of the national sample supported preserving 5 million acres (2 million ha) of national forest land, at the cost of jobs and building materials, to protect the grizzly bear. Similarly, a significant 55 percent disapproved of building an industrial plant to employ 1,000 people in an area of high unemployment if it destroyed a marsh needed by an endangered bird species.

Based on the four endangered species questions, a protection-of-endangered species scale was developed. Significantly higher scores on this scale—meaning a greater willingness to protect endangered wildlife—were obtained by such groups as the college-educated, single, under 30 years of age, large city residents and Alaskans. In contrast, the lowest scores, according to analysis of variance results, were found among the following groups: 76 years and older, less than an eighth-grade education, farmers, residents of highly rural areas, and Southerners.

On the basis of these results and relevant literature (Ziswiller 1967, Brokaw 1978), six factors were identified as critical to the public's willingness to protect endangered wildlife: aesthetics, phylogenetic relatedness to human beings, direct versus indirect causes of endangerment (overexploitation versus habitat loss, for example), economic value of the species, socioeconomic impact of protection, and cultural and historical relationship to the species.

The public's attitude toward *predator control* mainly focused on the issue of controlling coyotes preying on domestic livestock. The views of an informed and uninformed public, as well as members of the National Cattlemen's and American Sheep Producers' Associations, were contrasted regarding five control options.[2] The general public was moderately but significantly opposed to indiscriminate population reductions through shooting or trapping as many coyotes as possible, with the informed public significantly more opposed than the uninformed. Additionally, more than 90 percent of both informed and uninformed groups were opposed to the use of poisons, despite this option being described as the least expensive. In dramatic contrast, both livestock producing groups strongly favored indiscriminate population reductions and poisons (in comparison to the national sample, the statistically largest differences in the entire study with X^2 values of 788 and 965, respectively).

Nearly 70 percent of both public groups supported the option of controlling only individual coyotes known to have killed livestock. Additionally, a significant two-thirds favored capturing and relocating problem coyotes. While the latter result was not offered as a practical alternative, it attested to the public's desire for nonlethal solutions. Both livestock producer groups strongly objected to relocating coyotes, while a majority of cattlemen supported and sheep producers opposed controlling only offender coyotes. Finally, a significant majority of both public and livestock producer groups disapproved of compensating ranchers for losses out of general tax revenues. These predator control results were strikingly similar to those reported by Arthur et al. (1977) and Stuby et al. (1979).

On the topic of *wildlife habitat protection*, the national sample consistently indicated a moderate but significant willingness to protect wildlife habitat despite substantial socioeconomic impacts. Fifty-seven percent disapproved of building houses on wetlands needed by waterfowl; a significant 51 percent opposed (44 percent approved of) natural resource development in wilderness areas if it meant much smaller wildlife populations; 60 percent favored restricting livestock grazing on public lands to protect vegetation needed by wildlife despite higher beef prices. At a more significant level, 76 percent favored forestry cutting practices that helped wildlife even if higher lumber prices resulted, and 66 percent disapproved of development of oil resources that might be discovered in Yellowstone Park if it harmed the Park's wildlife. An overwhelming 86 percent of the national sample favored restrictions of off-road vehicle use if it harmed wildlife animals (moreover, a significant 79 percent of frequent off-road vehicle users also supported this restriction). A significant 57 percent of the informed public opposed, while a significant proportion of the uninformed public approved of, using pesticides harmful to wildlife if needed to maintain current food production levels.[3]

Public attitudes toward *hunting* were examined in relation to six different kinds of hunting. A significant 82 percent approved of traditional native subsistence hunting, and 85 percent of hunting for meat. In marked contrast, significant majorities disapproved of hunting exclusively for sport or recreational purposes whether for big game (62 percent opposed) or waterfowl (59 percent against).

[2]Informed and uninformed groups consisted, respectively, of 22 percent and 52 percent of the national sample, based on self-reported familiarity with the issue.
[3]Informed and uninformed groups, regarding the effects of pesticides such as DDT on wildlife, consisted of 42 percent and 32 percent, respectively, of the national sample.

Additionally, 80 percent disapproved of trophy hunting. On the other hand, a significant 64 percent approved of hunting for recreational purposes if it also included using the meat. The implication was that hunting was viewed as too serious an activity to be engaged in solely for sporting or recreational benefits, but acceptable if the animal's meat was also consumed. Significant urban–rural differences were found, with 85 percent of highly rural respondents approving, and a majority of large city residents opposing, hunting for recreation and meat.

Attitudes toward species population control—an issue sometimes associated with hunting—was also explored. A significant 60 percent disagreed with the notion that "most wildlife, such as deer and ducks, would be better off if government officials did not try to control the populations of these animals." Particularly surprising was that 61 percent of anti-hunters, 69 percent of humane organization members and 74 percent of wildlife preservation organization members also disagreed.

On *trapping*, a significant 70 percent of the national sample objected to the use of steel leg-hold traps although, as would be expected, almost all trappers approved.

On *harvesting wildlife*, a significant 57 percent disapproved of killing furbearers to make clothing even if the species were not endangered. Somewhat unexpectedly, 77 percent approved of "killing whales for a useful product as long as the animals (were) not threatened with extinction." On the other hand, a significant 70 percent were willing to pay a higher price for tunafish if it resulted in fewer porpoises being killed in fishing nets. The difference between these latter results may have been related to the romantic whaling history in this country, in contrast to the absence of a similar tradition involving porpoises.

Public attitudes toward seven *wildlife management funding* possibilities were explored. A significant 82 percent supported an excise tax on fur clothing derived from wild fur-bearers and 71 percent a similar tax on off-road vehicles. Interestingly, a significant majority of professional trappers (70 percent) and frequent off-road vehicle users (58 percent) approved of those options relating to their activities. Seventy-five percent of the national sample approved of entrance fees to wildlife refuges and other public wildlife areas. A moderate but still significant 57 percent approved of excise taxes on backpacking equipment and birdwatching equipment and supplies. Nonsignificant numbers of birders and backpackers approved of those options involving their activities. Finally, a significant 57 percent approved of an increased proportion of general tax revenues for wildlife management, although 54 percent disapproved of an excise tax on wildlife-related literature and art. These results, for the most part, were consistent with those reported by Shaw et al. 1978.

Knowledge of Animals

As indicated in the introductory section, the knowledge-of-animals scale included 33 true–false and multiple choice questions scored on a 0 to 100 basis. All animal-related activity groups had knowledge scores above the national sample mean, although the scores of zoo visitors, pet owners, anti-hunters and fishermen primarily motivated to catch large fish were not significantly higher. The very highest knowledge scores were obtained by birdwatchers, members of various types of conservation organizations,[4] nature hunters and scientific study hobbyists. Mail survey trappers, cattlemen and sheep producers also had very high knowledge scores, although as professional groups it was difficult to compare these results with the national sample.

Among demographic groups, the highest knowledge scores were characteristic of the college educated (especially graduate education), residents of Alaska and the Rocky Mountain states, professionals and respondents with high incomes. In contrast, blacks, respondents with less than a high school education, those over 75 and, ironically, under 25 years of age, and residents of large cities had significantly the lowest knowledge scores. These results accounted for possible confounding interrelationships of the variables by using analysis of variance and multiple classification analysis techniques.

The American public, as a whole, was characterized by extremely limited knowledge of animals. For example, on four questions dealing with endangered species, less than one-third gave the correct answer—for example, only 26 percent correctly responded to the statement, "The manatee is an insect." and, only 26 percent knew the coyote is not an endangered species. Regarding other knowledge questions, merely 13 percent were aware that raptors are not small rodents, and only one-half correctly answered the question, "spiders have ten legs." A better but still distressingly limited 54 percent knew veal does not come from lamb, and only 57 percent correctly answered the statement, "most insects have backbones."

The knowledge questions were divided into a number of generic categories, and a comparison indicated the public was most knowledgeable about animals which inflict human injury ($\overline{X}$ = 63.4), pet animals ($\overline{X}$ = 55.6), basic characteristics of animals—for example, "all adult birds have feathers" ($\overline{X}$ = 55.3), and domestic animals in general ($\overline{X}$ = 53.4). On the other hand, they were least knowledgeable about predators ($\overline{X}$ = 47.1), "taxonomic" distinctions—for example, "koala bears are not really bears" ($\overline{X}$ = 39.8) and invertebrates ($\overline{X}$ = 36.6).

The national sample was also questioned regarding its perceived familiarity of eight comparatively prominent wildlife issues. These issues elicted relatively limited recognition, with none regarded as very or moderately familiar by more than 50 percent of the public. The three most recognized issues were the killing of baby seals for their fur (43 percent very and moderately knowledgeable), the effect of pesticides such as DDT on birds (42 percent), and the use of steel leghold traps to trap wild animals (38 percent). The least familiar issues were the use of steel versus lead shot by waterfowl hunters (14 percent knowledgeable) and the Tennessee Valley Authority/Tellico Dam/snail darter controversy (17 percent). The public appeared to be far more aware of relatively emotional issues involving specific, attractive, and "higher" animals than of more abstract issues involving indirect impacts on wildlife due to habitat loss or dealing with "lower" animals.

Species Preference

A limited understanding of species preference was obtained by examining re-

[4]Membership in at least one of 36 different conservation organizations was reported by 11.3 percent of the national sample. These organizations were divided, for comparative purposes, into five types: humane, wildlife preservation, environmental protection, sportsmen, and general conservation organizations.

sponses to a 33-animal, seven-point like/dislike question. According to this analysis, the most preferred animals were two domestic species, the horse and dog, followed by two familiar and highly aesthetic birds and one insect—robin, swan and butterfly. The trout was the best liked fish (ranking sixth overall), while the most preferred wild predator was the eagle (ranked seventh). The most preferred wild mammal was the elephant (ranked eleventh overall). On the other hand, three of the four most disliked animals were biting and stinging invertebrates—the cockroach, mosquito and wasp. Additionally, the third, fifth and sixth least preferred animals were all associated with human injury or disease—the rat, rattlesnake and bat. Finally, relatively negative views were expressed toward the vulture, shark, skunk and lizard, and especially ambivalent views toward the coyote, wolf and crow.

The 33 animals were grouped on the basis of generically related qualities. The most preferred types were domestic, attractive and game animals. On the other hand, the least preferred were biting and stinging invertebrates, unattractive animals and animals known to inflict human injury. At an intervening level were animals which cause human property damage and predators. Among vertebrate classes, the best liked were birds and mammals, while invertebrates were preferred less than any vertebrate class, including reptiles and amphibians.

Attitudes Toward Animals

A typology of attitudes toward animals was developed to describe basic perceptions of animals and the natural world. One-sentence definitions are provided in Table 1, although far more detailed descriptions can be found elsewhere (Kellert 1976, 1979b).

Scales were developed to assess eight of the attitudes (Table 2). No useful scale was devised to measure the aesthetic attitude, and the neutralistic attitude could not be adequately distinguished from the negativistic (only one scale resulted, with more of the former than latter attitude).

The scales only crudely approximate the underlying attitude types. Nevertheless, the relative presence of eight attitudes in the national sample was roughly determined by standardizing the scale scores on a 0 to 1 range and plotting a regression line through the sample frequency distributions.

According to this analysis, the most frequently occurring attitudes, by a large margin, were the humanistic, negativistic, moralistic and utilitarian. The greater "popularity" of these four attitudes was interesting to note as they appeared to reflect two broad and conflicting perspectives of animals and nature. Specifically, the moralistic and utilitarian attitudes actively clash on the theme of human exploitation of animals. The moralistic perspective typically objects to human utilization of animals leading to death and presumed suffering (for example, hunting, trapping, laboratory experimentation), while the utilitarian attitude endorses such use if substantial human benefit results. In an analogous fashion, but at a more latent than manifest level, the negativistic and humanistic attitudes tend to clash on the theme of human affection for animals. The latter involves intense emotional attachment to individual animals, while the former is characterized by indifference or incredulity toward the idea of "loving" animals. The greater prevalence of these four attitudes in the national sample may suggest a dynamic basis

Table 1. Attitudes toward animals.

Naturalistic:	Primary interest and affection for wildlife and the outdoors.
Ecologistic:	Primary concern for the environment as a system, for interrelationships between wildlife species and natural habitats.
Humanistic:	Primary interest and strong affection for individual animals, principally pets.
Moralistic:	Primary concern for the right and wrong treatment of animals, with strong opposition to exploitation or cruelty toward animals.
Scientistic:	Primary interest in the physical attributes and biological functioning of animals.
Aesthetic:	Primary interest in the artistic and symbolic characteristics of animals.
Utilitarian:	Primary concern for the practical and material value of animals or the animal's habitat.
Dominionistic:	Primary interest in the mastery and control over animals typically in sporting situations.
Negativistic:	Primary orientation an active avoidance of animals due to dislike or fear.
Neutralistic:	Primary orientation a passive avoidance of animals due to indifference.

for the considerable conflict existing today regarding various interactions between people and animals.

The least frequently occurring attitudes were the scientistic and dominionistic. The naturalistic attitude was strongly evident among a minority of the national sample, but relatively weakly present among the great majority. Finally, the ecologistic attitude appeared to be modestly present among a substantial number, but strongly manifest among only a very small fraction.

The scales were also used to assess the attitudes of various demographic and animal-related groups. These results can be reviewed either in terms of the scores of many groups on a single attitude, or scores across all the attitude scales for one or a small number of groups. Insufficient space precludes a thorough presentation of either result and, thus, only findings pertaining to a few attitude scales and some important groups will be reviewed. The reader is referred to other papers for a more complete presentation of the attitude findings (Kellert 1980a,b,c).

The highest and lowest scoring groups are indicated for only the naturalistic, moralistic, utilitarian and negativistic attitude scales. The tables following were derived from both a comparison of mean scores, and the results of analysis of variance and multiple classification analysis. All differences between high and low groups are significant at $P = \leqslant .001$.

The most naturalistic activity groups included professional trappers, nature hunters, nature fishermen, birders, environmental protection and wildlife preservation organization members. In contrast, pet owners, anti-hunters, sport/recreation hunters and all fishermen, as well as those who fished primarily for large fish and for sporting purposes, had the lowest scores. Interestingly, all

Table 2. Naturalistic, moralistic, utilitarian and negativistic scale means by high and low scoring activity and demographic groups.

Naturalistic scale ($\bar{x}$ = 3.1)[a]

Demographic groups high	$\bar{x}$	Activity groups high	$\bar{x}$
Alaska	4.6	National trappers	9.6
Graduate education	4.5	Nature hunter	8.5
18–35 years old	3.6	Nature fisherman	7.2
Pacific Coast states	3.6	Environ. protection org. member	6.5
College education	3.5	Birdwatchers	6.3
Rarely attend religious service	3.2	Wildlife preservation org. member	5.8
Demographic groups low	**$\bar{x}$**	**Activity groups low**	**$\bar{x}$**
Unemployed	2.4	Sport/recreation hunter	3.8
Farmer	2.4	All fishermen	3.7
9–11th grade education	2.4	Anti-hunter	3.4
56–75 years old	2.3	Sport fisherman	3.4
Black	2.1	All pet owners	3.3
6–8th grade education	1.9	Large fish fisherman	3.2

Moralistic scale ($\bar{x}$ = 5.5)[a]

Demographic groups high	$\bar{x}$	Activity groups high	$\bar{x}$
Pacific Coast states	7.5	Environ. protection org. member	9.6
Graduate education	6.8	Humane organization member	9.5
Student	6.7	Anti-hunter	7.9
1 million pop'n. residence	6.3	Wildlife preservation org. member	7.7
Female	6.0	Zoo visitor	7.1
Rarely attend religious service	6.0	Backpacker	7.0
Demographic groups low	**$\bar{x}$**	**Activity groups low**	**$\bar{x}$**
Male	4.7	Sportsmen organization member	4.3
Unskilled laborer	4.6	Meat hunter	4.2
Southern states	4.5	Sport fisherman	3.8
Alaska	4.5	Sport/recreation hunter	2.9
Less than 500 pop'n. residence	4.0	National trappers	2.8
Farmer	3.7	Livestock producer	1.6

activity groups had naturalistic scores higher than the national sample, and the highest scoring activity groups were considerably above the top scoring demographic ones. Among demographic groups, the college educated, those under 35, the nonreligious and Alaska and Pacific Coast residents had very high naturalistic scores, in contrast to the significantly lower scores of farmers, the unemployed, elderly, poorly educated and black respondents.

Humane, environmental protection and wildlife preservation organization members, as well as scientific hobbyists, anti-hunters, zoo visitors and backpackers all scored very high on the moralistic scale. In striking contrast, extremely

Table 2. Continued.

Utilitarian scale ($\bar{x}$ = 5.3)[a]

Demographic groups high	$\bar{x}$	Activity groups high	$\bar{x}$
Farmer	8.5	Livestock producer	12.9
56+ years old	6.7	Large-fish fisherman	5.9
Black	6.4	Meat hunter	5.6
Southern states	6.4	Off-road vehicle user	5.5
Less than $5,000 income	6.1	Sport/recreation hunter	5.4
9–12th grade education	6.1	Sport fisherman	5.4
Demographic groups low	$\bar{x}$	**Activity groups low**	$\bar{x}$
Professional	4.6	Backpacker	3.7
$15,000–19,999 income	4.6	Nature fisherman	3.6
Graduate education	4.2	National trappers	3.4
Single	4.1	Scientific hobbyist	3.3
Alaska	4.1	Humane & wildlife pres. org. memb.	3.0
18–35 years old	4.1	Environ. protection org. member	1.6

Negativistic scale ($\bar{x}$ = 4.4)[a]

Demographic groups high	$\bar{x}$	Activity groups high	$\bar{x}$
76+ years old	6.0	Large-fish fisherman	4.3
Less than 8th grade education	5.9	Anti-hunter	4.1
Black	5.6	All pet owners	4.0
Farmer	5.3	Sport fisherman	3.9
56–75 years old	5.1	Livestock producer	3.9
Female	5.0	All fishermen	3.8
Demographic groups low	$\bar{x}$	**Activity groups low**	$\bar{x}$
$15,000–24,999 income	4.0	Backpacker	2.7
Rocky Mountain states	4.0	Birdwatcher	2.6
Less than 500 pop'n residence	3.9	Wildlife pres. org. member	2.4
18–25 years old	3.5	Scientific hobbyist	2.2
Graduate education	3.0	National trappers	2.1
Alaska	2.4	Environ. protection org. member	1.5

[a]The number in parentheses, adjacent to each attitude label, indicates the entire national sample mean.

low scores were characteristic of livestock producers, trappers, hunters and sport fishermen. Demographic results indicated that residents of large cities and the Pacific Coast states, females, the highly educated and nonreligious had quite high moralistic scores. On the other hand, persons from highly rural areas, Alaskans, farmers, residents of the South, unskilled laborers, and males had the lowest moralistic scores.

Livestock producers had exceedingly high utilitarian scores, more than twice the next highest scoring activity group. At a much less pronounced level, high scores were characteristic of meat and sport/recreation hunters, off-road vehicle users, and large fish and sport fishermen. Very low utilitarian scores were obtained by backpackers, nature fishermen, trappers, (despite very low moralistic scores), scientific hobbyists, and members of humane, wildlife preservation and environmental protection organizations. Among demographic groups, farmers, the elderly, blacks, residents of the South, and those with limited incomes and education were quite utilitarian oriented, in marked contrast to the young, highly educated, single, professionals, those of moderately high incomes, and respondents from Alaska.

All activity groups had lower negativistic scores than the general population. Relatively high negativistic scores, however, were characteristic of fishermen, pet owners, anti-hunters and livestock producers.On the other hand, especially low scores were found among environmental protection and wildlife preservation organization members, trappers, scientific hobbyists, backpackers and birders. Among demographic groups, very high negativistic scores occurred among the poorly educated, elderly, blacks, farmers and females. Particularly low scoring groups were Alaskan and Rocky Mountain residents, the highly educated, those with moderately upper incomes, the young, and residents of highly rural areas.

As previously noted, the activity and demographic groups were also examined in terms of their scoring patterns across all attitude scales. A few of these attitude "profiles" are briefly reviewed.

Educational differences were particularly striking, with limited education groups having significantly lower scores on all attitude scales except the dominionistic, utilitarian and negativistic. These findings suggested a relative lack of interest, affection, and concern for animals among the least educated, with the possible exception of situations involving sporting satisfactions and material gain. Differences were so dramatic, as indicated by Figure 1, that education appeared to have a fundamental impact on perceptions of the natural world. Moreover, the likelihood of this relationship not simply being a function of social class was suggested by far less striking income results.

Regional differences were also quite marked. The most outstanding result was the greater wildlife knowledge, appreciation and protectionist sentiment of Alaskans compared to other regions of the country. Most respondents from this state were strongly inclined toward maintaining healthy and abundant wildlife populations despite the loss of various material benefits. This pattern was revealed on the attitude scales as well as on various habitat protection and endangered species questions. On the other hand, Alaskans had quite low moralistic and high dominionistic scores, in addition to including far more hunters, fishermen and trappers than found in other regions. The protectionist sentiment of Alaskans, thus, was not related to an ethical antipathy toward the consumptive use of animals.

Age differences, especially among respondents over 75 and under 30, were particularly significant on the naturalistic, humanistic, negativistic, and utilitarian scales. Younger persons appeared to be characterized by far greater interest and affection for, and opposition to the exploitation of animals. Ironically, respondents over 75 and under 25 were similar only in their lack of knowledge of animals.

Racial differences clearly revealed a relative lack of concern and affection for wildlife among non-whites. Urban–rural results found respondents from large cities were far more moralistic, humanistic, and substantially less utilitarian. Sig-

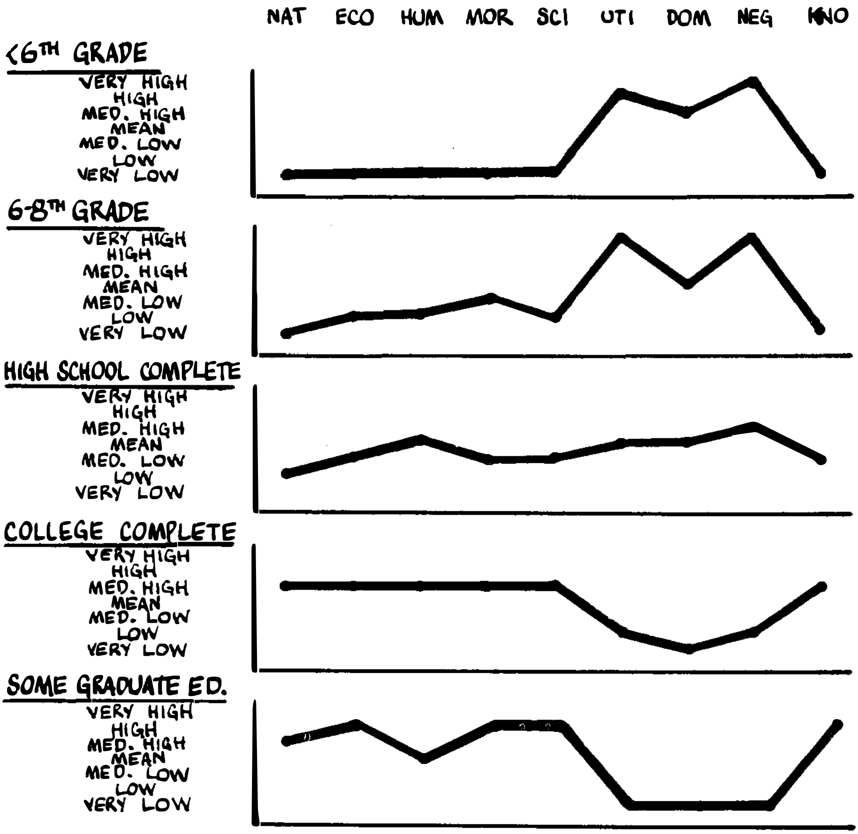

Figure 1. Education groups by selected knowledge and attitude scales.

nificantly lower negativistic scores among rural residents, however, suggested a strong general interest in animals, although relatively unrelated to animal rights concerns or a sense of loving animals.

Differences among hunters—distinguished according to primary reason for hunting—were roughly similar to those previously reported based on a 1975 investigation (Kellert 1978). Nature hunters were characterized by significantly greater knowledge, appreciative interest and protectionist concern for wildlife. Meat hunters, on the other hand, were most distinctive in their degree of utilitarian orientation to animals, while sport/recreation hunters had relatively high dominionistic scores, suggesting a primary concern for the competitive and physically challenging aspects of the hunt.

A somewhat analogous pattern was evident among those who fished primarily for sport, to be close to nature, and to catch large fish. The latter group had relatively high utilitarian, negativistic, especially low naturalistic and ecologistic scores, suggesting a strong pragmatic orientation not related to particular affection or concern for wildlife. Sport fishermen, on the other hand, had especially low moralistic and high dominionistic scores, indicating a strong interest in competitive and recreational satisfactions largely divorced from animal rights and cruelty considerations. Finally, nature fishermen, like nature hunters, had very high naturalistic scores indicative of a strong attraction to wildlife and the outdoors. Quite unlike nature hunters, however, nature fishermen had relatively high moralistic and humanistic scores, suggesting a possible view of fishing as an ethical alternative to hunting.

Birdwatchers were characterized by very strong affection, knowledge and protectionist interest in wildlife. On the other hand, comparatively low scores on the humanistic and moralistic scales indicated a primary orientation to wildlife and conservation of natural habitat than to domestic animals or animal welfare concerns. The extraordinary knowledge and ecological concern of birders may have been fostered by such characteristics of the activity as a primary focus on species than individual animals, the highly specialized habitat dependencies of many bird species, and a tendency for much avifauna to be sensitive indicators of human induced environmental stress.

Zoo visitors were characterized by extremely limited knowledge, naturalistic appreciation and ecological understanding of animals. Indeed, zoo visitors scored high only on the humanistic scale, suggesting an interest in animals related more to strong affection for domestic animals than for wildlife and the outdoors (Kellert 1979c).

Participation in Animal-related Activities

The final section will briefly consider the relative occurrence of various animal-related activities. Although estimates regarding participation in these activities varied considerably depending on the criteria employed, some limited impressions can be provided, although a far more thorough discussion can be found in another paper (Kellert 1980b).

The following activities occurred, at varying levels of participation, among 25 percent or more of the national sample: owning a pet (84 percent at any time in life, 67 percent during the past two years), television viewing of "Wild Kingdom" during the past two years (78 percent at least once, 37 percent frequently), visiting a zoo during the past two years (46 percent), fishing during the past two years (44 percent), owning a pet bird at some point in life (42 percent), reading a book about wildlife during the past two years (35 percent), birdwatching during the past two years (25.5 percent), and hunting at any time in life (25 percent). Collectively, the extent and diversity of these activities reflected the substantial role animals play in the lives of many Americans.

Additional activities occurring at more moderate levels of participation, during the past two years, included: hunting (14.5 percent), backpacking (13 percent), membership in a conservation-related organization (11.3 percent) and owning a pet bird (10 percent).

Finally, activities participated in by 5 percent or less of the population, during the past two years, were: "committed" (i.e., frequent participation and considerable knowledge) birdwatching (3.2 percent); membership in sportsmen (3.3 percent), wildlife preservation (2.9 percent), humane (1.4 percent), and environmental protection (1.1 percent) type organizations; hunting for more than 36 days (3.4 percent) and nature hunting (1.4 percent); scientific study of animals (2.2 percent); and fur trapping (0.7 percent).

Conclusion

Some general conclusions can be derived from the data presented. Perhaps most important was the majority of Americans appeared to strongly value wildlife and have expressed a willingness to make substantial social and economic sacrifices to protect this resource and associated habitat. Various findings consistently indicated wildlife was not just the concern of an esoteric and elitist minority, but, instead, had broad appeal to many, if not most, Americans. The impression was that an abundant, diverse and healthy wildlife population contributes, in the minds of many, to a high standard and quality of life.

On the other hand, the wildlife views of most Americans appeared to be based on limited factual understanding and awareness. Moreover, interest and concern for animals were largely confined to attractive and emotionally appealing species. While substantial growth in wildlife appreciation is certainly a welcome development, inadequate knowledge and an inordinately narrow perspective must also be recognized and used to form the basis for more innovative public awareness efforts.

The wildlife management field appears to be confronted by a major change in the public it serves, with many new and atypical groups becoming appropriate recipients of professional attention. This expanded constituency must inevitably constitute a threat as much as a challenge to a field that has historically defined itself in far narrower terms. Nevertheless, the challenge represents a rare chance, and it would be a disservice to the profession, let alone to an American public and wildlife resource in need, if the professional reaction was more to avoid an alien reality than a creative and bold response to an evolutionary opportunity.

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Necessary Conditions for Resource Allocation and Management

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Lakes are an important natural resource in Wisconsin. Each year, 65 percent of the adult citizens use lakes. These citizens are concerned about the quality of the lakes they use. A majority of Wisconsinites feel lake pollution is a problem. More citizens are concerned about lake pollution than any other type of pollution (Bouwes et al. 1980).

In addition to expressing concern, Wisconsinites are willing to pay higher fishing license fees if it means reducing water pollution or improving habitat for fish (Sharp 1979). In another recent study, over 60 percent of Wisconsinites indicated that they were very interested in water quality. "Saving home energy" was the only nature/environment topic that elicited more interest (Nichols et al. 1980).

Lakes are also important to citizens of other states. The residents of water-poor states frequently travel to water-rich states to enjoy the aesthetic qualities and outdoor recreation that lakes provide.

This paper focuses on lakes as a resource to be allocated among users and restored/protected for long-term user enjoyment. In the first section of the paper, several necessary conditions for management are outlined. Corresponding aspects of the lake management program in Wisconsin are also presented. In the balance of the paper, management projects in two communities are described and some of the data from evaluation studies are discussed.

Necessary Conditions

Many factors are involved in natural resources allocation and management. Management of national forests or U.S. Army Corps of Engineers reservoirs is directly influenced by decisions in Washington. Management of other resources is largely dependent on conditions in a local community or the perception of an individual landowner. Whatever the resource and the setting, at least four conditions must be present to implement sound management: technical expertise, institutional framework, citizen education, and finances.

Technical Expertise

Scientific understanding provides the basis for management. Trained professionals and hard data have a key role, but not an exclusive or final place in the decision-making process.

In the Wisconsin Lake Management Program, technical expertise is provided to local communities. The Office of Inland Lake Renewal in the Department of

Natural Resources (DNR) is staffed by a limnologist, aquatic biologist, hydrogeologist, environmental engineer, and soil scientist. This team provides technical assistance by designing feasibility studies to be carried out by private consultants who are hired by the local community. Based on the study data, the DNR team also provides management alternatives to the community and assists with implementation if the community decides to proceed with a project. The team frequently draws on the data and expertise of other agencies.

Institutional Framework

Data and professionals trained to interpret it are only one of the necessary ingredients for implementing resource management. In a democracy, experts should be on tap but not on top. The institutional structure should encourage the use of scientific findings but the structure should give paramount consideration to the values and preferences of interest groups and citizens.

Under Wisconsin's enabling legislation, local communities can organize public inland lake protection and rehabilitation districts (Klessig 1976, 1979). The districts are organized and operated by local residents and property owners. They have authority to levy a property tax to maintain the district and finance projects. Projects (Table 1) are approved or disapproved at the annual meeting of the district. Since 1974, 120 of these special purpose units of government have been created.

Citizen Education

If citizens and their representatives are to make resource management decisions, education becomes crucial. All democratic processes require citizen education, whether the citizen will use that information in direct participation at annual meetings, election of representatives, or participation at public hearings. Citizens should understand the basic principles of resource use and conservation and the political process by which allocation and management decisions are made.

The Wisconsin Lake Management Program includes statutory recognition of the education role. The University of Wisconsin Extension has responsibility to provide a systematic flow of information to lake communities. That flow begins when local citizens contact county Extension agents to inquire about creation of a lake district. The educational service continues as the district matures. To serve a broad range of education needs, the two state specialists employed by University of Wisconsin Extension have complementary expertise in the natural and social sciences (Klessig 1977).

Finances

Money is needed to carry out the decision reached through the political process, regardless of the level. Congress must appropriate funds before the U.S. Environmental Protection Agency (EPA) can award grants under the "Clean Lakes Program" (Gibson et al. 1979). A county board must hire a code administrator before its shoreland and floodplain zoning ordinance will have any effect.

As noted earlier, the Wisconsin Lake Management Law enables lake districts to raise funds; property taxes, special assessments or user charges may be selected

Table 1. Major Lake District projects not including maintenance, such as annual weed control or dam repairs, or protection activities, such as septic tank inspection or appearances before zoning boards.

Lake district	Project	Cost
Mirror/Shadow	Storm sewer diversion Alum treatment Aeration	$ 430,000[a]
White Clay	Manure storage Grass waterways	230,000[a]
Half Moon	Dredging Pumping Aeration Storm sewer diversion	730,000[a]
Largon	Dam construction Aeration	$30,000 of work for $5,200 plus local labor
Henry	Stream bank riprapping Dredging	440,000[a]
Noquebay	Winter drawdown Intensive weed harvesting	490,000[a]
Emery	Purchase flowage rights Rebuild dam Dredging	435,000[a]
Lilly	Dredge Alum treatment	730,000[a]
Bugle	Watershed protection/ dredging	500,000[a]
Little Muskego	Dredging	2,000,000[a]
Decorah	Dredging	525,000[a]
Puckaway	Carp control/restocking Water level management Shoreline riprapping	20,000[a]
Chilton	Dredging	80,000[a]
Marinuka	Watershed protection/ dredging	880,000[b]
Perch	Watershed protection/ dredging	320,000
Upper Willow	Watershed protection/ dredging	670,000[b]
Big Cedar	Purchase grass waterways Land use management Manure storage	270,000
Angelo	Dredging	270,000[a]

[a] 50% of the cost is shared by EPA.
[b] Pending EPA application.

at the annual meeting. However, other citizens from distant locations use the lake via the public access sites. Equity requires that they also pay part of the cost of lake management. The Wisconsin legislature has appropriated general purpose revenues for this purpose. The grants administered by DNR provide 60 percent state cost-sharing for feasibility studies and up to 80 percent state cost-sharing for project implementation. (EPA grant programs operate on a similar equity principle.)

The Study Lakes

Mirror/Shadow Lakes in Waupaca

Waupaca is a city of about 5,000 people in central Wisconsin. Mirror Lake is a small lake of 13 acres (5.2 ha) within the city limits. It has experienced algae problems and dissolved-oxygen depletion. Excessive macrophytes have not been a problem since the littoral zone is small in the 43-foot-deep (13.1 m) lake. *Oscillatoria rubescens*, a red-pigmented algae that is symptomatic of eutrophic lakes, became common in the 1950s.

Shadow Lake is 43 acres (17.4 ha) in size. It has a broader littoral zone along the shore where aquatic vegetation has developed. The lake is 38-feet-deep (11.6 m) and supports the only swimming beach in the city. South Park, on the municipally-owned west shore, is heavily used for picnicking and swimming. In 1979, swimmers accounted for 19,000 visits, boaters 180 visits, and fishermen 1,200 visits. The quality of Shadow Lake was acceptable even before the project was undertaken, but the drainage of Mirror Lake water and storm sewers into Shadow Lake worried local residents. They wanted Shadow Lake protected.

In response to that concern, the City of Waupaca created a lake district in 1974 soon after the Wisconsin Lake Management Law went into effect. A study revealed that most of the phosphorus entering the lakes was entering through two storm sewers. With technical assistance from DNR, the lake district decided on a three-phase project:

1. to eliminate most of the annual phosphorus loading, which was promoting excessive algae and weed growth, by diverting the storm sewers away from the lake;
2. to treat the lakes with alum to precipitate the phosphorus in the water column and seal off the phosphorus-rich sediment; and
3. to promote turnover (destratify) by periodically aerating Mirror Lake. (Natural turnover and mixing by wind action is inhibited by Mirror Lake's depth and sheltered location.)

The storm sewers were diverted in 1976. Alum was added in 1977. Aeration began later in 1977. The project cost $430,000. Cost-sharing for the project amounted to: 50 percent EPA, 30 percent DNR, and 20 percent local lake district. A limnological evaluation of the effects of these treatments has been conducted since 1977 (Knauer and Garrison 1980). Phosphorus levels have dropped and the red-pigmented algae have disappeared. Oxygen levels have increased to again support fish life in Mirror Lake. However, water clarity as measured by Secchi disc has not increased. The *Oscillatoria rubescens* that live deep in the water column have been replaced by green algae that are characteristic of less eutrophic lakes and that support a better aquatic food chain. However, they are found near the surface where they are visible to recreationists.

White Clay Lake in Shawano County

White Clay Lake is a 250-acre (101.2 ha) lake surrounded by dairy farms, a small resort, and a few non-farm homes. The lake supports an active sport fishery of pike and pan fish for the recreation of local residents and day visitors from Green Bay and other nearby communities. Data for 1978 indicate about 5,000 such visits per year; ice fishing is often more popular than open water fishing. On derby days, well over 100 fisherman and their families enjoy a weekend fishing expedition on the ice.

The watershed consists of 3,000 acres (1,214 ha) owned by 25 landowners. Fourteen have livestock. Agriculture dominates the watershed. Water quality in the lake has been consistently high. With encouragement of the county Extension agent and Soil Conservation Service personnel, a study was conducted to measure the phosphorus in the run-off waters entering the lake from barnyards and fields.

The study showed that the water entering the lake contained more phosphorus that the water in the lake. Many dairy farmers had switched from pasturing to green-feeding cattle on confined lots; manure run-off had increased as a result. Erosion from cultivated fields was also noted as was run-off from manure spread on frozen ground.

A lake district was organized by the local landowners through their town board. The district decided to proceed with a project that concentrated on upgrading barnyards and storing manure for spring or fall spreading. With extensive assistance from several agencies, the district developed a management plan which included every farm in the watershed. Ninety percent cost-sharing was provided by EPA and DNR (Peterson et al. 1978).

After three years of work, district landowners gathered in February, 1980 to review their project and discuss the formal evaluation (Peterson and Madison 1980). They learned that the water reaching the lake contains less phosphorus than it did before the project was implemented.

A Rural/Urban Comparison

All four necessary conditions were present, to at least a minimum degree, in both communities; the projects were efficiently implemented with little conflict. And the limnological results indicate the lakes are better protected or being restored for recreational use. Nevertheless, there are differences in the secondary benefits associated with the projects. The urban community entered the effort with a developed institutional structure: it has professional employees in the public works department who could manage the undertaking. The rural community lacked such infrastructure—it had to be grown. The differences shown in the comparisons that follow can be traced back to this basic difference between the communities.

Technical Assistance

Both communities received extensive assistance from public agencies. City of Waupaca employees discussed project plans directly with the contractors the district hired and with DNR.

The White Clay Lake District did not have any employees to call upon. Consequently, it relied heavily on agency personnel from the county and state. Soil Conservation Service and Agricultural Stabilization and Conservation Service offices in Shawano County provided operational assistance in both engineering and administration. The University of Wisconsin Extension and other agencies provided additional assistance.

Institutional Development

In Waupaca, creation of a lake district did not substantially change local institutional arrangement. The city council, at the urging of a councilman who lived on Mirror Lake, created the lake district. Less than 2 percent of the city voters reported attending a meeting to discuss creation of a district. A district was simply created to make the city eligible for funds under the Wisconsin Lake Management Law. The city council became the lake district board of commissioners and held lake district meetings as a subset of other council meetings. The structure in Waupaca required little citizen involvement and participation.

In the White Clay Lake situation, no structure existed, not even a voluntary lake association. Although a sportsmen's group provided some focus of interest, the only formal structure was town government. The town occupied a much larger area and the town board was concerned with broader issues such as road maintenance. When local citizens became concerned about maintaining water quality, they sought technical and educational assistance. Part of that assistance was information on organizing a lake district. Over half of the White Clay Lake families attended meetings on the subject prior to organizing the lake district. The town board formed the district after a consensus had been reached in the community. The town board served as the initial commissioners of the lake district as required by law. However, when state law was changed to allow such districts to elect their own commissioners, White Clay residents opted to do so. The lake district chairman, who had become well known for his lake work, was later elected to the town board. The institutional structure at White Clay Lake was built from scratch.

Citizen Participation and Understanding

The institutional development at White Clay Lake demanded significant involvement from a small community. The watershed residents responded. In Waupaca, residents could rely on the city council to make decisions and residents were apparently willing to trust the council's judgment. The council was required to hold annual meetings, similar to other lake districts, but only 2 percent of the citizens ever attended an annual meeting. In contrast, nearly half of White Clay Lake residents attended lake district meetings; 14 percent attended as many as eight annual and special meetings.

In Waupaca, 40 percent of the residents were unaware of the project even though the regrading of storm sewers was a visible project—it disrupted streets for an entire summer. Only 26 percent were aware that a local lake district was involved in the project.

At White Clay Lake, all families were aware of the project and all were aware of the role of their local lake district.

Citizen involvement in creating the lake district at White Clay Lake continues with involvement in the operation of the district. Waupaca residents, who were not involved in creation of their district, continued to trust their council and did not participate in the operation of the district. Such behavior is rational and efficient; after all, the council was elected to represent the voters and govern accordingly. However, the lake district project provided little experience in self-governance—experience that is important in training new leaders and keeping citizens aware of decision-making processes. The capacity for self-governance was enhanced at White Clay Lake; it was largely unchanged at Waupaca.

In addition to providing educational opportunities in civics, the projects presented opportunities for citizens to learn more about their lakes. To determine if such learning occurred, the following questions were asked of a sample of Waupaca residents and all household heads at White Clay Lake (the correct response is underlined):

1. City and village storm drains can empty into nearby lakes without hurting the quality of lake water. Agree or <u>disagree?</u>
2. The major cause of lake fish dying—or fish kills—in the winter months is that the water gets too cold for the fish to live. Agree or <u>disagree?</u>
3. If farmers near lakes fertilize their field by spreading manure only in the winter, the amount of pollutants running to the lakes would be reduced. Agree or <u>disagree?</u>
4. Marshes around lakes act as a filter because they keep out material which would otherwise pollute lakes. <u>Agree</u> or disagree?
5. The lakes would always remain clear, clean and fresh if there were no people around to cause pollution. Agree or <u>disagree?</u>

As a control, the same questions were asked of a statewide sample of Wisconsin adults.

The involvement of White Clay Lake residents in their district's project is reflected in their knowledge of lake processes (Table 2). White Clay Lake residents scored high on four of five questions. In contrast, Waupaca residents did not score substantially above 50 percent—the score expected by simple chance. They did, however, score highest on the question of storm drains which was the central component of their lake project. In general, Waupaca residents showed no greater understanding of lakes than was true for the statewide sample.

Table 2. Knowledge of lake processes in percent correct answers.

Test question	Statewide adults	Waupaca residents	White Clay Lake residents
Storm drains	69	73	80
Fishkills (too cold)	72	70	97
Manure spreading	49	45	71
Marshes	60	58	86
Man as cause of eutrophication	39	41	31
(N)	(1342)	(140)	(35)

White Clay Lake respondents were much more likely to understand the role of marshes in protecting water quality by filtering out nutrients from run-off. The questions on manure spreading and storm drains also indicate that respondents in White Clay Lake see the role that nutrients play in eutrophication, and the source of those nutrients. The White Clay Lake respondents seemed to understand that winter fish kills result from lack of oxygen in the water, not from water temperature.

None of three sets of respondents understand natural eutrophication of lakes. Apparently, the emphasis on controlling cultural eutrophication has highlighted the impact of man and underrated the impact of natural evolutionary processes.

Cost-Sharing

Residents of the two communities were also asked who paid for the lake projects. Most respondents were aware (or guessed) that state and federal levels of government helped pay for the project. In both communities, most respondents did not know the percentage paid by these agencies; however, many respondents in White Clay Lake were aware of the split between local and outside money (Lovejoy et al. 1980). Fifty-one percent of the White Clay Lake residents knew the local community percentage contribution; while in Waupaca, only 1 percent knew the local community contribution. In addition, respondents at White Clay Lake were aware of how the local contribution was raised, while most respondents in Waupaca were not.

Summary

Both communities obtained technical assistance from public agencies. Waupaca had an institutional infrastructure and the residents of White Clay Lake developed one through their district. In Waupaca, citizen education was limited to the city council, the public works department and limited numbers of property owners. At White Clay Lake virtually everyone in the community was involved. Both communities received federal and state grants and were able to meet matching obligations.

While both communities initiated and successfully completed a lake management project, there are important differences between the communities in terms of secondary benefits. The White Clay Lake district fostered much higher levels of involvement and participation of local citizens, as well as greater levels of knowledge about lake eutrophication and its causes. At White Clay Lake, a higher proportion of respondents felt that the experiences gained from the lake management project would be useful in dealing with other community issues. The White Clay Lake project also fostered interest in new zoning ordinances for the community, promoted environmentally-sound farming practices, and facilitated leadership development.

As an incorporated municipality, Waupaca exhibited greater self-sufficiency. The project was taken in stride since the necessary conditions were largely met *a priori*.

While both an institutional framework and citizen education are necessary conditions for resource management, it appears that the two factors can complement each other to a degree. If an existing institution can smoothly incorporate new management initiatives into its ongoing operations, there is less need for intensive educational campaigns and public involvement. When such involvement is required to develop or change institutions, the investment of effort should pay dividends in citizens, leaders and institutions better prepared to cope with the next community issue. The capacity for self-governance is enhanced when citizens have occasional opportunities for direct participation, but are confident that their elected representatives are competently handling most problems. Rural lake districts in Wisconsin provide one such opportunity for direct participatory democracy.

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Implementation of Executive Order 11988 on Floodplain Management

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Background

It was the expectation of the agencies assigned consultation responsibility under the Order—Water Resources Council (WRC), Council on Environmental Quality (CEQ) and Federal Emergency Management Agency (FEMA)—that several major factors would have by this time significantly increased federal floodplain management efforts under Executive Order 11988. First, the Order's implementation date, May 24, 1978, is well over a year past. Second, recognizing this, the President specifically directed the agencies to expedite their implementation of the Order in a July 12, 1978 memo. Two additional progress reports were required in order to monitor progress. Third, the results of the first of these progress reports, due November 30, 1978, showed a clearly unsatisfactory effort on the part of the agencies. Cecil Andrus, Chairman of the Council, notified the agency heads in May of their status and in most cases had to request a firm schedule for completion of final regulations and procedures.

Unfortunately, the expected upgrading of the federal effort has not occurred. Agency progress is still far from adequate. Since the January 15, 1979 WRC Status Report when there were five agencies out of 31 with final implementation procedures, the number has now only risen to 15.

Status of Implementation Procedures

Executive Order 11988 applies to all proposed actions by all federal agencies with the sole exception of the emergency activities specified in Section 9 of the Order. The term "agency" as used here refers to 13 cabinet level organizations within the Federal Government, and 18 independent agencies. The term "Subagency units," refers to individual program areas within the agencies that are anticipated to be preparing more detailed procedures of their own. For those agencies carrying out actions of a nature essentially without direct or indirect effects on a floodplain, (for example, labor mediation and securities regulation), the publication of extensive implementation procedures may not be appropriate. To focus attention on those agencies whose activities more frequently affect floodplains, a survey was made of agency activities as described in the 1978-79 Government Organization Manual. Consequently, 31 agencies and 40 of their subunits have been identified (Appendix B) as the focus of this effort to evaluate progress under the Presidential directive of July 12, 1978. The status of each of these as of January 1, 1980, is discussed in this report. However, as information and experience warrant, agencies and subagency units may be added to or deleted from this list.

Among the 31 agencies, 13 cabinet level departments and administrative units have been identified (Table 1). In the consultation process these units have been encouraged to first issue agency-wide procedures indicating general policy, substantive and mechanical requirements, designation of responsibility, and identification of subagency units expected subsequently to issue more detailed implementation procedures. Similar broad procedures and specific subagency procedures may be appropriate for a few of the 18 independent agencies identified in this report. To date, of the 31 agencies, 20 have published implementing procedures including 16 final procedures. Of these 31 agencies, 20 have submitted the May 30 status report required by the President's Memorandum of July 12, 1978.

At the subagency level, 49 units were identified. Of these, 29 have prepared implementing procedures including 14 in final form. In addition, most of the subagencies are drafting regional and field level documents such as management directives, handbook inserts, manuals, etc. Three of these units submitted the May 30 reports independently, while several others were spoken for in the agency reports.

Analysis of Progress to Date

We are now over a year and a half past the due date for agency implementing procedures that is set in Executive Order 11988 at Section 2(d). As summarized in Table 1, about one half of the procedures expected from the agencies are in final form. For the subagency units, about one quarter of the total expected are in final form.

In response to Secretary Andrus' May letter calling for firm implementation schedules from the agencies, some commitments were made to propose or promulgate final procedures between June and December of 1979. Nineteen commitments were made, 6 for agency and 13 for subagency units. Two agencies and six subagencies have yet to meet their commitments (refer to appendix B). If each of these commitments is fulfilled, the total of agencies with published procedures will be 22 and the total for subagencies will be 35.

It should be noted that the data compiled here on the status of agency procedures gives no firm indication of the effectiveness of the Order's implementation at the field level. Few procedures have been in effect for very long, and the provision of adequate guidance to agency field staff is only in its initial stages. Only 4 of the 21 agencies submitting the May 30 report made reference to the effectiveness of their implementation efforts. In summary, they reported modest results and emphasized the need to await the administration of final procedures to gather useful data.

Table 1. Status of procedures to be issued in connection with Executive Order 11988 at 1 January 1980.

Type of Procedures	Expected	Published: Preliminary	Published: Final	Unpublished	No progress evident
Agency	31	4	16	4	7
Subagency Units	49	14	14	1	15

Despite the status report's lack of detail on implementation, there is evidence that the Order is having an impact across the nation. Both WRC and FEMA[1] receive inquiries daily about the applicability of the Order to specific field situations. In some of these situations, the Executive Order has clearly resulted in desirable modification of a proposed action.

Impact of the Order on Agency Activities

The May 30 written status reports were received from 23 agencies and subunits. These reports concerned themselves primarily with descriptions of progress in developing implementing procedures, manuals, handbooks, etc. Only 4 agencies commented on the impact of the Executive Order on their programs, not a sufficient number to permit meaningful evaluation.

The status reports also included four agencies which indicated the Executive Order did not apply to their program activities. These agencies stated either that Executive Order 11988 does not apply to their activities, or that by the nature of the activities they carry out, any effort that they might make to implement the Order would not achieve its intent. One of these agencies, however, noted that it is continuing its review of the applicability of the Order (see Appendix B).

From our experience to date, it appears that the potential for the objectives of Executive Order 11988 to be achieved can be expected to vary based on the type of federal program under consideration. The greatest long-term potential would appear to be in technical assistance and water and land use planning programs. These include the Coastal Zone Management Program and EPA 208 and HUD 701 planning programs, as well as the technical assistance programs of the Soil Conservation Service and the Corps of Engineers, and the National Flood Insurance Program. Such programs, through integration of the Order's concepts of floodplain avoidance and impact mitigation into land and water planning efforts, can provide the best vehicles for laying the groundwork for sound floodplain management.

The greatest short term potential for achieving the Order's objectives may be expected from the day-to-day application of the Order's provisions through direct federal construction and land management programs. These include programs implemented by the Corps of Engineers, General Services Administration, the Forest Service, Bureau of Land Management and others. In these programs, the Order's implementation is quite straightforward, and results are more immediate and measurable over the short run.

It appears that the potential for achieving the Order's objectives is somewhat less among the grant and loan and regulatory and licensing programs such as those administered by the Economic Development Administration, Environmental Protection Agency, Federal Energy Regulatory Commission, the Coast Guard and others. In these programs, the federal agencies provide the wherewithal for others to perform actions affecting the floodplain, such as state or local governments or private developers. In the grant and loan programs, especially, the Federal Gov-

[1]The President's Executive Order 12148 of July 20, 1979, established the Federal Emergency Management Agency (FEMA) as co-consultant on agency Executive Order 11988 procedures along with WRC and CEQ. This role was previously performed by the Federal Insurance Administration (FIA) which is now a part of FEMA.

ernment does not have full control over every aspect of considering a proposed floodplain action. This effect is compensated for to some degree, and thus, the potential for achieving the Order's objectives is greater among agencies providing grants and loans for disaster relief and recovery, such as the Small Business Administration and FEMA. In post-flood situations, there is an unusually high receptivity to the initiation of sound floodplain management efforts. While the federal regulatory programs have the power to revoke licenses or permits and to demand restitution of disrupted flooplain areas, they frequently lack the resources for effective monitoring.

The potential for federal agency efforts to achieve the Order's objectives is least strong in the federal instrumentalities, e.g., FDIC, FSLIC, etc. However, even among these agencies which have the least direct involvement in actions having the potential to affect the floodplain, opportunities to achieve the Order's intent exist. For example, although the federal agencies that guarantee, regulate, approve or insure financial transactions related to floodplain locations have a very indirect connection with persons carrying out actions impacting floodplains, they can aid in achieving the Order's intent through the transmittal of information about the nature of the risk to potential floodplain developers and occupants.

It is to be anticipated that there will be similarities and continuity between the procedures developed by different agencies performing the same type of functions. The public notice, floodplain avoidance, and impact identification and mitigation provisions of the Order will logically be addressed in a basically similar manner by agencies performing the same types of activities. This is already becoming evident from the procedures of agencies involved in property acquisition, management and disposal, construction of structures and facilities, granting of licenses and permits, provision of grants and loans, land use planning, etc. It is these similarities, in fact, that will provide WRC with a comparative framework to perform the first comprehensive evaluation of the effectiveness of the federal effort to implement Executive Order 11988. This evaluation is being initiated this month by WRC pursuant to the provisions of Section 5 of the Order.

Appendix A
Implementation of Executive Order 11988, Floodplain Management

May 24, 1977	Executive Order 11988 issued by the President.
Nov. 20–21, 1977	CEQ meeting with designated agency contact to discuss the Order.
Feb. 10, 1978	Guidelines for Implementing E. O. 11988 published by WRC.
March 6–9, 1978	WRC/CEQ/FIA Workshops for agency contacts.
March 1978—to date	WRC/CEQ/FIA consultation and comment on agency draft procedures.
March 21, 1978	CEQ memo to agency heads discussing implementation and offering guidance.
May 24, 1978	Publication of draft procedures in *Federal Register* by only five agencies.
June 6, 1978	President's Water Policy Reform Message calls for expedited implementation.
July 12, 1978	Presidential memorandum to agency heads directing agencies to expedite implementation and submit progress reports by November 30, 1978 and May 30, 1979.
Nov. 15, 1978	Draft regulation for consultation and comments submitted by 32 agencies, including 23 published in the *Federal Register*.

January 15, 1979	Progress Report based on consultation and status reports submitted by agencies indicates the following: —31 Federal agencies have largest amount of program activity affecting floodplains; —Of 13 cabinet level agencies, one has published final procedures and seven have published draft or interim procedures; —Of 18 independent agencies, four have published procedures and five have published draft or interim procedures; —Of 44 subdepartmental units, 10 have published draft or interim procedures and five have submitted unpublished drafts for consultation.
April 19—June 7, 1979	WRC/CEQ/FIA conducted comprehensive field staff training on the Order in 10 major cities nationwide. The sessions were attended by 360 staff from over 35 Federal agencies.
May 8 and 11, 1979	Secretary Andrus, Chairman of the Water Resources Council, informed the agency heads of the unsatisfactory rate of progress in implementing the Order and requested a firm schedule for issuing final procedures.
January 1, 1980	Progress report based on consultation and May 30, 1979 status reports submitted by agencies indicates the following: —31 Federal agencies have largest amount of program activities affecting floodplains; —Of 13 Cabinet level agencies, seven have published final procedures, two have published proposed procedures, and three have informal drafts; —Of 18 independent agencies, eight have published final or interim procedures, two have published proposed procedures, and one has an informal draft; —Of 49 subagency units, 14 have published final procedures, 14 have published proposed or interim procedures, and one has an informal draft.
January 1, 1980	First formal evaluation of the effectiveness of agency procedures initiated by WRC pursuant to Section 5 of Executive Order 11988. A Work Group of the Council's Floodplain Management Task Force is performing the evaluation which is to be completed in September 1980.

Appendix B
Status of Federal Agency Procedures for E. O. 11988, Floodplain Management at 1 January, 1980

Agency and Subunit	**Status of Procedures**	
Department of Agriculture	Final	–Internal Memo, October 30, 1978
Soil Conservation Service	Final	–*Federal Register,* July 30, 1979
Rural Electrification Administration ...	Proposed	–*Federal Register,* Aug. 29, 1978 (September, 1979)[1]
Economic, Statistics and Cooperative Service	Proposed	–*Federal Register,* June 9, 1978
Farmers Home Administration	Proposed	–*Federal Register,* Sept. 14, 1978

Agency and Subunit		Status of Procedures
Forest Service	Proposed	–*Federal Register,* May 4, 1979
Science and Education Administration	Proposed	–*Federal Register,* June 9, 1978
Agricultural Stabilization and Conservation Service	Proposed	–*Federal Register,* June 9, 1978
Department of Commerce	Final	–*Federal Register,* May 23, 1979
Economic Development Administration	Final	–*Federal Register,* August 31, 1979
National Oceanic and Atmospheric Administration	Informal Draft	–December 1979 (August 1979)[1]
Department of Defense (Military Construction)	Final	–*Federal Register,* March 6, 1978
Air Force	Final	–Design Manual, Dec. 22, 1978
Army	Internal Directive	–May 22, 1978
Navy	Final	–Design Manual, August, 1979
(Civil Works) Corps of Engineers	Final	–*Federal Register,* May 15, 1979
(Regulatory Programs) Corps of Engineers	Final	–*Federal Register,* July 19, 1977
Department of Energy	Final	–*Federal Register,* March 7, 1979
Federal Energy Regulatory Commission	Proposed	–*Federal Register,* August 23, 1979
Department of Health, Education and Welfare	Informal Draft	–August, 1979 (June 1979)[1]
Education Division	None	
Public Health Service	None	
Department of Housing and Urban Development	Proposed	–*Federal Register,* Aug. 9, 1979
Community Planning and Development	None	
Housing	None	
Neighborhood, Voluntary Associations and Consumer Protection	None	
New Community Development Corporation	None	
Department of the Interior	Final	–*Federal Register,* June 20, 1979
Fish and Wildlife Service	Final	–*Federal Register,* Nov. 20, 1979
Heritage Conservation and Recreation Service	Final	–*Federal Register,* June 21, 1979
National Park Service	Proposed	–*Federal Register,* Sept. 28, 1979 (July, 1979)[1]
Bureau of Land Management	Final	–*Federal Register,* Mar. 15, 1979
Water and Power Resource Service	Final	–*Federal Register,* July 17, 1979
Bureau of Indian Affairs	Proposed	–*Federal Register,* Oct. 1, 1979[1]
Office of Surface Mining	None	

Bureau of Mines	None	
Geological Survey	None	
Department of Justice	Proposed	–*Federal Register,* August 2, 1979
Bureau of Prisons	None	
Law Enforcement Assistance Administration	None	
Immigration and Naturalization Service	None	
Department of Labor	Informal Draft	–June 1979
Department of State (provided by)		
Bureau of Oceans and International Environmental and Scientific Affairs	Informal Draft	–September 1978
Department of Transportation	Final	–*Federal Register,* April 26, 1979
Federal Aviation Administration	[2]	
Federal Highway Administration	Final	–*Federal Register,* Nov. 26, 1979
Federal Railroad Administration	[2]	
Urban Mass Transit Administration	[2]	
Saint Lawrence Seaway Development Corporation	[2]	
U.S. Coast Guard	[2]	
Department of Treasury	Final	–*Federal Register,* May 24, 1978
Environmental Protection Agency	Final	–*Federal Register,* Jan. 5, 1979
Office of Air Quality Planning and Standards	None	
Office of Drinking Water	None (October 1979)[1]	
Office of Enforcement	Final	–*Federal Register,* June 7, 1979
Office of Environmental Review	Proposed	–*Federal Register,* June 18, 1979
Office of Solid Waste Management	[3]	
State Plans	Final	–*Federal Register,* July 31, 1979
Disposal Facilities	Proposed	–*Federal Register,* Feb. 6, 1978 (June 1979)[1]
Hazardous Waste Permits	Proposed	–*Federal Register,* Dec. 18, 1978 (December 1979)[1]
Office of Water Planning and Standards	Final	–*Federal Register,* May 23, 1979
Office of Water Program Operations	Final	–Handbook, January 1979
Independent Agencies		
Advisory Council on Historic Preservation	None	
Action	None	
Community Services Administration	None (July 1979)[1]	
Farm Credit Administration	None[4]	
Federal Communication Commission	Final	–*Federal Register,* Nov. 15, 1977
Federal Deposit Insurance Corporation	None[4]	
Federal Emergency Management Agency	Interim	–*Federal Register,* Dec. 27, 1979

Office of Plans and Preparedness ..	None	
Office of Disaster Response and Recovery	Proposed	–*Federal Register,* June 13, 1979
Federal Insurance Administration ..	None	
Federal Home Loan Bank Board	None[4]	
General Services Administration	Final	–*Federal Register,* August 1, 1979
International Boundary Water Commission	Final	–*Federal Register,* Dec. 29, 1978
National Aeronautics and Space Administration	Final	–*Federal Register,* Jan. 4, 1979
National Credit Union Administration	None[4]	
Nuclear Regulatory Commission	Proposed	–*Federal Register,* Oct. 6, 1978
Small Business Administration	Interim	–*Federal Register,* Oct. 28, 1978
Tennessee Valley Authority	Final	–*Federal Register,* August 3, 1979
U.S. Postal Service	Final	–PS Bulletin, August 14, 1978
Veterans Administration	Final	–*Federal Register,* Aug. 22, 1978
Water Resources Council	[5]	
NEPA Procedures	Council of Members Approval–Nov. 13, 1979	
Title I–Principles and Standards	Council of Members Approval—Nov. 13, 1979	
–Floodplain Management Guidelines	Final	–*Federal Register,* Feb. 10, 1978
Title II	Informal Draft	
Title III	Internal Memo	–October 1977

[1]Date agency committed itself to publish proposed or final rules in *Federal Register* according to its May 30 Progress Report.
[2]A DOT Memorandum of October 1, 1979 points out that these subagency units have adopted the DOT-wide directive as their own.
[3]The Office of Solid Waste Management will be reflecting the Order's requirements in the three sets of referenced procedures.
[4]In their May 30, 1979 progress reports, these agencies stated either that Executive Order 11988 does not apply to their activities, or that by the nature of the activities they carry out, any effort that they might make to implement the Order would not achieve its intents. The National Credit Union Administration, however, noted that it is continuing its review of the applicability of the Order.
[5]The Water Resources Council is reflecting the Order's requirements in the referenced procedures.

Alternatives to Land Acquisition

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In the past one of the most popular ways to protect a natural, cultural, or recreational resource was to have the federal government buy it, manage it, and maintain it. Early this year the General Accounting Office (GAO) released a report entitled "The Federal Drive to Acquire Private Lands Should be Reassessed." GAO's image of a federal "drive" and criticism of the agencies' land acquisition programs are somewhat exaggerated. For example, during the 15 years that the Land and Water Conservation Fund has been a major source of revenue for federal land acquisition in parks, wildlife refuges, and recreation areas, some 2.6 million acres (1 million ha) have been purchased—only about one-tenth of one percent of the nation's land. Nevertheless, the GAO report has become one of several factors stimulating a useful debate about the federal land acquisition program and encouraging more attention to other means of protecting natural resources.

Of course federal land policies have always been a controversial issue. For the first century of our national history, federal land policies consisted on the one hand of acquiring through purchase and treaty land to expand the western frontier, while on the other hand providing for the wholesale disposal of that land. After being acquired, much of the public domain was given away as bounties to former soldiers, grants to the railroads, and grants to states to support public education, or sold cheaply to encourage private farming, and facilitate exploitation of timber, water, and mineral resources.

As the conservation movement was beginning, Congress also saw fit to set aside large portions of the public domain for preservation purposes under continued federal stewardship. Starting in 1872 with Yellowstone National Park, and growing with the National Forest Reserve Act, the Antiquities Act, and other mandates, national systems of parks, forests, and wildlife refuges were created, primarily through withdrawals from the public domain.

The early land disposition policies were a great success and much productive property was transferred into private hands. Lands most suitable for agriculture, industry, and development were taken first and the Federal Government was frequently left holding the lands no one else wanted—at the time. Only in recent years has Congress had to authorize the purchase of private lands for conservation and recreation purposes. From modest beginnings, the federal land acquisition program has grown to multi-million dollar proportions.

The Land and Water Conservation Fund started in 1965 at an authorized level of $100 million with at least 40 percent available for federal purposes and the balance provided through 50:50 matching grants to the states. The fund has grown to a $900 million level of authorization for each year through 1989. However, the demands on the fund have grown even faster. There are currently about $2.8 billion of authorized claims against the fund. Assuming a 14 percent rate of land price escalation, even if Congress appropriates the full $360 million authorized for the federal side each remaining year, there will be enough money to buy less than one-half of all the claims already identified. In spite of the shortage of money, there is no shortage of additional areas deserving protection—or the willingness of Congress to pass bills establishing new acquisition projects.

But money is not the *only* obstacle to the federal land acquisition program. State and local governments frequently oppose federal purchases which remove land from the tax rolls and economic base. Landowners frequently don't want to sell and are becoming well organized. Although the "Sagebrush Rebellion" is focused on state control over current Bureau of Land Management (BLM) lands, it is another sign of the growing opposition to the federal land managing presence.

These financial constraints and political realities require that we fully explore new alternatives to federal land acquisition and improve the procedures for determining how to achieve our conservation goals. In this connection, I would like to mention the National Heritage Policy Act. Although this legislation is not an alternative to land acquisition *per se*, it is a governmental approach to historic and natural area protection that encourages *many* alternatives.

In 1977 President Carter's Environmental Message called for development of a National Heritage Trust proposal to coordinate and enhance federal programs that protect natural and cultural resources. The results of a careful analysis of alternative ways of protecting the national heritage are reflected in the Act, now under consideration by Congress. It emphasizes the importance of recognizing heritage resources and developing a true partnership among federal, state and local governments and the private sector to protect the natural and cultural resources of importance to the nation as a whole. One of its main thrusts is to establish an administrative environment that encourages whatever protection tool is most appropriate in a given case. Such alternatives may include a variety of approaches, some new and some well tested, that fall into several broad categories.

Let me review some of the tools that are being used today. First, there is the educational and awareness approach, which attempts to promote public and landowner stewardship. The National Natural Landmarks Program administered by the Heritage Conservation and Recreation Service (HCRS) provides one good example of private landowners, properly encouraged and publicly recognized, voluntarily protecting their land.

Efforts to avoid federal actions which could adversely affect natural or cultural landmarks and other wildlife habitat are an obvious complement to recognition programs. For example, the National Heritage Policy Act includes a requirement that federal agencies should not take any action which would adversely affect a natural or historic landmark unless there is no "prudent and feasible alternative."

On the incentive side, grant programs can be targeted to encourage state and local activities to be consistent with conservation objectives. President Carter's 1977 Executive Orders on wetlands and floodplains are good examples of this type of approach to help assure that federal activities will be consistent with protection of many important natural areas.

Regulatory approaches are frequently the most effective and direct alternatives to federal acquisition. Air and water quality controls, exercised by the Environmental Protection Agency (EPA) directly or through the states, provide a strong means of preventing habitat destruction. Basic state and local police powers include most of the authority necessary to control the use and development of private land. Zoning, building codes, public health regulations, and other powers can be used to manage growth. There are innumerable varieties of zoning, from agricultural districts and large lots to planned unit developments, that can be applied to the protection challenges facing most areas. Soil conservation and sediment control regulations administered by state and local governments provide another useful bag of tools.

Even in those cases where the conservation purposes require a degree of resource control that can only be achieved by acquisition, it may be possible to achieve that control through only *partial* acquisition. Looking at property ownership as a "bundle of rights," it is possible to acquire only those interests in land necessary to achieve certain objectives. Development, timber, water, mineral, grazing, or other rights may be all that the public needs to own in order to secure a habitat for wildlife or protect important natural areas. These rights may be obtained by purchasing an easement that restricts the owner's activities. However, easements also may be positive, for example by establishing a public right to access. U.S. Fish and Wildlife Service experiences with wetland easements, for example, are well documented as a cost-effective approach. Another approach is to purchase land with reserved interests, such as a life tenancy for the previous owner. Land also can be purchased by the government and re-sold to private parties with restrictions in the deed, or it can be leased back.

If acquisition of fee or less than fee interest is desirable, there are many ways to go about it. Because of tax benefits available, many people can be encouraged to donate all or part of their land or to sell at bargain price. Public spirit and the tax benefits can also encourage donations of conservation easements. Land exchanges provide another way for public agencies to obtain land they want without giving up cash.

In brief, there are a tremendous number of alternatives to acquisition. The problem facing the resource planner or manager is, which one should I use? Indeed, the challenge of the years ahead is to develop and enhance "craftsmanship" in formulating land protection strategies. There is no simple formula or rule of thumb to say that easements are "better" than full fee or that regulatory approaches work when education efforts fail. Each case must be evaluated on its own merits considering five basic factors.

First of these is the character of the resource. Its rarity or fragility will often determine the degree of physical control that is needed. Its location and accessibility, and its relationship to other types of land uses also must be considered. What works well for one ecosystem, or in one land use condition, may not be appropriate in another.

Second, and perhaps of most importance, the public agency's management objectives for the resource must be clearly defined. If the objective is to protect a scenic vista, then easements may do the job. If private ownership and farming activities are part of a beautiful landscape, then zoning and acquisition of development rights may be sufficient. But if the goal is to protect a woodland habitat from urban development it may be that agricultural zoning would be self defeating, as it would only serve to transform the land from a forest into a *farm* instead of a subdivision. In other words, "open" space can be preserved at the expense of natural and wildlife values if the wrong tools are applied.

Third, a realistic analysis of landowner interests is necessary to distinguish between the speculator or developer and the owner who has a sincere attachment to the land. The line is not always easy to draw, as a farmer descended from generations on the same land can easily be persuaded to become a developer by the right offered price. Nevertheless, there are some people who have a sincere interest in staying on the land and continuing low intensity uses which may be compatible with natural and wildlife protection goals.

Fourth, market conditions play an important role in determining landowner intentions and therefore what conservation tools are appropriate. Where development pressure is intense, as evidenced by increasing land values and, especially, rising taxes, even the most dedicated conservation-minded landowners may be inclined to sell, and only the more stringent regulatory approaches can control development. Conventional wisdom suggests that some easements and tax incentives only work well up to the point at which the owner feels economically compelled to commit his land to uses that are contrary to conservation purposes or the protection of natural values. On the other hand, only where the economic pressures for development or other changes in land use are relatively weak, can recognition, educational approaches and persuasion work to achieve voluntary cooperation.

And finally, political realities are an important consideration too often overlooked or misinterpreted in selecting an appropriate resource protection technique. Many of the most appealing ways of controlling adverse impacts on natural or wildlife areas are simply not politically feasible. What seems like a reasonable exercise of federal, state, or local government powers in California or New Jersey may, in other states, generate all sorts of opposition. Zoning, which is well accepted in most metropolitan areas, still is seen as an unthinkable interference with private property ownership in some rural counties.

Sensitivity to political reality *is* important, but we cannot be too shy about proposing innovative approaches for fear of adverse reactions. Where opposition is expected to arise, it may be possible to generate the necessary popular support before a protection strategy is dropped as politically impractical. Although many alternatives to acquisition may generate political controversy, there may be even more opposition to federal or state acquisition of private land. Sometimes politically sensitive regulatory approaches may prove to be a popular substitute for direct acquisition and displacement of current owners.

The financial and practical constraints on the traditional approaches to federal land acquisition require that we take full advantage of all of these alternatives for protecting natural resources. These alternatives can be applied in protecting new areas, and can also be useful in established parks, refuges, and conservation areas to address problems posed by *adjacent* land uses and private inholdings.

While the federal land managing agencies have conducted active full fee acquisition programs, they also have a substantial amount of experience in using many alternatives. Several units of the national park, wildlife refuge, and forest systems have used various other-than-fee protection techniques. The Cape Cod National Seashore, for example, provides for continued private ownership subject to zoning regulations. Similar mixtures of public and private lands subject to controls are found at Fire Island, Pictured Rocks, and Sleeping Bear Dunes. The Sawtooth National Recreation Area and the Wild and Scenic River System have used scenic easements to protect vistas and natural qualities of the landscape. The U.S. Fish and Wildlife Service has used easements to protect more than one million acres (400,000 ha) of wetlands for waterfowl production areas throughout the country.

Other easements, leases, and agreements have been used to protect more than 600,000 additional acres (243,000 ha) in the National Wildlife Refuge System.

New York State's Adirondack Park provides another example of how public lands and private ownership can be mixed and managed within a single boundary. The "blue line" defining the boundary of the Adirondack Forest Preserve provided a beginning for new terms to describe other-than-fee protection. Since then, "greenline parks," "reserves," "preserves," and "the Cape Cod Formula" have been used to describe similar approaches. Most recently, the term "Area of National Concern" (ANC) has been used to describe these concepts and the federal initiatives in the Santa Monica Mountains, the New Jersey Pinelands, Jean Lafitte and the Mississippi River Delta, and in Lowell, Massachusetts.

The Area of National Concern concept is based on the premise that the best way to protect some resources is to build a partnership among federal, state, and local governments and the private sector. Many areas proposed for federal action contain a mixture of natural, cultural and recreational values. Private ownership and use may be an integral part of the landscape to be protected and direct federal acquisition would be either impractical or unnecessary. The ANC approach relies primarily on state and local planning and management, supported by a limited amount of federal financial and technical assistance.

The Pinelands National Reserve in New Jersey is the most complete current example of these ideas at work. The reserve includes about one million acres (404,000 ha) of relatively natural landscape in the Northeast's most industrialized state. The Pinelands offer a unique combination of fascinating plants, important wildlife habitat, valuable supplies of pure water, and a significant local economy based largely on compatible agricultural uses. After many years of discussion about how to save the Pinelands, Congress authorized the national reserve in 1978. The protection strategy calls for a comprehensive management plan to be developed by a 15-member commission, including state, local, and federal representation. The plan must be completed within 18 months and forwarded to the Secretary of the Interior for approval. While the plan is being developed the Act provides for "emergency" acquisition of lands with critical ecological values which are in immediate danger of being destroyed. Once the plan is approved, the Act authorizes grants for land acquisition by the state. However, the plan must require that state and local police powers be used to the maximum extent practicable to regulate the use of land and water resources. Only $23 million of federal money is authorized for the land acquisition in the one million acres (404,000 ha), supporting the point that state and local regulations will be the most important planning tools. Significantly, once the plan is approved, there are requirements that federal actions be consistent with it.

Since the Pinelands is the first and most complete example of the ANC approach, the going has not been easy. There has been intense political pressure over state initiatives to control encroaching land development fueled by growth around Atlantic City. Establishing a planning program and building a cooperative arrangement among federal, state and local agencies has not been easy within the time constraints set by law. Nevertheless, a remarkable amount of progress is being made and there is a very good chance that the program will be successful.

In the Santa Monica Mountains, Jean Lafitte/Mississippi River Delta area, and

Lowell, Massachusetts, there is a more direct federal role in acquiring land in a central area, with state and local planning and regulatory powers to be used in a buffer zone or on private inholding areas. These three additions to the National Park System do not go as far as Pinelands in relying primarily on state and local powers, but they do embody the ANC concept which is likely to receive even more attention in the future.

In the past, each agency has followed its own policies and procedures in planning for new national areas and determining what protection techniques will be used. During the past few months three important steps have been taken to improve the new area study process and help assure that agencies using the Land and Water Conservation Fund consider a full range of alternatives to fee-simple acquisition. First, a Memorandum of Understanding has been adopted by the Directors of Bureau of Land Management, Fish and Wildlife Service, Heritage Conservation and Recreation Service, National Park Service, and the Chief of the Forest Service outlining the responsibilities of the Land and Water Conservation Fund Policy Group. The Land Policy Group recommends how the federal side of the fund is to be allocated each year and coordinates the studies of potential new areas. The group is composed of the agency directors and is chaired by the Deputy Assistant Secretary for Fish and Wildlife and Parks.

Second, the Land Policy Group has adopted a new planning and decision-making process for studies of potential new national areas or major expansions in existing areas which might draw on the fund. This planning process incorporates many of the ideals of the heritage bill with an emphasis on systematic inventories to identify the most outstanding resources. The Land Policy Group will coordinate initial reconnaissance surveys of individual sites, and for areas which really do merit attention, more detailed studies of protection and management alternatives will be conducted. The new planning process will help avoid duplication in study efforts, encourage full consideration of alternatives, provide more consistent approaches to protection, and afford greater opportunities for state, local, and private participation.

Third, the Land Policy Group has adopted a policy statement to provide general guidance on new area studies and recommendations. The policy emphasizes identifying important resources and assuring their protection through means other than direct federal acquisition. Developing a single policy for four land managing agencies with diverse missions is a formidable task. Nevertheless, this new policy statement provides a significant step in improving the federal approach to protecting our natural, cultural, and recreational resources under the Land and Water Conservation Fund program.

I think it is fair to say that both in theory and in practice the federal land managing agencies have already responded to the points raised by the GAO report and others who have questioned land acquisition programs.

HCRS is committed to finding better ways of meeting the conservation challenges that lie ahead. In some cases outright acquisition may be the only way to protect an area, but in many of the areas now under study there are some real opportunities to use other protection methods. HCRS will be working with the land managing agencies, state and local governments, and the private sector to find out what alternatives to acquisition really work and we will encourage their use where appropriate. We look forward to working with many of you who have had experience with these techniques, and to exploring your ideas on how to find even better ways to protect our national heritage.

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Progress and Problems in Implementing the Fishery Conservation and Management Act of 1976

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The Fishery Conservation and Management Act of 1976 (FCMA) went into effect on 1 March 1977 (U.S. Congress, House 1976). At the outset FCMA was generally misunderstood by the fishing industry, many of whom assumed that it would outlaw all foreign fishing off our shores, and that Americans would then be free to harvest the resources out to 200 miles (320 km) from the coast without restraints. This became abundantly clear at public hearings, which the fishery management councils were required to hold prior to approving fishery management plans (FMPs). It has dawned slowly upon industry and recreational fisherman that neither assumption is true. The Act requires that when the total allowable catch (TAC) of a species or group of species is clearly greater than American fishermen can harvest, the excess must be allocated to foreigners, and that this foreign fishery will continue as long as this remains true. As for domestic fishermen, it should be obvious that they must be regulated equally strictly if the Act is to remain viable. Yet, by and large, domestic fishermen have failed to grasp this important point, or are unwilling to recognize it. Indeed, domestic fishermen generally have been relatively free of controls up to now, as the decline of our inshore fisheries makes quite clear. Thus, it is not surprising that it was perceived that this policy (or rather lack of it) would continue.

It came as somewhat of a shock to domestic fishermen that foreign fishing was to continue, although at a somewhat lower level than in the past. It was even more of a shock to many to learn that from now on American fishing would be subject to much more regulation than before.

Contribution 278 from the Marine Sciences Research Center.

Plans Presently in Effect

In the Middle Atlantic region it is significant that a domestic resource was selected for the first management plan. This was the sea clam plan, which places limits on surf clam and ocean quahog harvests (McHugh 1977, Mid-Atlantic Fishery Management Council [MAFMC] 1979). This plan is unique in several ways. The resource has never been subject to foreign fishing, and never will be, because both are species of the continental shelf (FCMA, preamble Sec. 3(4)). There is no recreational fishery (other than for bait) to complicate the management plan. Therefore the resources can be managed by controls on the domestic commercial fishery alone. The surf clam was in dire need of management, for it had been overharvested for some time. In fact, this was the principal problem, for there were already considerably more boats in the fishery than were needed to take the allowable catch, which made management difficult. The plan froze the numbers of vessels at their present level, but the excessive number of boats, and their capability to increase efficiency of effort in a number of ways, including increasing the number of dredges hauled per vessel, and lengthening the blade of the dredge, required also that the catch be limited. Quotas were placed on the catch that could be taken in any one quarter, and the fishery finally was limited to one day per week. This is hardly an ideal plan from the fisherman's point of view, but it was necessary to spread the allowable harvest over the entire year. The same constraints are not placed on the ocean quahog fishery, which still can go on seven days a week, and is not limited in number of boats or number or size of gear. This may be a bad decision because the ocean quahog may be very long lived, and consequently may support a relatively small maximum sustainable yield. If 36.8 percent of the population lives to 100 years the MSY may be as low as 6.7 million pounds (3.0 million kg). If less than 0.1 percent lives to 100 years the sustainable yield may be as low as 66.6 million pounds (30.2 million kg) (MAFMC 1979). The present quota is 40 million pounds (18.1 million kg), and this may well be exceeded in 1979 or 1980, which may not bode well for the economic welfare of the industry. It would have been prudent to at least freeze the number of boats allowed in this fishery also, especially since the age of ocean quahogs needs to be clarified and confirmed and therefore the allowable catch is uncertain.

Enforcement

Sea Clam Controls

In 1979 the General Accounting Office of the Comptroller General's office issued a report which reached a major conclusion that enforcement problems hinder effective implementation of the new fishery management activities (Comptroller General of the United States 1979). They concluded that surf clam regulations require extensive enforcement resources, which are not now available. They also concluded that regulations have been changed frequently and thus are confusing to fishermen and enforcement personnel. Moreover, effective enforcement cannot be achieved without uniform regulations which apply to the territorial sea and the fishery conservation zone. Enforcement efforts have been hampered by inadequate coordination between the National Marine Fisheries Service (NMFS) and Coast Guard, within NMFS, and by inadequate training of Coast Guard people. The existing penalty system has been untimely and thus has not been a deterrent to illegal fishing. NMFS failure to assess appropriate penalties, and its limited success in collecting them, has inhibited enforcement efforts and encouraged fishermen to ignore regulations, and when appreciable numbers ignore regulations, it is not surprising that law-abiding fishermen are tempted to do so also.

Recommendations of the study were primarily that the agencies change to dockside enforcement rather than enforcement at sea wherever possible. In addition it was recommended that the practicability and feasibility of enforcement strategies be considered in the approval process, and that states be encouraged to regulate fishing in territorial waters or that the Federal Government take preemptive action whenever their failure to do so prevents implementation of federal FMPs. NMFS was advised to develop specific enforcement goals, devise strategies to achieve them, and identify the resources necessary to carry them out; and to ensure that stiffer penalties are imposed and collection action is pursued vigorously.

These recommendations were based upon the following observations. It is generally believed that up to 65 percent of clam fishermen are fishing several hours before and after the authorized fishing periods. Enforcement agents must actually observe the vessel fishing at unspecified times, but this has not been possible because vessels or aircraft are not available on short notice. Violations often occur at night when enforcement at best is difficult. In one case, enforcement agents on a helicopter observed a vessel with gear over the side after its authorized time to fish. The vessel had not been boarded and NMFS could not refute the captain's claim that equipment had broken down, thus could not prosecute. Coast Guard also has other important duties which take precedence over fishery matters.

Groundfish Regulations

New York and New Jersey fishermen have even greater trouble with groundfish regulations. Cod, haddock, and yellowtail flounder have been seriously overfished by foreign and domestic fishermen, and drastic measures are now necessary to rehabilitate them. No foreign fishing is allowed, and domestic catches are strictly limited by quota (New England Fishery Management Council 1979a). In the Mid-Atlantic region the quotas have been particularly severe because the fishery usually does not begin until about the middle of the last quarter, in November, and the fishery usually has been closed before the end of December. It opens again in January, but may close before the end of March, at a time when prices are high for Easter. After March the fishery drops off. In addition to these early closures there is a good deal of lawbreaking in New England, such as exceeding quotas, discarding undersized fishes, and reporting catches from incorrect areas. Measures to correct them are often not reported to the Mid-Atlantic region in timely fashion, and some work a great hardship on some fishermen. This affects fishing in the Mid-Atlantic area at a time when other species are absent, consequently affects local fishermen severely. These difficulties have not been completely alleviated.

Another even more difficult problem is that the numbers of vessels have increased, lured by the promise of larger catches as foreign fishing phases out. Some local fishermen also have upgraded their vessels, and consequently have large unpaid loans. Even though cod and haddock have increased in abundance recently, through the appearance of stronger than usual year classes, this has not brought the individual fisherman greater profits. Thus, there has been no perceived benefit from FCMA, and some fishermen are saying that they were better off under the old regime. It is clear that the solutions are not easy.

Enforcement Summary

The Mid-Atlantic Council is saying at present that unless enforcement is improved and penalties made meaningful there is little point in trying to manage at all. Management presently is not working in the surf clam industry and New England's groundfish plan is neither working well nor giving equitable treatment to Middle Atlantic fishermen. In fact, the present groundfish plan is so deficient that the New England Fishery Management Council (1979b) is considering a completely new approach, that would manage by means of mesh size and area closure regulations, thus eliminating quotas as such, and other constraints.

Problems That Have Not Been Addressed

These are some of the problems that have been addressed, and obviously still require more effort before they are reasonably adequate. Other problems, perhaps even more difficult, have not yet been seriously addressed at all. Perhaps the most difficult of all is what to do about recreational fishing. Some species, in the Mid-Atlantic region especially species like bluefish, Atlantic mackerel, summer flounder or fluke, weakfish, striped bass, winter flounder or blackback flounder, and scup, to name only a few, are major recreational species. If we are to believe the figures, all are more important recreationally than commercially. This means that before management plans go into effect on these species, some fair way of limiting the sport fisheries also must be devised. In my view, it will not be acceptable to do this by the present method, which in effect is to calculate the total sustainable yield, subtract from it the estimated sport catch (which may be larger than actual), then from the remainder subtract the estimated commercial catch (which may be smaller than actual), and if any is left allocate it to foreigners. What if the estimated sport catch equals the TAC or exceeds it? Do we immediately declare it a game fish, and prohibit commercial fishing? At best this could be done only for species that remain within three miles (4.8 km) of the coast and so are under state jurisdiction. In the Federal Conservation Zone (FCZ) this alternative is not available under the terms of the Act, because it requires that the needs of consumers be considered, and that allocation be carried out in such a manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges (Sec. 301(a)(4)).

If by using this method, which for want of better information may be the only one possible at present, we find that there is still enough for the domestic commercial fishery, but only enough, then what happens if the recreational fishery continues to grow? Do we limit the commercial fishery in favor of the recreational fishery, or do we arrive at some equitable method of allocating the catch among the two? This appears to be the only fair way of doing it, but at present we do not have enough information to decide what is equitable. If there is also a foreign fishery, or a desire to have one, and a surplus is believed to be available, what is to prevent a foreign country from questioning the allocation to recreational fishermen on the grounds that it is too large? And how would we handle that? Or what is to prevent a domestic commercial fisherman from doing the same thing, and how would we handle that? Some very difficult questions appear to arise, which cannot be answered to any degree of precision. No council, to my knowledge, has ever discussed these points in any detail, and they are in a very poor position to answer them.

Progress in Reaching Objectives

The principal task of the councils is to develop management plans that will be accepted by the Secretary of Commerce and put into effect. In this respect progress has not been rapid. As of August 1979 only the sea clam plan was operating in the Mid-Atlantic Council, and despite fairly constant tinkering, not operating well. Perhaps the only way to find whether it has been operating well is to await the test of time. However, if enforcement and penalties are inadequate, this may be pointless. Another way is to add to the enforcement staff and to provide enough facilities to do the job, and see to it that action in the courts is rapid and responsive.

A second responsibility is to be able to act more quickly on approval of plans that are complete. One reason why only one plan was in effect until quite recently, has been the slow reaction of the Secretary of Commerce and his staff. Steps to speed up this process are already being taken, and we will have to see what effects these have.

A third, and much more difficult task will be to provide much better information on recreational fisheries. This is more important with respect to the Mid-Atlantic Council than any other. Whereas, around the coasts of the United States as a whole, the sport catch about equals the commercial catch of food fishes (McHugh 1977), in the Mid-Atlantic region it is about three times the commercial catch of food fishes, and in New York about six times, if present estimates are to be believed. Thus, for many of the species that are harvested in quantity by commercial and recreational fishermen, it is pointless to attempt to manage only the commercial fishery, without managing the recreational fishery also. Unfortunately, for no sport fishery do we have adequate knowledge. To give the sport fisheries priority in setting quotas is neither equitable nor consistent with the Act, yet it is about the only way we can set quotas at all under the circumstances. This cannot continue, because recreational fisheries are apt to continue growing, hence will gradually reduce the commercial quotas. This is not equitable to the consumer, who will have to content himself more and more with species of lesser interest to sport fishermen. Thus, it appears that the only alternative will be to gather much more complete and accurate statistics from recreational fishermen. No one appears to have calculated how much that will cost, but it certainly will be much more than the government now spends, and may be beyond reason.

What Alternatives Are Available?

It is fairly obvious that, in view of the existence of FCMA, the first alternative is to determine what is necessary to do the job properly, and then act to set the mechanism in motion as soon as possible. This will require determining what is needed to bring surf clam enforcement up to adequate performance, and studying the groundfish plan to see if it is equitable, and further adjusting the plan to avoid evasion. These should be possible in time, and the question that remains is whether NMFS and the Coast Guard can provide the necessary men and equipment. These may become more difficult as more management plans are put into effect, and the problems must be worked out with these other plans in mind.

The most difficult problem will be to decide how to put adequate sport fishing controls into effect at reasonable cost. The first task, before anything else, will be to determine how to get the basic information. This will require the enthusiastic support of the states, if it is to work. There will be no workable FMPs for bluefish, Atlantic mackerel, summer flounder, weakfish, striped bass, winter flounder, scup, and others in the Mid-Atlantic region until this is done. It may be that better statistics on commercial fisheries are needed also, if for nothing else than to be sure that they are reported fully in the commercial fisherman's interest. Once accurate landings records are available, then reasonable decisions can be made on the balance between commercial and recreational fishing, and if both need to be controlled, what is an equitable division?

Once that is done, then the more difficult job arises, how can recreational fishing be controlled, if control is necessary? About the only reasonable way will be to set quotas per fisherman, including individual quotas on particular species, adjusting these quotas as the number of fishermen increases. This is the system that appears to be working in California. The real problem will be the costs of enforcement at acceptable levels, recognizing and allowing for the fact that no enforcement is perfect. This will probably be costly, perhaps too costly at acceptable levels of performance to be acceptable. If that turns out to be true, what alternatives are there?

The other extreme is a laissez-faire system, based on the philosophy that the ideal system is too costly, and that at any rate no one will fish out a resource entirely. This system, a little reflection will show, will not work either. With no controls on anadromous species, it is obvious that what stocks remain probably would disappear completely in a relatively short time. Furthermore, public health must be considered. It would be too dangerous to allow anadromous species no protection at all. The same holds true for nonmotile or limited motility species of estuaries and coastal waters, like oysters, clams, some crabs, and species of limited mobility like sea bass and others. These are not insignificant in national landings, and in the Mid-Atlantic region in 1975 they produced 134.2 million pounds (60.9 million kg) worth $60.8 million (Pileggi and Thompson 1978). This was only 19.2 percent of the total weight landed, but 57.5 percent of the total landed value. There is no question that these could produce considerably more if properly protected, and protection might not be too costly, especially since they must be monitored anyway for public health reasons.

For this reason, it might be much better to concentrate on managing inshore species, which should be easier and less costly to manage, and offer a greater return. Let us suppose, just for the sake of argument, that a safe harvest of inshore resources would be equal to half the maximum, provided that these resources were managed. The value of this resource at today's prices would be at least $100 million at a conservative estimate, or about twice the value of present landings.

This does not include the additional values of recreational fisheries. This would appear to be a reasonable first objective. It would benefit commercial and recreational fishermen, would be feasible, and probably would not cost very much more than is now being spent.

This would leave the ocean and migratory resources unmanaged. What would be the probable result? In the near term, domestic fishermen probably would gain, because the foreign catches will be reduced. Most fishermen probably would be happy, because they would be free to fish where and when they wanted. If the fleet does not grow substantially, they probably will not damage the resources too much in the short run, and the Council can watch carefully and put constraints on if the species is too much affected. This will also allow time to get the basic statistics that are needed, and to think about how best to manage the sport fisheries. Neither commercial nor recreational fishermen will be likely to fish a species to extinction, and the overall mixture of fishes, for the most part, will wax and wane with time.

The only trouble with that solution is that as long as the Act in its present form remains, laissez-faire managemnt with respect to oceanic and migratory resources is not possible. They must be managed according to the national standards established under Sec. 301(a), which include, but are not restricted to "prevent(ing) overfishing while achieving; on a continuing basis, the optimum yield from each fishery." In that case, considering the task of the Mid-Atlantic Council, the efforts of the Council should be to see first that the sea clam plan is working adequately. If it is not, then there is little point in pushing to complete other management plans, which will be considerably more difficult to control. Meanwhile the staff can go on preparing FMPs for other species, but should not be too precipitate in getting them approved and put into action.

The task is most frustrating. The Council has done about all that is possible, and it is necessary for others to act. The Council has been pushing for a series of seminars under the auspices of the Justice Department to educate United States attorneys on the importance of effective prosecution of violators. It has also urged the Department of Commerce to reduce to a minimum, consistent with due process, the time required to impose appropriate penalties and remedies; to establish criteria for penalties and remedies that permit such assessments to be effective deterrents; and other appropriate actions. Until action is taken on these recommendations, there appears to be little else the Council can do. Most of the other management plans depend to a large degree upon solution of the sea clam problem. They also depend upon a much closer relation, and enthusiastic cooperation, between the states and the federal establishment. These matters require more attention by the Councils than they appear to have been given in the past.

Conclusions

It appears that the Mid-Atlantic and New England Councils should proceed slowly with additional management plans, doing everything possible to see that sea clam and groundfish plans are working well before others are implemented. This will require further action by NMFS and Coast Guard, as well as closer and more rapid collaboration by the states.

Meanwhile Council staffs can proceed with developing plans for other species and having them approved by the Secretary of Commerce. These plans should then be held in abeyance until more effective enforcement measures are in effect.

Meanwhile the Councils, with the help of the Atlantic States Marine Fisheries Commission, should be considering the need for better handling of anadromous and coastal resources, with major help from the states. It may be that the Councils can act only as coordinators in this respect, for they have no authority over fisheries in the territorial sea and inland waters. In addition they have a very important role in improving the gathering of knowledge about the recreational fisheries and in developing plans for enforcement. Here the Councils have a great stake in the future of recreational fisheries, but only partial responsibility for enforcement. Regulations must be consistent with state regulations, however, and this will require close cooperation with the states. Most of the forthcoming plans will not be workable unless this problem is solved.

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Coastal Zone Studies: A Holistic Approach

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Introduction

As demands upon the coastal zone increase there is concomitant increase in the number of resource conflicts requiring resolution. For management strategies to be responsive to these complex problems, a comprehensive and holistic approach is required. The supportive framework is the information base, which serves as an integrated overview of the ecology of a region. This overview identifies and delineates the important biological and physical components of ecosystems, the interrelationships of these components, including functional aspects of ecosystems and potential responses to natural and man-induced changes.

Ideally this overview should incorporate and identify the status of scientific information from a broad range of sources, because decision makers need to be cognizant of studies in progress and those that are completed, and should have access to both published and unpublished ecological information. Descriptions of certain socioeconomic features and processes are important as an aid to predicting impacts from man-induced modifications of the environment.

In response to this need for an integrated overview, the U.S. Fish and Wildlife Service's Coastal Ecosystems Project within the Biological Services Program started a series of studies in 1976 called "coastal ecological characterizations." These studies compile existing available information utilizing a holistic approach that identifies functional relationships among natural processes and components of coastal ecosystems. An ecological characterization study is designed primarily to integrate environmental and socioeconomic information in a form useful for planning, impact assessment, and analysis, and to identify research needs. A characterization study is a tool that will enable decision makers to address problems including planning for urban and industrial developments, determining corridors for pipelines, siting of onshore and offshore facilities for Outer Continental Shelf (OCS) oil and gas activities, and determining priorities for future research.

The products from a characterization study are an ecological atlas, ecosystem models, a narrative report, and an information base or data source appendix. The atlas is a series of maps and diagrams that depict biological resources, including habitats; factors of potential impact, including land-use practices, socioeconomic activities, environmental perturbations; and ecological processes within the study area. The ecosystem models delineate structural components, functional processes and their integral relationships with physical-chemical processes characteristic of the region. The narrative report contains descriptions of the study area, emphasizing natural and socioeconomic interrelationships, major uses of natural resources, and changes resulting from human activities. The information base or data source appendix includes a record of all references, copies of reprints and unpublished information and data acquired, with a report on the location and a description of unpublished data not acquired.

The primary users of the products of these studies will be planners and natural resource managers of the U.S. Fish and Wildlife Service (FWS), Environmental Protection Agency (EPA), Bureau of Land Management (BLM), and other federal, state, and local agencies as well as the general public.

Between 1976 and 1979 the Coastal Ecosystems Project had seven studies completed or in progress that characterize specific coastal areas of the United States (Figure 1). The areas studied are the Chenier Plain of southwestern Louisiana and southeastern Texas (completed in 1979), the sea island region of South Carolina and Georgia, the rocky coast of Maine, the coast of the Pacific northwest, the Mississippi deltaic plain region, the Texas barrier islands region, and the northern and central California coast. Studies scheduled for completion in 1980 are the sea islands, Maine, and the Pacific Northwest. The Mississippi deltaic plain, Texas barrier islands, and northern and central California studies are scheduled to be completed in 1981, although various products from these studies will be available in 1980. Characterization studies for the northeastern Gulf of Mexico (Alabama and panhandle of Florida) and southwestern Florida are scheduled to begin in 1980. The locations of completed, ongoing, and proposed coastal ecological characterization study areas are indicated in Figure 1.

Characterization study areas are selected on the basis of their diversity, geographic distribution, high fish and wildlife value, and their proximity to actual or proposed major developmental activities. These criteria will also be used for selecting future coastal areas for characterization studies. Funds for the nine completed and ongoing studies were provided by EPA, BLM, and FWS.

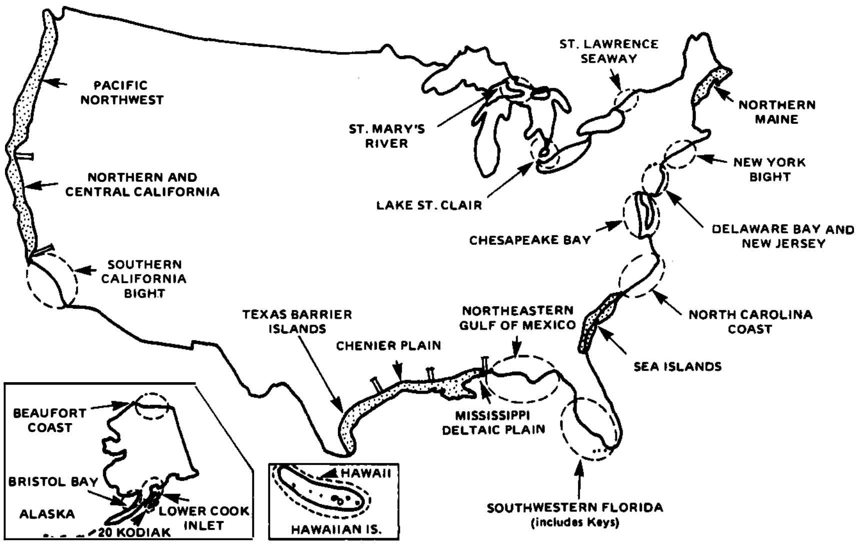

Figure 1. Location of coastal ecological characterization studies. (Dotted area indicates studies completed or ongoing in 1979; dashed line indicates proposed or high priority study areas for 1980 and beyond.

Products

The range of products varies depending on user needs, available information, funding level, size of area, and time available to complete the study. The development of characterization products follows a hierarchical approach, designed in accordance with the conceptual ecosystem models and information needs of users during the data collection and analysis. Figure 2 illustrates the data collection and analysis process and production of the ecological atlas, ecosystem models, narrative report, and data source appendix of a characterization study. Approximately 18 to 36 months are required to complete any one of these products.

Ecological Atlas

The ecological atlas consists of maps and diagrams with supporting narrative and tabular data that depict biological resources, coastal processes, socioeconomic activities, coastal studies locations, physical features, and hydrological information. Map scales vary from 1:24,000 to 1:1,000,000, depending upon the topic portrayed.

The mapping of biological resources has included oyster and clam beds, fish spawning and nursery areas, submerged vegetation, nesting and high density areas for birds and sea turtles, waterfowl and furbearer high density areas, artificial reefs, critical habitats for endangered and threatened species, natural or artificial fishing reefs, and habitat maps. For some study areas, habitats (wetland and upland) are portrayed at a scale of 1:24,000 for both past (1950s) and present distribution. Results of these efforts show that the areal extent of natural habitats is being preempted by man-related habitats. The loss of natural marsh is a major habitat change. For example, a 20 percent loss of natural marsh in the Chenier Plain over 22 years was calculated in a recently completed characterization study (Gosselink et al. 1979).

Physical features that have been mapped are shoreline changes, high and low wave energies, and inundations by major hurricanes and storms. Boundaries of fresh and nonfresh marshes in the 1950s, 1960s, and present, and water control structures including dams, locks, and weirs have also been mapped.

Socioeconomic features that have been portrayed include conservation, preservation, and recreation areas; point source discharges; energy developments, such as oil and gas infrastructure including pipelines; mineral resources; dredge spoil disposal sites; and historical and archaeological sites.

In addition, the characterization atlases contain maps that show significant historical and current coastal studies sites, geological features, spoil areas, active dunes, currents, seasonal wind patterns, and estuarine circulation patterns.

Ecosystem Models

The conceptual ecosystem models are a series of graphic (energese and pictorial) and narrative representations of the study area. The representations define and delineate physical processes, biological resources, socioeconomic features, the functional relationships among these factors, and the forces that influence them. A flow model summarizing primary and secondary effects of cultural modifications on the hydrologic regime of the Chenier Plain Region is shown in Figure 3.

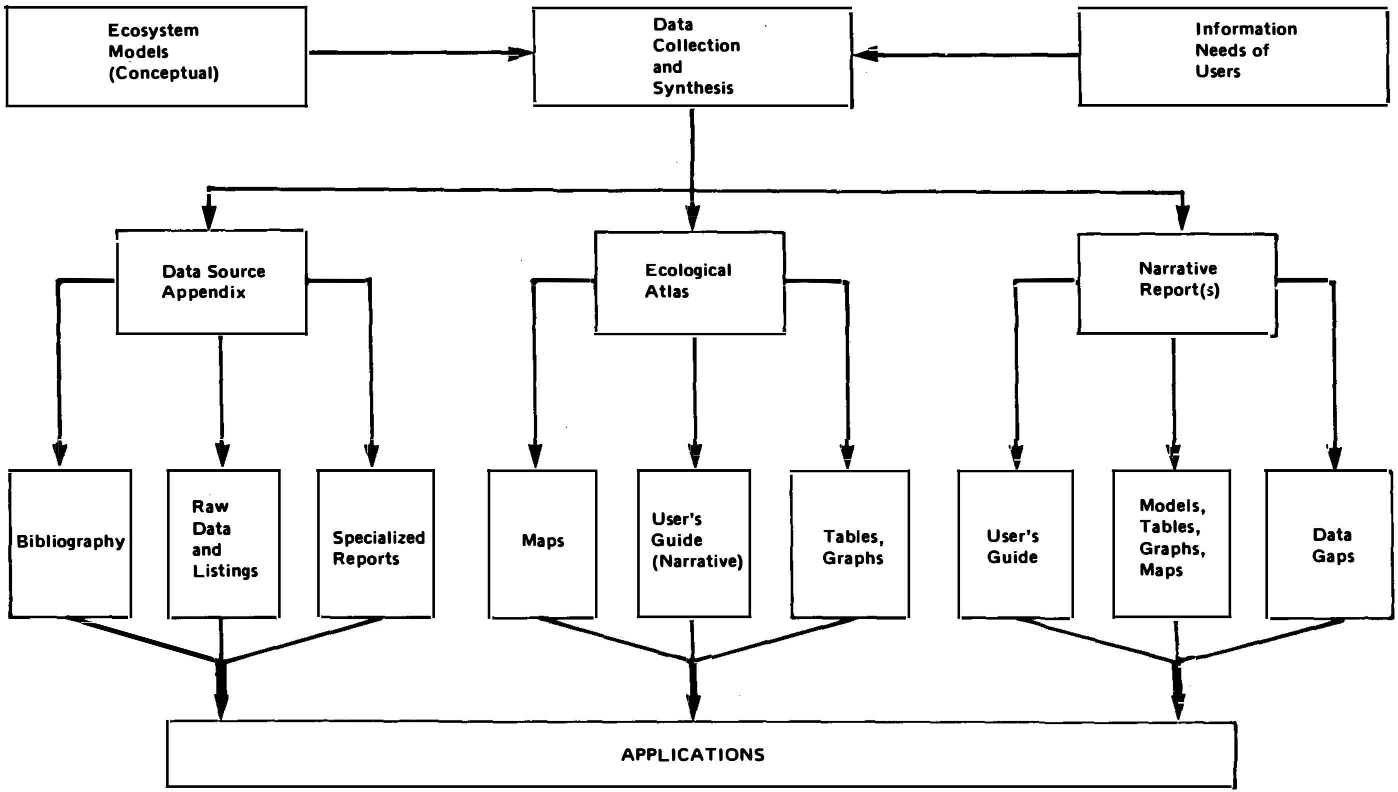

Figure 2. Simplified diagram of data collection and analysis process for a characterization study.

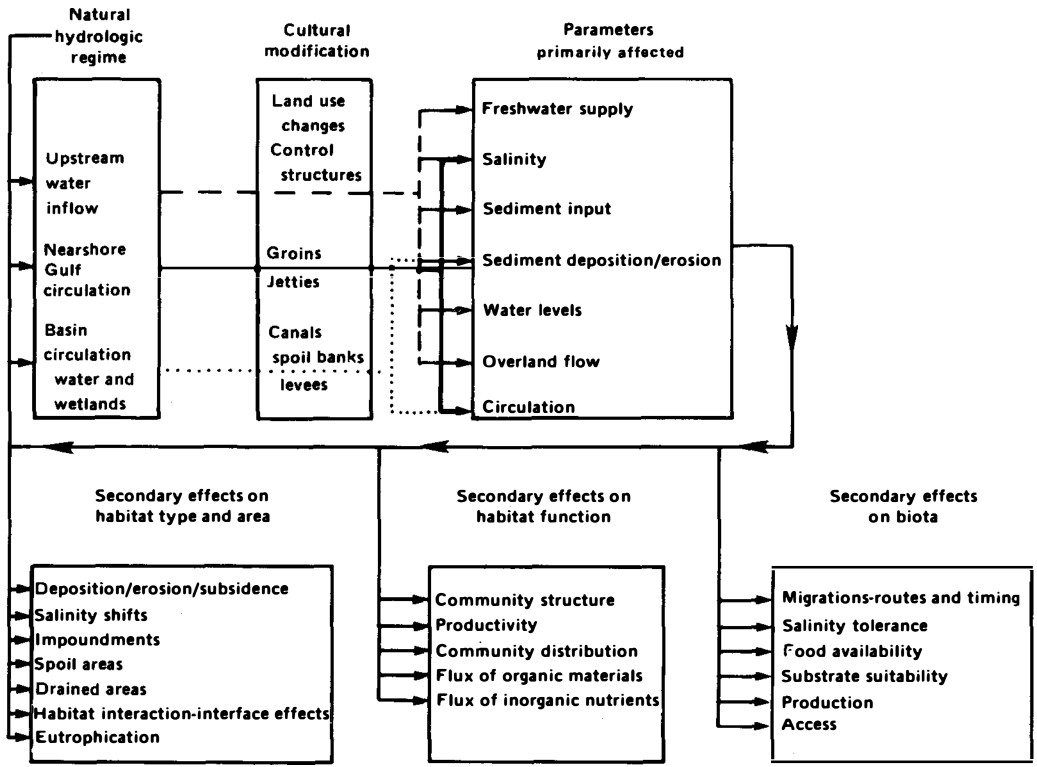

Figure 3. Flow model summarizing primary and secondary effects of cultural modifications on the hydrologic regime of the Chenier Plain (Gosselink et al. 1979).

The ecosystem models serve as tools for the organization and preparation of the narrative report. The following procedures are common to both model construction and narrative preparation: (1) collecting, organizing, and interpreting existing information about ecosystems within the study area; (2) describing terms, concepts, and the holistic approach of the study; and (3) evaluating environmental changes resulting from human activities, management strategies, and their implications for components of the study area.

Narrative Report

The narrative report complements the ecosystem models by more fully explaining cause and effect relationships of human activities, natural changes, and controlling influences upon the study area. The narrative report is organized into five major descriptive sections: the regional environment, subsystems, habitats, populations and species, and identification of data gaps.

The description of the regional environment provides an overview of the important physical-chemical, biological, and socioeconomic features, processes, and interactions that occur in the study area. This section also discusses the relationship of the study area to adjacent regions and describes trends that are occurring within the various systems.

Subsystems are defined as watershed units, drainage basins, hydrologic units, and estuarine systems, or a combination of these, that occur in the study area. Descriptions of subsystems include, as appropriate: areal extent, topography, soils, bathymetry, sediments, oceanography, climate, hydrology (including freshwater inflows), habitat (vegetative) types, energy inputs and balances, subsystem linkages, habitat changes related to specific socioeconomic activities, areas of ecological concern, and species of concern (i.e., species of ecological, sport, economic, subsistence, or endangered and threatened significance), and socioeconomic activities. Processes and interactions within the subsystem level are also discussed.

The aquatic, wetland, and upland habitat and community descriptions include: areal extent by study area and subsystem, physical characteristics (hydrology, sediments, soil), chemical characteristics (pH, nutrients, salinity), physical-chemical-biological interactions or processes affecting productivity, natural succession, trophic relationships, species of concern, seasonal use, and functional roles.

Selected populations or species of animals and plants occurring in the study area are discussed. The descriptions include information concerning seasonal use of and ecological role in habitats, seasonal and historical trends in abundance, feeding ecology and trophic relationships, breeding biology, limiting factors, economic value, efforts and success at management (state and federal), status of human use, and vulnerability to disruptive influences. Species lists are also compiled by subsystem and habitat.

The last section of the narrative report describes important ecological data deficiencies. For these data gaps, methods for additional data acquisition are suggested as well as recommendations for future research. This section also identifies inaccessible data and the effects of the data gaps on the development of the characterization study.

Data Source Appendix

The data source appendix for most studies is composed of the following:

1. A computerized storage and retrieval system of all reference material used in the characterization study;
2. An annotated list of high-interest species and their habitats;
3. Raw data such as water quality, habitat measurements, and economic statistics; and
4. A list of pertinent data sources that includes location, type of data, and statement of accessibility for each source.

Applications

While only one of the characterization studies, "An Ecological Characterization Study of the Chenier Plain Coastal Ecosystem of Louisiana and Texas," is presently completed and in the hands of the users, actual and expected applications of this body of information have already become apparent. In the case of several studies which are not yet complete, draft products have been made available to potential users for examination and evaluation.

Major application areas for which the characterization materials were developed include: coastal zone management planning, environmental evaluation of energy-related developments, and assessment of environmental impacts that result in habitat change.

In Louisiana, the Department of Transportation and Development (DOTD) is responsible for coastal zone management (CZM) planning and for administration of federal CZM programs. The separate parish governments are authorized to develop their own coastal programs with DOTD assistance, subject to DOTD approval. The Mississippi deltaic plain region characterization study, as well as the Chenier Plain study, have both provided a sound information base for both state and parish needs. Additional examples of the use of characterizations for state and local coastal zone planning include the use of the sea islands study as a primary source in developing the biological sections of the recently approved CZM program in South Carolina. The Maine study has been used by the State Planning Office in report preparation and in the clarification and reinterpretation of the definitions of wetland and habitat categories. In addition, the Maine Department of Marine Resources is directing its research efforts to fill gaps in information identified by the characterization study.

When a planning body is confronted by the need for a natural resource inventory as the foundation for management planning, the characterization studies prove useful on many levels by providing descriptions of species inhabiting an area, their life histories, their dependence upon particular habitat types, and the locations and extent of such habitats. The National Audubon Society found the Chenier Plain products to be a useful summary of the area's ecology and available information for use in the design of a detailed ecological study of the Rainey Wildlife Sanctuary near Abbeville, Louisiana.

Characterization studies are designed to be particularly applicable to data needs for projects related to energy development. In 1953, with passage of the Outer Continental Shelf Lands Act, the Secretary of the Interior was charged with the responsibility for administering OCS oil and gas exploration and development.

The BLM was subsequently designated as the administrative agency for the leasing of submerged federal lands for mineral development. In the leasing process, assessment of possible impacts on human, marine, and coastal environments must be consistent with the National Environmental Policy Act (NEPA) of 1969 which requires a systematic, interdisciplinary approach to impact assessment. In order that the Environmental Impact Statement (EIS) include only relevant supportive information, the NEPA regulations of 1979 require that detailed descriptions of the environment only be referenced. As a result of these responsibilities, BLM has provided funding for several characterization efforts that are expected to provide a data base to be referenced in EIS's and also provide guidance in the design of OCS environmental studies.

The characterization data bases will aid in oil spill contingency planning and damage assessments, in review of permit applications for dredging, and in siting industrial facilities. The data bases are also applicable in assessing impacts of other coastal energy development activities such as a study by the State of Louisiana Geological Survey funded by the Department of Energy to assess peat reserves and mining prospects in Lake Maurepas. Another energy-related problem for which characterization data bases are applicable is in the environmental evaluation of geopressure and geothermal development in Louisiana and Texas.

In Maine, the characterization study has been used by FWS's Division of Ecological Services (ES) in determining potential impacts of a U.S. Army Corps of Engineers tidal power project in Cobscook Bay. The Maine characterization study has also been source material for expert testimony by FWS personnel about ecosystems that would be affected by the siting of an oil refinery.

Ecological Services used the sea islands characterization in South Carolina for basic information to assess the effects of federal projects such as the widening and deepening of Georgetown Harbor, the maintenance of the Atlantic Intracoastal Waterway, and the Cooper Santee Rediversion Project. In the State of Washington, the Pacific northwest characterization has proven to be a valuable tool for Olympia ES office personnel in dealing with a U.S. Army Corps of Engineers navigation improvement project for Grays Harbor. The origin of logs passing through the harbor has been clarified using the narrative report, and questions regarding the sources and amounts of sediment entering the harbor have been addressed by using the sediment model in the Ecosystem (Conceptual) Models Section of the study. In addition, the Columbia River Basin Commission has recommended the approach of the Pacific Northwest characterization for use in the data acquisition program for the Columbia River estuary.

Other federal, state, local, and private agencies have incorporated characterization study materials in their work. The National Park Service (NPS), through its Branch of New Area-Urban Studies of the Denver Service Center, recently initiated a study in the Mississippi deltaic plain region, evaluating sites which may contain nationally significant examples of natural resources. The products of the characterization study of this region were provided in draft form and were described by community planners in the Park Service as "a comprehensive study that should serve as a critical element in any environmental decisions in the region." The NPS expects to use not only the data illustrative of man's past and present activities, but also the information on trends that are occurring within the various natural systems in the Mississippi deltaic plain region. The NPS has also used both ecological and socioeconomic information from the study to prepare testimony to support protection plans for offshore barrier islands in Mississippi and Louisiana.

Characterization data form the basis of environmental impact statements and preliminary planning studies prepared by many agencies and private contractors. A pipeline company in Illinois sent a representative to the National Coastal Ecosystems Team to examine maps from the Mississippi deltaic plain region study to obtain information needed for evaluating potential pipeline routes in the area.

Large scale maps (1:24,000) of coastal habitats in some of the characterization study areas provide an overview of each area from which generalizations can be made about areal habitat extent and changes of habitats through time. The maps facilitate analyses that relate changes of habitats to natural and man-induced perturbations. Preliminary habitat data from the Mississippi deltaic plain study show a 28 percent loss of total marsh from 1956–1978 in Hydrologic Unit IV–Barataria Basin, but only a one percent loss in Hydrologic Unit VI–Atchafalaya Basin (Figure 4). Fresh marshes were reduced in areal extent by 85 percent in Unit IV over the 22 years and increased 139 percent in Unit VI (Coastal Environments, Inc. 1980). The ecosystem models and narrative report will suggest causes of these changes and delineate the functional role and value of marshes for the study area and individual hydrologic unit.

The narrative documents and maps produced in these studies are presently being considered for use in university courses in ecology and fisheries and wildlife management. Literature searches from the studies are computerized for wide accessibility to all users (in California, Georgia, Louisiana, Mississippi, Oregon, South Carolina, Texas, and Washington, for example), and plans are being made to digitize various maps for ease in updating. Workshops have presented the Chenier Plain characterization study to concerned federal, state, and local agencies to demonstrate and test the application of characterization products in a "hands on" exercise. Such workshops are also a means by which users can provide direct contribution to future studies by clarifying their needs for information and making suggestions to improve the quality and usability of the products.

In view of the variety of applications of the ecological characterization study products, the primary contribution made by these studies appears to be the compilation of diverse kinds of information from widely scattered sources. The reported information is the best available, its sources are verified, and readers are directed to a wide range of related reference material. Mapped data are presented at the same scale to facilitate comparative analysis, and the products are accessible on both scientific and technical levels.

Summary

The first four years of characterization studies by the U.S. Fish and Wildlife Service may be viewed as a developmental phase that included identifying users and their needs, examining the role of modeling, testing product formats, transferring characterization information, and evaluating the study design through peer review and recommendations by users. The most challenging portion of the program has been in developing and testing methods of presenting characterization information to a wide range of users.

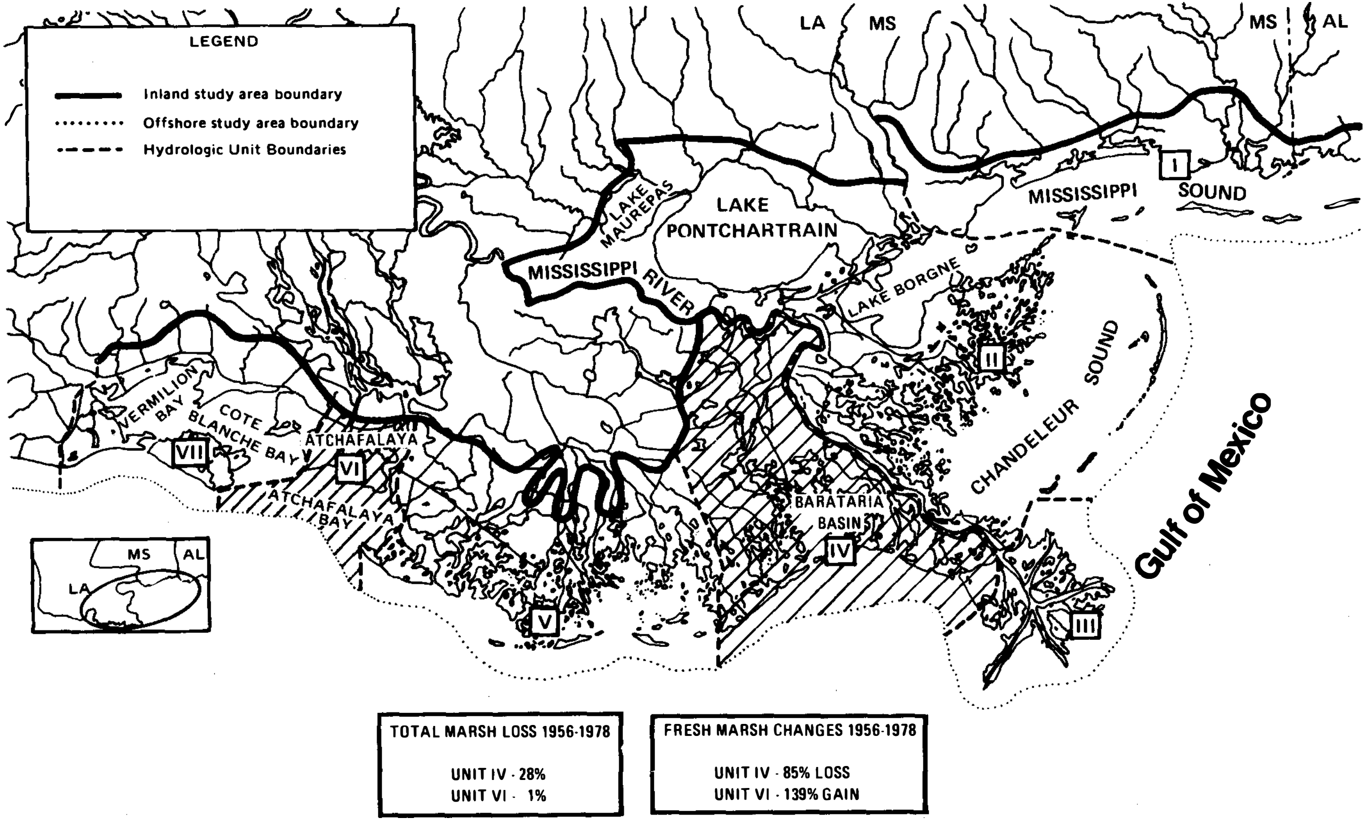

Figure 4. Mississippi Deltaic Plain Region study area (Hydrologic Units IV–Barataria Basin and VI–Atchafalaya Basin are patterned).

The major thrusts of future characterization efforts will focus on the development of information management systems, data analysis, implementation of field studies to fill data voids, and application of characterization information to emerging coastal development issues. The characterization process itself will be continually refined so that future products from the studies will more effectively address the needs of the users.

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Engineering Solutions for Fish and Wildlife Management Problems

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Good afternoon. I'm happy to be here at this 45th North American Wildlife and Natural Resources Conference. Your committee asked my boss, Lieutenant General Jack Morris, to come. But he is just returning from a month's trip to China with Secretary Andrus and others, and asked me to express his deep regret—he really wanted to come.

I do appreciate your asking us to participate in talks about fish and wildlife resources and I hope that shared knowledge will help us capitalize on our common goals and better compromise our differences. I will talk about policy and current programs in areas which I know are of concern to you—our regulatory program, our approaches to mitigation and non-structural solutions, some of our long term research—and then we will take time for questions.

Before I talk about current policies and programs, let me give you some background. The decade of the seventies represented a period of change, of reordering national priorities. As a nation we shifted from the depression-spawned mentality of "economic development is good—more economic development is better" to a close examination of where this nation was headed with our precious natural resources. When I went to work for the Secretary of the Army in 1972, the National Environmental Policy Act had just recently been passed. It required us to change what we were doing in many ways. Not only that, the Act did not have a grandfather clause, so we not only had to change what we were going to do, but also what we were already doing. Policies had to be changed—and they were changed. Our organization also changed; we brought in environmental planners, biologists, resource managers. Most important, our way of thinking adjusted to consider the new priorities. We adapted. Some of you no doubt think we didn't change fast enough or far enough, but the adaptation was a significant change for us.

The disruptions and frustrations we experienced in the early seventies are past. The procedures we've adopted to comply with the body of environmentally-oriented legislation are simply part of how we do our business these days. We are seeking an optimum blending of human needs with preservation or enhancement of natural values as a routine matter. The conflict that characterized dealings between environmentalists and developers in the early part of the decade seems to be entering a new era—an era in which both sides recognize that the other side has something to offer, and that it is possible to reach workable compromises when reasonable people approach competing water resources with open minds. I hope that this spirit of compromise grows as the national emphasis on conservation of our resources and development of domestic energy sources gains momentum.

Our research and development program has been a critical element in fulfilling our environmental responsibilities. A significant portion of our research and development effort is aimed at planning and executing our water resources mission more efficiently and effectively. It also provides information for other government and private agencies. Two research programs of which the Corps is very proud—the Lake Erie Wastewater Management Study and the Dredged Material Research Program—are worthy of mention.

The deterioration of water quality conditions in Lake Erie undoubtedly did as much as any other single issue to trigger our national concern for the environment in the late 1960s. It must have seemed ironic to many that the agency called upon to find a way to restore Lake Erie was an agency that was often charged with environmental carelessness.

To the informed observer of water resource affairs, however, it was a natural choice. Throughout the country's history the Corps has served the wishes of the citizenry. When the citizens saw the need for development of an inland waterways system in the 19th century, the Corps was there to do it. When the population grew and early 20th century communities began to suffer enormous flood losses, the Corps was there with engineering solutions. Now that the country faced an environmental problem it turned to the Corps for a practical strategy for recovery.

The Water Pollution Control Act amendments signed into law in 1972 contained a provision which directed the Secretary of the Army to "develop a demonstration wastewater management program for the rehabilitation and environmental repair of Lake Erie." Work began in late 1973.

Many materials cause pollution in Lake Erie: organic materials, nutrients, sediment, metals, pathogens, and pesticide residues. One of the most serious water quality problems is caused by excessive nutrient loadings—primarily phosphorus.

Recognizing the detrimental effects of phosphorus, Canada and the United States have set limits for its introduction into the Great Lakes. The goal for Lake Erie is to reduce phosphorus loads until they reach 11,000 metric tons a year.

The Corps of Engineers' Lake Erie Wastewater Management Study indicates that somewhere around 20,000 metric tons of phosphorus enters the lake each year—most of it from Lake Erie's own drainage basin. Within this basin, phosphorus pollution is the result of municipal and industrial wastewater outfalls, called "point sources," and runoff from widespread areas, called "diffuse sources."

The effort to reduce point source phosphorus has been underway since the early 1970s and the solution clearly seems to lie in treatment facilities. Even if point source standards are met, however, phosphorus coming from diffuse sources will still have to be reduced by one-third in order to reach the targeted 11,000 metric ton load.

Because agricultural activity is the predominant land use in the Lake Erie drainage basin, farmlands contribute most of the phosphorus load to the lake. Although some phosphorus comes from agricultural livestock operations, the primary agricultural activity that contributes phosphorus is crop production. Crop production and other land uses were studied using the Land Resource Information System. The Corps observed the entire Lake Erie drainage basin, incorporating into the system high-level aerial photos provided by NASA, and information on local soil types provided by local governments and the U.S. Soil Conservation

Service. Now, information is readily available, down to an area as small as 10 acres.

Reduced tillage appears to be the key to reaching the phosphorus reduction target. There are several additional practices that will also help reduce the amount of sediment and phosphorus that enter the waterways. These include animal waste runoff and disposal systems and structural control of gully erosion. These practices are currently being demonstrated by the Corps in the Honey Creek Watershed, a 187 square-mile (484 km^2) portion of the Sandusky River basin in northern Ohio.

Local farmers must understand the benefits of new practices before they will accept them. We intend to implement a basin-wide education program to make local officials aware of the information we have developed. Technical report presentations, seminars, demonstration events, field days, and local news media orientation will be used to spread the word. It is hoped that by the end of the eighties, Lake Erie can be pronounced "restored." I've brought some handouts further describing our Lake Erie program. You may pick them up at the back of the room.

We hope that the results of the Lake Erie study will be fully implemented and that the lake will soon take on a new sparkle. I know that the results of the other program I mentioned—the Dredged Material Research Program—are being used. That program included over 250 individual studies and was conducted between 1973 and 1978. Rather than being site specific, these studies were generic in nature. The intent was to develop predictive techniques. Specific goals of the program included examining water quality and biological effects of open water, upland and wetland disposal. They also included improving the effectiveness of confined land disposal; testing concepts of wetland and upland habitat development; and developing and testing concepts of using dredged material as a productive resource. The most significant overall conclusion to be drawn from the program is that no single disposal alternative can be presumed suitable for a geographic region or a group of projects. Each project must be evaluated on a case-by-case and site-by-site basis. For open water disposal, the studies indicated that, in general, physical impacts are of more potential consequence than chemical or biological impacts.

Confining dredged material on land by diking may offer increased environmental protection, but it is not an alternative without problems and is not always beneficial. Guidelines were developed for planning, constructing, and managing confined disposal areas. Also, guidelines were developed for reducing turbidity from open-water disposal operations and for treating effluents from confined disposal areas. Several major field tests and demonstration projects clearly showed the viability of using dredged material to develop both wetland and upland wildlife habitats. As a result of these studies, guidance is now available as to what species to plant and how to do it in order to produce a desired habitat. Concepts for using dredged material productively were explored with emphasis placed on analyzing constraints such as transportation, public perception, legal and institutional factors and economics. Successful tests were conducted using dredged material for shrimp mariculture and strip mine reclamation as well as agricultural soil improvement.

These two research and development projects have given us a lot of useful information. We see them as assets in our planning for new projects and maintaining existing ones. These specific programs as well as our approach to general areas of concern—water conservation, non-structural approaches to problems, wetlands protection and fish and wildlife mitigation—affect our implementation of the President's water policy.

One of the areas of concern to us is water conservation. As a result of ever-increasing demands and competition for water, the Corps is placing increased emphasis on sound conservation practices. This means more explicit procedures to incorporate conservation into all elements of our Civil Works program.

Water conservation is different from some other forms of conservation. Energy conservation is usually thought of in terms of nonuse so that the resource will be available at a future time. Fish and wildlife conservation provides for use of the resource, but in a manner that preserves and protects the regenerating capability of the resource. Nonuse of water does not automatically insure its future availability and the regenerating process—the hydrologic cycle—is still beyond our capability to manage. We believe that water conservation is any beneficial reduction in water use or in water losses.

Water supply and water conservation have much in common. Neither can be implemented without making demands on other scarce resources and the merits of both must be evaluated using the same basic criteria. In addition, the fact that not all new supplies should be considered desirable is also applicable to water conservation measures. The evaluation of the adequacy of existing water supplies and the measures needed to address future water needs requires an assessment of: demand reduction practices, more efficient use of existing supplies, and need for new supplies.

The Corps is putting water conservation into everything it does. First, we are looking at our own water use—that is use of water impounded behind Corps' dams—to improve efficiency. Second, water conservation will be made an integral consideration in the planning of future water projects.

The Civil Works program has five parts for implementing water conservation: planning, design and construction, reservoir regulation, operation and maintenance, and regulatory. Our planning role represents a major opportunity to reduce the demand for additional supplies of water. Our agency is in the lead in this area throughout most of the United States. The final draft of a detailed procedures manual for evaluating water conservation is under review. Our design and construction program is expected to be project and site specific. Each project will be required to undertake three value engineering reviews for water conservation—pre-authorization, post-authorization and final design. The interested public therefore, has several chances to make its views known. Under reservoir regulation, we are making drought contingency plans for use of our projects to assist the public during droughts. Our operations and maintenance personnel are reviewing every Corps facility that uses water, looking for ways to conserve it. And we've instructed our field personnel to implement beneficial conservation measures without headquarters approval. Under our regulatory program, we have made water conservation part of our public interest review.

Most water conservation techniques can be considered non-structural solutions. And there are other non-structural solutions.

We believe that all of our water resource planning should include consideration of non-structural approaches. General Morris was talking about flood control measures when he said to both the House and Senate Public Works Subcommittees on appropriations in 1977, "We now look at non-structural options as the most desirable solution to flood problems since they are usually least disruptive to the natural environment." The President's Executive Order (11988) of that same year made it clear that this Administration is firm in its intent to discourage development in floodplains. We are to avoid development in floodplains unless it is the only practicable alternative.

The Water Resources Council's Principles and Standards have encouraged non-structural approaches and the emerging revision of the Principles and Standards will give even greater emphasis to them.

The Corps of Engineers must plan for both national economic development and environmental quality. We have to maintain a balanced approach. We look at alternatives, trade offs, compromises. Non-structural measures are considered and every reasonable effort is made to use them. "No development" plans are also made when they can be seen as meeting public concerns. One statistic you should know. The Corps system has historically turned down—that is, before they leave our offices—more than half the proposed projects that we study. And recently the number of "recommendations against" has increased significantly. Our Board of Engineers for Rivers and Harbors tells us that for calendar year 1979 we recommended construction of only 23 percent of the projects proposed to us.

We are encouraging non-structural management practices at existing projects: encouraging the use of helper boats to improve efficiency at locks, planning for peak periods at hydropower projects, encouraging water conservation in situations where water supply is scarce. We are also discouraging development on beaches and other waterfront areas.

The most widely discussed non-structural approach, of course, is the approach to floodplain management. The President's Executive Order has greatly reduced federal support of future construction in floodplains. As a nation, we have learned a lot about our fragile environment in the last few years. We are plagued, though, with development that already exists in floodplains. There are things that we can do and things we *are* doing: using early warning techniques, extending emergency relief help with evacuation, flood fighting, assisting communities in developing land use regulations, zoning regulations, flood proofing. However, there are problems for both the Corps and the communities we serve. The Corps' problems center on justification of projects. Cost:benefit analysis doesn't usually indicate that moving communities off a floodplain is feasible. Because of severe flooding, both Prairie Du Chien, Wisconsin, and Baytown, Texas actually proved to be cost effective, using the criteria normally applied to project planning. However, we hope to be able to find better ways to evaluate the unquantifiable benefits of projects of this type. Though not all benefits are quantifiable, they are nonetheless observable. The Indian Bend Wash Project in Phoenix, providing open space for floodwaters, has been very successful. I discussed this project with the Governor of Arizona right after the floods last month, as he is as delighted and proud of that project as the Corps is.

The public has other concerns. Community problems do not focus merely on pure economic issues. Communities have to look at social upheaval and lost jobs. And it is difficult to see the importance of moving off the floodplain if there hasn't been a flood for several years. And too, regional planners who see the regional benefits of reduced development upstream don't always live upstream. So we at the Corps have to continue to strengthen our planning efforts, particularly with regard to finding improved, more effective ways of involving the concerned publics.

In wetlands protection we have a great deal of public involvement and we are on the firing line from both sides of every wetlands issue. This is true because the Corps is at the forefront of the Federal Government's action in the protection of wetlands. This is the case both in our regulation of development in wetlands and in our efforts to create new wetlands. As you may know, the first federal statement on wetlands came from the Corps. Our policy developed back in the late sixties and has remained unchanged. We do not grant permits for construction in wetlands unless a real need can be demonstrated. The Marco Island case is still representative of our philosophy. We concluded (painfully—it was *not* cut-and-dried!) that Marco Island was not in the public interest. In the same spirit of finding the full public interest, we recently reached a different conclusion on environment and development concerning a new refinery at Hampton Roads, Virginia, which is unpopular with many here. Some development is in the public interest and as a water resources development agency we must not lose sight of our purpose to serve the general public.

Though our philosophy has not changed, changes have occurred in our ability to run our program. One problem which has plagued us for some time is the problem of definition. Just what is a wetland? And what should be our area of regulation? As we explained in nationwide public hearings in 1975, we do not intend to expand our sphere beyond what is truly aquatic. We do not intend to make 404 a "land use" tool. If it were to become a "super-zoning" tool, I expect it would be modified or weakened by the Congress or the courts. Many agree with me on this—we have it approximately right at this time.

You in the scientific community can help us with definitions. We need to know what criteria are distinguishable and unchanging for vegetation, soils and hydrology. We need help identifying important functions of wetlands. Then we can make policy based on science. But here you must appreciate two cautions. First, there is no simple, clear definition. Second, scientific definition does not lead directly to policy—nor should it, necessarily. We are likely to continue to have ambiguities—for example, a "scientific" wetland boundary, and a more constricted policy boundary.

We have further problems. Administratively, our program has many ambiguities. In the opinion of the Attorney General, we should regulate, but the Administrator of EPA should determine the criteria for jurisdiction. It is important that the *public* knows where to turn for jurisdiction decisions and we are working out an agreement with EPA on this matter. We feel the need to be able to make daily field decisions.

So, we have some problems to solve in the regulatory program. In our own navigation projects, wetlands also play an important role. Our wetlands policy as it applies to other agencies in our regulatory program, applies to us as well. Our expertise is complementary. I have to admit if I'm really to be honest with you that we created our first wetlands quite by accident. Some of them are on the North Carolina coast and others near New Orleans. Since then we have learned a lot about the value of wetlands and have *aimed* to create them. Though we knew wetlands were vital, we didn't know enough about their functions or about their creation. The Dredged Material Research Program I mentioned earlier has given us new information which we had badly needed. The program has shown us a great deal about developing wetlands.

There is just one final area of concern that I want to discuss before we stop for questions. That is mitigation. Mitigation is one of the important concepts which applies to environmental protection. Our concern for mitigation of fish and wildlife losses has led us to make some important changes in our policies and procedures. For example, our current planning procedures strive to produce zero negative impacts to fish and wildlife resources, obviating the need for mitigation. This is always a first choice, but often unavoidable losses do occur. Mitigation measures are included to offset these adverse effects.

When planning for a project, the Corps develops mitigation features based on recommendations of the Fish and Wildlife Service, Corps' biologists, and appropriate state agencies. As a construction agency, we are required to justify mitigation measures to Congress with respect to maximum overall project benefits. In some instances we have had difficulty quantifying the needs and outputs of mitigation measures to justify the extent of mitigation recommended by others. An approach to quantifying is the Habitat Evaluation Procedures—called HEP—developed by the Fish and Wildlife Service. The Procedures focus on habitat rather than man's use of fish and wildlife resources. The HEP establishes methods of quantifying wildlife habitat indices and project-induced losses—as well as positive contributions. The latest HEP is scheduled for publication soon and we have agreed to evaluate the new HEP in five Corps studies during the next two years. We hope that this series of evaluations will clearly establish the strengths and weaknesses of HEP as a reliable planning tool. It is quite possible that we will *also* use other tools to help make our final judgments. We would like the habitat indices to have some determinable correlation with fish and wildlife productivity. Presently, the procedures can be used to evaluate habitat for one or more species, but this evaluation does not identify the numbers of animals which the habitat supports.

Sometimes the mitigation of fish and wildlife losses involves the acquisition of new land. Land acquisition is usually controversial because it often affects the local economy, reducing the tax base, and displacing residences and businesses. Sometimes it is better to manage project lands more intensively than acquire additional land. Like all other mitigation measures, land acquisition questions have to be answered on a project by project basis.

Land acquisition, funding for operation and maintenance of mitigation features, quantifying and evaluating mitigation—these are areas where there are more questions than answers.

As you may know, the Chief of Engineers established an Environmental Advisory Board in 1970. It is a six-member group of experts from outside the Corps, representing a broad range of environmental knowledge and experience. The Board meets quarterly and focuses on one particular area of concern at each session. Our February meeting with the Board focused on fish and wildlife mitigation. The members had some good things to say about our program, but also had some useful substantive suggestions for its improvement.

The Board expressed pleasure that we will be participating in the HEP demonstration. And they made some suggestions about land acquisition. They suggested that acquisition of lands and waters for mitigation should be as close as possible in kind and in physical proximity to that taken by the project. And that the Corps should retain its authority to condemn lands necessary for mitigation and should look to lands already in public ownership as a last resort. The Board's suggestions regarding replacement in kind and nearby, are consistent with current Corps policy for projects where mitigation cannot be accomplished on site. The Board suggested that mitigation, including its operation and maintenance costs, should be recognized as a project cost for the life of the project. This means that the "project" should pay the costs. This is in accordance with the Fish and Wildlife Coordination Act, but there may be differing provisions in specific project authorizing legislation. The Board was concerned with how and who provides the funds. We are looking at this, but regardless of who pays, we will continue generally to rely on the expertise of state agencies and the Fish and Wildlife Service in carrying out the mitigation work.

The Board also considered a new approach to mitigation—looking at certain areas of the country on an ecosystem basis. For example, in the Mississippi bottomland hardwoods, opportunities exist to (a) restrict transmission and transportation encroachments to corridors; (b) identify sensitive "off limits" areas; and (c) provide for a "pooling" of mitigation acquisition which can lead to the conservation of a significant chunk of the resources, as opposed to a checkerboard of more insignificant "green spots." This is an idea which appears to have a good deal of merit and we are evaluating its application. I should note for you that "pooling" of mitigation acquisitions will not be consistent with the policy to provide mitigation as close as possible to where the losses occur.

I have given you a smattering of information about our activities relating to the environment. I want you to understand that we are really involved in gearing our programs to meet our legislative mandates. The new procedures we've adopted to comply with the body of environmentally oriented legislation are simply part of how we do our business these days. And I also want you to understand that we want you to give us your ideas. We want to have a dialogue with the people we serve.

Assessment of Fisheries Management Options in National Parks

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Of approximately 300 units which comprise the National Park System, 109 units offer recreational fishing opportunities to the visitor and 20 units allow commercial fishing within their boundaries. Historically, the Park Service has never viewed fishing as a resource consumptive activity but rather as a visitor experience. Because of this attitude the Park Service has endeavored to promote the recreational fishing experience, many times ignoring conservation of fishery resources.

Most of the freshwater park units have actively participated in ambitious stocking programs and in some cases, have poorly managed stocking efforts. Barren alpine lakes have been stocked, mountain streams have been the recipients of nonnative species or native species of the wrong size (or age) and in too numerous numbers for that section of the watercourse. All of the management activities have led to enhanced visitor fishing opportunity, but have not approximated the ecosystem management mandates of the Service.

Added to the recreational fishery management problem is commercial fishing that is permitted in 20 Park Service areas. In some cases this commercial fishing activity competes for the same species as the sportfisherman. In other cases the commercial fisherman is harvesting species lower in the food chain whose taking possibily lowers overall productivity and thereby reduces recreational catch and the sportfishing experience.

The emergence of an ever-increasing, vocal and potentially powerful recreational fishing lobby has caused many state game and fish agencies and, recently, the Department of the Interior to reassess fisheries management policy for public lands and waters. In areas where recreational and commercial fishing activities coexist, the once-powerful commercial fishing industry is losing ground to sportfishing interests. The sportfisherman is demanding a larger piece of the fishery resource. As more shorefront and floodplain land succumbs to development, more watersheds and coastal waters are rendered unproductive, and as dwindling energy supplies reduce the work week, allowing for more worker leisure time, the pressure on easily accessible public lands and waters is going to increase. Attendant to this increased recreational demand will be the expanded effort by sportfishermen to catch fish, thus intensifying the conflict between the recreational and commercial fishing interests.

In response to changing public needs of National Parks, Monuments, Preserves, Seashores and Recreational Areas, the National Park Service is currently reviewing, in concert with the public, the findings and recommendations of an *Ad Hoc*

Fisheries Task Force which recently completed an evaluation of the effectiveness of National Park Service fishery policy and management practices.

These recommendations are:

1. Present Park Service policy focuses on fishing activity, not the conservation of fish resources.
2. Many parks lack adequate fishery information and data.
3. Following appropriate environmental analysis and after consideration of all other factors, nonnative species which contribute to the maintenance and well being of the ecosystem may be declared by the National Park Service Director, as "naturalized" and managed as native species.
4. Commercial fishing is viewed, in most cases, as a "nonconforming use of park system resources."
5. Park Service managers and planners need more fishery expertise.
6. Formal agreements defining the roles of the Park Service and state conservation agencies should be struck for the proper management of aquatic resources within parks.
7. U.S. Fish and Wildlife Service should assure that state management programs support Park Service goals in parks.

These recommendations and their supporting data are currently undergoing public review. If and when they are implemented, they will represent changes in Park Service management policy and, in turn, require changes in individual Park Service unit regulations governing fishing.

In all likelihood, these changes in policy and/or regulations will be initiated through the Park Service's planning process which requires the preparation of an environmental assessment, abundant public participation in selecting management alternatives, review of the alternatives, possible preparation of an Environmental Impact Statement and concluding with publication and promulgation of the new rules.

This is a time consuming process and a much needed one since needs and attitudes of the public will, and should, be considered at nearly the same level as the ecosystem that the Park Service is mandated to manage for its use. Recently, I have participated in this assessment–review–rule scenario at Everglades National Park in drafting new special regulations on fishing and boating activities. I believe that some interesting parallels exist among our experiences in changing fishing regulations and the recommendations of the Fisheries Task Force.

Our largest problem in Everglades is trying to manage roughly 750,000 acres (303,500 ha) of estuarine and marine ecosystem at the bottom of a watershed that is surrounded by a burgeoning population with a large appetite for water for both industry and recreation. This situation has caused ecosystem changes which have resulted in fluctuating catch rates of major recreational and commercial finfish and shellfish species.

These fluctuations in catch rates created a conflict between the sportfishing sector who harvested secondary consumers, such as redfish, spotted sea trout, grey snapper and snook; and the commercial fishing industry who netted for primary consumers, namely, silver and black mullet; trapped stone crabs and hook and line fished for grey snapper, spotted sea trout and redfish. In analyzing this problem and formulating solutions to it, we considered many of the same factors that the Task Force had in composing their recommendations to the Park Service.

First, we considered Park Service policy, enabling legislation for Everglades and past management practices, and found that the Park Service has never condemned or condoned the taking of fishery resources for consumptive purposes or commercial enterprise; that commercial fishing was never provided for in the enabling legislation creating Everglades National Park; and that commercial fishing pressure, while controlled superficially by an annual nonfee permit system, did not prevent or adequately control growth of this segment of the fishery.

In dealing with these factors, we proposed, in our assessment, various options that would have prevented the growth of commercial fishing through a moratorium on permits or eventually eliminate commercial harvest through a 30 to 40 year phase-out period. The public comment on these options was overwhelmingly negative. The public could not tolerate the thought of a commercial enterprise in a National Park, much less one that was resource consumptive. This public dissatisfaction resulted in a re-thinking of the phase-out option and a shortening (to 6 years) of the time interval which was based on amortization schedules for boats and gear.

Secondly, the cornerstone of the Everglades assessment was data. This data provided extremely valuable information on economic and environmental impacts as well as insights into the potential benefits or detriments of alternative actions. The Everglades data base also added much credibility to the selected options. Park managers have been collecting sportfishing data at Everglades since 1958 through creel censuses at public boat ramps in and around the park. This historic data base allowed for catch rate predictions and trending. Commercial fishing data has been collected on a voluntary reporting basis since 1965.

Our data revealed that, since 1972, the annual average number of sportfishermen using the park was 129,700 individuals. The recreational fishermen's average annual harvest, since 1972, was approximately 3.3 million gamefish from park waters. This recreational fishing activity also accounted for $2.45 million of business to the local economy.

Commercial fishing data revealed that, since 1972, the netters' average annual harvest of mullet, pompano and assorted gamefish species was 1.1 to 1.5 million pounds (490,000 to 680,000 kg); stone crab harvest for the same period averaged 152,000 to 222,000 pounds (68,947 to 100,000 kg), annually; and hook and line fisherman annually took 355,700 pounds (161,345 kg) of gamefish. This commercial fishery was valued at $1.21 million annually to the local economy. This data indicated that recreational fishing was harvesting more finfish, but also was applying considerably more effort and was more selective in their harvest than the 164 permitted commercial fishermen. It also demonstrated that the conflict between recreational and commercial fishing interests was more perceived than real and that recreational catch needed to be regulated just as much as commercial harvest.

We proposed to achieve regulation of recreational harvest through a bag limit option. These bag limits, 10 fish of any one species with an aggregate bag of 20 fish per angler per day, will result in conserving approximately 315,000 pounds (142,884 kg) of gamefish annually while reducing recreational harvest by about 4.2 percent. However, the most controversial aspect of our assessment, and of probably any fishery assessment in Park System units with a commercial fishery, was the control and eventual elimination of commercial fishing. This single point, which initiated the assessment and review, revealed public dissatisfaction with the existence of commercial fishing in a National Park. The public viewpoint that commercial fishing is a "nonconforming use of park system resources" may be more universal than the Park Service knows. Nonetheless, parks with commercial fisheries within their boundaries will have to examine two major questions when assessing commercial fishing impacts: (1) resource allocation priorities; and, (2) the concept of common property.

All too often, resources are allocated and managed for the most noticeable user groups. In assessing or reassessing fishery management options, Park System units will have to consider not only the visitors, their needs and expectations, but, more importantly, the ecosystem resource itself. In our case at Everglades, we reallocated the park's fishery resource from one of human use to one highlighting the value of the natural resource. We reduced the visitor experience to a secondary priority and placed commercial fishing below the visitor. We feel that this re-allocation will conserve park fishery resources in a stressed ecosystem and promote conservation of gamefish resources.

I believe that much of the furor facing park managers when they attempt to reassess fisheries management policies will not only center on resource allocation priorities, but also on the intent of resource use. This resource use consideration will be based on the purpose and goals of Park Service resource management and the concept of common property. The recreational sector views the purpose of a national park as one dedicated to environmental enhancement, recreation and environmental preservation. Commercial fishing interests view park resources as being their private property where, in effect, it is common property belonging to all citizens. The problems associated with fishery management in a multi-use area usually revolve around this common property idea. Overharvesting of the resource by commercial fishermen imposes its consequences on society and usually results in a loss of the recreational fishing experience due to an increased number of fishless trips and a general disruption of the delicate ecological balance of the aquatic resources in a given area. Also, the fact that the activity, effort and success, of one group of fishermen imposes an unanticipated cost upon all other fishermen in a fishery, greatly influences decisions on expansion and continued harvest.

One area in which the Task Force did not have any recommendations was endangered species and their critical habitats. Since park areas are relatively pristine and human pressure on resources is controlled, they have become excellent habitats for endangered and threatened species. When assessing fishery management alternatives, park managers must relate the value of the fishery to these endangered organisms, either as food or the habitat the aquatic resource provides. In Everglades, we have at least six endangered species that depend on the estuarine-marine resource for food and in some cases for habitat. When evaluating possible management options, we had to consider the effect of fish harvest as well as the effect of fishing gear and boat traffic on their habitat. It is a known fact that crocodiles, manatees and sea turtles can and will encounter fishing nets, become entangled in trap buoy lines, and get run down by pleasure boats. To offset these possible impacts, we set aside a small portion of the shoreline of Florida Bay as a sanctuary, closed to all entry, for the study and protection of endangered species.

Also, as a side benefit from the eventual prohibition of commercial fishing, net encounters and trap buoy line entanglement incidents would be eliminated. The reduction in recreational fishing through the adoption of bag limits coupled with the abolition of commercial fishing should effectively reduce the possibility of boat propeller accidents with manatees, crocodiles and sea turtles.

In conclusion, the success we achieved in Everglades National Park in assessing fishery management options rests entirely on the fact that we had a good, credible data base from which to assess both environmental and economic impacts of our impending decisions. We also considered the feelings of the public about the reason and purpose for a national park and realized that not only did commercial fishing need to be more strictly regulated and eventually phased out, but recreational fishing needed to be controlled and aquatic resources reallocated with emphasis on conservation and ecosystem preservation.

I firmly believe that park managers who wish to accomplish what we did will have to consider the following factors: public perception of the Park Service's purpose; allocation of the aquatic resource with the needs of the ecosystem being of prime concern; the concept of common property; and the establishment of a credible data base for their park unit from which they can formulate management alternatives. The real challenge, however, may be to collect data and implement changes in a period of decreasing budgets, reduced fuel allocations and increased visitation.

Georgia's Approach to Coastal Zone Management

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The nation has become aware of the coastal zone as an area deserving special attention and care. During the decade of the seventies, the United States Congress passed the Coastal Zone Management Act, legislation designed to address concerns of coastal waters and shorelands, the use of which could have direct and significant impact on coastal waters. Slowly the national wheels of government have been grinding to coerce states into formation of coastal management programs.

Georgia, having over 100 miles (160 km) of shoreline and more salt marshes than any other east coast state, had a head start on recognizing the potential economic and ecological importance of the coast. Through the pioneering leadership of Professor Eugene P. Odum and others, Georgia had already "noticed" the coast and started drawing national and international attention to its coastal zone during the fifties and sixties. The "trailblazing" research activities at the University of Georgia's Marine Institute on Sapelo Island laid the foundation of basic coastal ecosystems knowledge upon which management frameworks were constructed.

By 1970, Georgia had passed a statewide Marshlands Protection Act. The law does not deal with state versus private wetlands ownership, but instead, requires permits for activities encroaching on the state's wetlands regardless of proprietorship. Through standards and criteria adopted in the law, the state established a committee of three scientists/resource managers to approve, condition, or deny applications. In addition, the state employs professional staff with experience in coastal science to process, evaluate, and study all applications for permits and make recommendations to the committee.

Consequently, for the past decade, Georgia has been regulating all saltwater wetlands activities. Through the Act and its rules, guidelines are given for permit evaluation. These guidelines include review of the public interest, the water-dependent nature of the proposed activity, channel dredging essential for navigation and public health, and public recreational benefit. Activities and structures such as filling marshlands for residential, commercial, and industrial uses; filling for private roadways or parking lots; use as dump sites for depositing waste materials or spoil; mining; impoundment structures; or structures which constitute an unreasonable obstruction of view to adjoining landowners are considered contrary to the public interest and, therefore, generally prohibited.

In addition to the specificity of the guidelines for permit evaluation, professional staff work with applicants in developing permit requests. In some states an applicant must hire a coastal consultant to complete the application and ultimately rely on trial and error for approval. Georgia, however, plays an assertive interactive role with applicants. Coastal Marshland Protection staff work directly with applicants to help in the completion of the applications and acquisition of data necessary for equitable decisions.

A decade of experience, including court litigation, verifies the functional value of this coastal management tool. Of 475,000 acres (215,982 ha) of coastal wetlands in Georgia, to date permits have been granted to modify less than 25 acres (11.4 ha); and yet, development has continued.

For nearly a decade, coastal resource managers consulted with numerous experts in geology, botany, and engineering to formulate concepts for management of the vital sand dunes, beaches, and offshore bars. In 1979, the Shore Assistance Act was passed by the Georgia General Assembly. The resultant law and rules recognize that the coastal sand dunes are the fragile product of shoreline evolution and are easily disturbed. The offshore sandbars and shoals are the shore's first line of defense against the destructive energy generated by winds, tides, and storms, and thus protect the onshore portions of the system by serving as a sand reservoir for the beaches. Since the ocean beaches provide an unparalleled natural recreation resource which has become vitally linked to Georgia's coastal zone and that of the entire state, wise conservation of this sand-sharing system, an integral part of Georgia's barrier islands, is of vital concern to all citizens to maintain their health, safety, and welfare. The law regulates all structures and activities on offshore sandbars, shoals, beaches, and dunes to insure that the values and functions of the sand-sharing system are not impaired.

This new law established the Shore Assistance Committee of three scientists/resource managers to approve, condition, or deny applications for activities or structures in the shore area. In addition, state professional staff work with applicants to provide free technical assistance so that the Committee will have the necessary details to make wise decisions regarding the alteration of the sand-sharing system.

Although the Act has only been implemented for the past year, it has already been tested in the Georgia Supreme Court. Litigation over the constitutionality of the Act, as well as the technical components related to hurricane resistant construction standards and areas under jurisdiction of the Act, has strengthened the state's authority to wisely manage this vital natural resource.

During the mid-seventies, Georgia, along with many other states, initiated participation in the Office of Coastal Zone Management's 305 planning program for a federally approved coastal management program. Georgia's Governor Busbee established the 35 member Governor's Advisory Council to begin work with staff from the state's Office of Planning and Budget. The evolutionary development of the Georgia Coastal Management Program resulted in the Program being primarily founded on statutory authorities of the Department of Natural Resources. In June 1978, responsibility for the Georgia Coastal Management Program was transferred to the Department of Natural Resources. Soon thereafter, the Board of Natural Resources established the Coastal Resources Division, and the Governor appointed eleven citizens (nine of whom live on the coast) to the Coastal Management Board, created by the General Assembly's passage of Georgia's Coastal Management Act of 1978.

This policy making group has the overall responsibility for shaping the Coastal Management Program and insuring its effective operation. Once appointed, the group set at work to continue the formulation of the Georgia Coastal Management Plan. After repeated negotiation and review with the United States Office of Coastal Zone Management, Governor Busbee made the commitment in June 1979 to withdraw from the federal Office of Coastal Zone Management Program but to continue the development of Georgia's Coastal Management Plan. He indicated that the decision to withdraw from the federal program was based on his belief that further efforts to satisfy federal requirements would not be beneficial to the state. Too much of the state's expertise which was needed for wise management of the coast was being used to respond to requests from federal agencies.

The Georgia Coastal Management Program is specifically tailored to preserve, protect, enhance, and develop the utilization of the coastal renewable and nonrenewable resources. The plan is formulated to prudently manage these unique coastal resources, giving equal consideration to economic and ecological goals.

Although time does not permit a detailed and exhaustive listing of all the components of the Georgia Coastal Management Program, several items relating to national interests in wildlife and natural resources conservation need further elaboration.

As a component of the Georgia Coastal Management Program, new legislation was enacted to clarify the laws relating to the regulations for harvesting coastal organisms. In the new law, "seafood" is defined to include estuarine and marine plant and animal life; criteria are established for the wise use and management of these "seafood" resources. The resultant eleven criteria of wildlife research and management are enumerated in order to provide an equitable basis on which to document decisions regarding opening or closing the season for these "seafood" species. In order to ensure abundant harvest in future years and adequate availability of seafood resources for all resource user groups, the new laws impose restrictions on commercial and sport fishing and shrimping.

In addition to establishing new legislation, the Georgia Coastal Management Program identifies goals for present and future decision making. After several years of careful deliberation, public hearings, and staff technical and legal analyses, the Coastal Management Board has established 17 program goals for the Georgia Coastal Management Program.

The Program's first and most central goal is to resolve conflicts between natural resource conservation and economic development in a manner that insures the greatest long-term increase in public benefit.

The Program aims to insure that renewable resources (such as fisheries and forests) and nonrenewable resources (such as natural gas reserves) are used in ways which best conserve their value for present and future generations. Other resources, including archaeological and historic sites, rare plants and animals and freshwater wetlands, have special values which must be considered in wise planning for the coast. In addition, some resources are suited for development, while others should be managed for maximum protection.

The third Program goal is to encourage the location of public and private developments in the most suitable areas where adverse impact upon natural resources are minimized. The Program must control the quality and kinds of development which occur in the coastal zone. This can best be accomplished through local zoning, although the state has limited authority over development in special vital areas, such as marshlands and coastal beaches.

The maintenance of diverse plant and animal life is a desirable goal for the coastal zone. The state already owns or manages many types of plants and animals and regulates their taking. Public funds are needed to manage present state holdings and to acquire additional natural coastal lands which can be kept in their diverse condition.

The Program attempts to maintain or improve the quality of coastal waters. Maintenance and, where possible, improvement of the coastal waters is important to public health as well as successful improvement of the tourist industry. Care must be taken to assure that industrial wastes and port activities, as well as urban growth, do not degrade coastal water quality.

Beaches, sand dunes, and offshore sandbars are all part of a vast and vital sand-sharing system which must be protected. The state has authority over activities on wet beaches and offshore bars as earlier outlined in relation to the Shore Assistance Act. Disruption of the sand-sharing system can adversely affect not only the dunes but also can result in damage or loss to economic development and massive, unnecessary public and private expenditures to repair the decimation which occurs.

Public access to coastal waters and beaches is an important Program goal, especially as the coastal counties grow and more people use these areas. Through (1) the use of state-owned facilities, (2) acquisition of additional public beach access sites, and (3) requirements that beach access be an integral part of any beach nourishment activity, the state has several ways of assuring public access to the coastal waters.

Of Georgia's 18 barrier islands, 5 are owned by the Federal Government and 5 by the state. Only four of the islands have causeways to the mainland while the rest are more protected due to their relative inaccessability. The Program seeks a balance between economic development of the islands and the protection of their unique natural features.

Another Program goal is to identify, preserve, and rehabilitate important historic sites, structures, and relics, both manmade and natural. Cultural resources which need special attention are those listed, or eligible for listing, on the National Register of Historic Places.

The Coastal Management Program attempts to protect coastal marshlands, including salt marshes, brackish wetlands, freshwater marshes, and river swamps, all of which provide considerable benefits to man. Through the pioneering activities of the Coastal Marshlands Protection Act (discussed earlier), Georgia has been accomplishing this goal for the past decade. The Program encourages development compatible with the ecology of the coast, since economic prosperity and environmental quality are intimately related.

The public interest should be considered in any allocation of coastal resources, though many of those who now allocate resources are not always concerned with public health and prosperity. The Program strives to work diligently with all relevant federal, state, and local agencies and the public to provide adequate opportunity for input into the ongoing coastal decision-making process. The federal, state, and local governments all have policies and programs affecting the coastal zone and its resources. These must all be continually updated and coordinated, in keeping with the Program goals.

The Program contains a goal to sponsor and monitor coastal planning and research programs. Recognizing the needs for new information which arise with coastal development, the Program continues wildlife and fisheries assessment, modeling efforts, and the collection of demographic data as required.

Keeping the public and local government involved in decisions about the use of coastal resources is considered a fundamental Program goal. It is essential to coordinate state and local government efforts in resource planning. This goal is closely related to the first goal in that it recognizes the importance of considering both development and conservation needs in deciding how coastal resources will be used.

Georgia's coastal zone is an area subject to management. Air and water quality, solid waste disposal, and National Pollutant Discharge Elimination System (NPDES) permits in the zone are all controlled through state laws equal to, or in many instances, more stringent than federal statutes. The Federal Government has given Georgia maximum legal authority to regulate air and water quality. All permitting is handled through the Environmental Protection Division of the Georgia Department of Natural Resources.

The Coastal Management Board manages 23 land and water uses, including those for which quality standards and criteria are set, those which conflict with other desirable resource uses, and those which provide short-term benefits to the detriment of long-term interests and safety. Included in the list are fishing, recreational boating, handling of solid waste, alteration of coastal marshland, hunting, and others. The Coastal Management Board also decides on the best means of managing any new uses, which have an impact on coastal resources, by adoption of policies and standards and criteria.

Georgia's Coastal Management Act of 1978 provides that local governments shall not unreasonably restrict or exclude uses of regional benefit from the coastal zone when such facilities cannot be feasibly sited elsewhere. These uses of regional and national benefit include power plants and transmission lines, public port development, regional airports, sewage treatment plants, regional solid waste disposal facilities, and energy exploration and production facilities.

Georgia can cooperatively manage land and water uses in the coastal zone through statutes and regulations, constitutional provisions, case law, executive order, state authority for land acquisition, zoning ordinances, and other land use controls. As Governor George Busbee has stated, "Enforcement of the program . . . is my responsibility as Governor, and I will take whatever steps I deem appropriate to carry out the provisions of the Georgia Program and to resolve conflicts if they occur."

In general, the Coastal Management Program is being accomplished through the help and cooperation of 13 state agencies and a number of local governments. The State Department of Natural Resources is the lead agency in the Coastal Management Program, and its divisions—Environmental Protection, Coastal Resources, Game and Fish, and Parks, Recreation and Historic Sites—bear the major responsibility for environmental management in the coastal zone. The Coastal Resources Division now reviews all federally funded projects located in, or capable of affecting, the coastal zone. The Division also reviews pertinent state permits, revocable licenses and certifications, as well as any state funds used in areas subject to program management (including all activities associated with Outer Continental Shelf energy exploration and development activities).

Local governments play a significant role in the Georgia Coastal Management Program chiefly by adopting and enforcing various ordinances and other land use controls which guide development. In addition to regulation of land use through zoning and planning, local governments also issue certain permits, prepare hurricane evacuation plans, administer local portions of the National Flood Insurance Program, monitor coastal zone activities, and inform the Coastal Management Board of problems within the Program which should be considered.

Primarily, the Board has the responsibility to establish goals and policies for the Coastal Management Program, although many public and private groups and individuals influence the Board in its decision making. Board actions include directing staff investigations, review of major projects and proposals, recommending new laws, adopting standards or model ordinances, allocating program funds, and identifying future problems and their solutions.

Although the Georgia Coastal Management Program is progressing as a state-approved program, the state has expressed its desire for approval of Coastal Energy Impact Planning (CEIP) funding from the Federal Office of Coastal Zone Management (OCZM). Due to the energy exploration and development activities currently ongoing and planned for the future, these funds would be beneficial in improving the state's ability to manage and mitigate any activities resulting from energy related sources. Because the Georgia Coastal Management Program is consistent with Section 303 of the Coastal Zone Management Act as amended, Georgia asserts that it is eligible for CEIP funding without meeting the requirements of Section 306 of the Federal Act. The Assistant Administrator of OCZM contends that in order for Georgia to receive these important CEIP funds, Georgia must be "making substantial progress toward an approvable 306 Program." Legal analysis from the Georgia Attorney General finds that Georgia is making significant progress in meeting four out of five of the requirements. OCZM has stated that additional work needs to be done on the enforcibility of "some" policies of the Georgia Program, and that otherwise, Georgia is making "satisfactory progress." Still, the Assistant Administrator determined, based on his discretionary judgement, that Georgia is not making sufficient progress and thus is ineligible for CEIP funds.

This issue still remains unsettled. Georgia has a strong legal opinion that it is not the intent of the Federal Coastal Zone Management Act, as amended, to require states to have federally approved coastal management plans in order to be eligible for CEIP funds. One solution is for the issue to be resolved through the courts. Georgia is currently weighing the advantages of this action.

Another possible solution is to legislatively clarify the Federal Coastal Management Act so as to more explicitly state the role OCZM and a federally approved program should have on a state's ability to receive CEIP funds to mitigate the energy exploration and development activities off its coast. Georgia is also considering pursuing this approach through the United States Congress.

Georgia has a Coastal Management Program that was initiated early in the seventies. Since the Program's creation, Georgia has been building an even stronger framework to manage its unique coastal resources. The resultant plan has assured the wise use of the coast, the shorelands, and coastal waters. The Georgia Program is tailored to specific state needs and is equal to, or better than, other federally (OCZM) approved coastal states' programs. This conclusion is based on the actual performance record of the Program and the impact it has had on the conservation of the coastal resources, instead of being based on hypothetical, furturistic, legal possibilities, plans, or dreams. We firmly believe that a site inspection of the Georgia coast by experienced, knowledgeable coastal resource managers, planners, or developers will document our findings and illustrate the effectiveness of our state's Coastal Management Program. In this way, Georgia is perhaps unique from other coastal states in that we are implementing a coastal management program not just for the approval of federal funds, but rather to assure the compatible uses of conservation and development which Georgia feels is vitally essential for wise coastal management.

Habitat Protection Through Coastal Zone Management

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The Coastal Zone Management Act (CZMA), originally enacted in 1972 and amended in 1976, provides many opportunities for the protection of living marine resources and their habitats.

In passing the coastal management legislation, the Congress found, among other things, that (1) the coastal zone, and the fish, shellfish, other living marine resources, and wildlife therein, are ecologically fragile and consequently extremely vulnerable to destruction by man's alterations; and (2) important ecological values in the coastal zone are being irretrievably damaged or lost. The Congress declared that it was national policy to preserve, protect and where possible, to restore or enhance, the resources of the nation's coastal zone for this and succeeding generations.

Under the Act, protection opportunities exist for important natural systems such as wetlands, estuaries, reefs, barrier islands and other marine related habitats. In less than a decade, implementation of the Act has produced (1) surveys and assessments of estuaries, reefs, and shoal areas which include important spawning and nursery grounds; (2) mechanisms to restore depleted shellfish beds and to enforce shellfishing regulations; (3) procedures restricting developments which would otherwise adversely affect marine and estuarine habitats; and (4) special management programs for natural areas including the establishment of Reserves and Sanctuaries.

Coastal Zone Management (CZM), as a national program, was a new concept in 1972 and therefore it is not surprising that it still carries a different meaning for different interest groups. For those concerned with habitat degradation and a diminishing supply of natural resources, coastal zone management means protection or restoration of salt marshes, wetlands, estuaries and other critical areas. Their solution is through strict development permits requiring mitigation and other conditions which make proposed projects more environmentally acceptable. Their ultimate goal is protection of sensitive areas in perpetuity. The Estuarine Sancturaies program for example, provides for such acquisition and management.

For those who make a living from fishing or indulge in it for sport, coastal zone management means protection of the habitats in which fish breed, spawn, and congregate. Commercial fishermen also expect their needs for adequate dockside facilities to be considered. Sport fishermen want coastal zone management to provide marinas, boat ramps, and fishing piers.

The developer feels that coastal zone management should provide expeditious and just regulatory procedures which eliminate unnecessary or duplicative permitting requirements. Some industries, such as aquaculture, simply want their activities to be designated as "compatible uses" in estuaries and bays which are "off limits" to other development activities. The energy industry believes that CZM should provide for coastal dependent sites for major energy facilities which are in the national interest. The same belief is held by port developers.

For the tourist, CZM means easy access to unspoiled beaches and parks, and the preservation of scenic coastal vistas. It also means a ready supply of recreational facilities, hotels, restaurants and parking lots to service their needs.

Whatever one's interpretation of the Act, hopes, or expectations, it is clear that a rapidly growing number of demands are being placed on the limited and often fragile resources of our coastal zone. Without some sort of comprehensive planning and improved management, the substantial benefits and amenities we now gain from our coastal areas could be lost or severely limited to all user groups in the future.

Before I move too quickly into the major theme of my presentation, I would like to provide a review of those sections of CZMA germane to Habitat Protection and a very brief status report of state programs.

Congress required that states wishing to participate in the national program would have to develop management programs (Section 305) that would, among other things:

1. Identify important resources, areas and uses within a state's coastal zone requiring management or protection; and
2. Establish a policy framework to guide decisions about appropriate resource use and protection.

The Secretary of Commerce, in approving a state program (Section 306), must find that, among other requirements, "the management program makes provision for procedures whereby specific areas may be designated for the purpose of preserving or restoring them for their conservation, recreational, ecological, or esthetic values."

Included within Section 306 plan approval and implementation is the provision for Coastal Fisheries Assistance. I will focus on this important element of the program later.

The Coastal Energy Impact Program (CEIP) (Section 308) provides for "financial assistance to meet the needs of coastal states and local governments—resulting from specified activities involving energy development." Of special interest to the National Marine Fisheries Service (NMFS) is the Section 308(g) provision to provide grants to "coastal states which have suffered, are suffering, or will suffer any unavoidable loss of a valuable environmental or recreational resource." For example, a $1.4 million Coastal Energy Impact Program grant was awarded in 1979 to the Volasco Drainage District, Corpus Christi, Texas. In that case, the National Marine Fisheries Service (NMFS), and Fish and Wildlife Service (FWS) opposed issuance of a Section 404 Corps of Engineers permit to the District on the basis that 50 acres (20.2 ha) of wetlands would be unnecessarily filled with dredge material. The CEIP funds provided a useful alternative by which to transport the materials to an established Corps of Engineers spoil dumping area, while avoiding further wetlands damage.

A provision of CZMA, which has received no appropriation to date is Section 310, Research and Technical Assistance. If funded, this section would provide for "research, study, and training to support the development and implementation of management programs." This provision, which is being considered for funding this year, could be extremely valuable for fisheries and habitat protection efforts.

Section 312 provides for an annual performance review of the state management programs and CEIP. The Secretary of Commerce can terminate financial assistance to a state if it is determined that state is failing to adhere to its approved program.

Section 315 provides matching grants to coastal states for the establishment of Estuarine Sanctuaries. The only true acquisition program under CZMA, estuarine sanctuaries are research areas set aside to provide scientists and students the opportunity to examine the ecological relationships of an estuary. Seven such sanctuaries exist and several more are being considered.

It should be noted that the Marine Sanctuary Program is not a part of CZMA although it is administered by the Office of Coastal Zone Management (OCZM). Authorized under the Marine Protection, Research and Sanctuaries Act of 1972, this controversial program has produced two Marine Sanctuaries; the Civil War ironclad *Monitor,* which lies off the Carolina coast, and a Key Largo coral reef.

At present, 20 state coastal programs have been approved by the Secretary of Commerce. Fifteen other states are awaiting enabling legislation, program development, or are negotiating approval with the Office of Coastal Zone Management. It appears, that of the 35 coastal states, only three or four will not have approved programs.

Against this backdrop, I would like to highlight some of the habitat protection efforts, under CZMA, to date. Examples of accomplishments can be cited in three general areas: (1) protection of wetlands; (2) protection of floral and faunal habitats; and (3) protection of reefs.

1. *Wetland Protection*

Thirty-one of the 35 eligible states and territories have new wetland statutes and regulations or improved implementation of existing laws dealing with wetlands preservation. The majority of these states have comprehensive wetland statutes that require a permit for any development that would alter a tidal wetland. In the Great Lakes states, control of dredge and fill activities in wetlands is through permits covering the lakebed bottoms.

South Carolina, Alabama, Louisiana, Texas, the Virgin Islands, and Guam have enacted statutes to protect their wetlands as a direct result of participation in this program. These are places where there are extensive wetland resources and where, previously, there were few, if any, state controls over wetland alterations.

In states where pre-existing wetland laws are being incorporated as part of coastal management programs, improvements in these laws are being achieved. In some cases new and expanded regulations have been issued; in others, more effective implementation has resulted from better information and technical reviews. This is the result of coastal management programs providing additional financial or human resources.

Specific examples of achievements in this area include:

1. *California* has improved dramatically the protection of wetlands under the jurisdiction of the San Francisco Bay Conservation and Development Commission.
2. *North Carolina* has revised its areas of environmental concern guidelines for estuarine systems to restrict development which would adversely affect estuarine resources and to permit only water-dependent uses.
3. *Maine* has adopted new regulations concerning alteration of coastal wetlands

and has broadened significantly state authorities to protect coastal resources by extending the jurisdiction of the state law covering sand dunes.
4. An amendment to *Oregon's* law governing fill and removal in state waters identifies standards for permits and defines, for the first time, the concept of mitigation.

2. *Floral and Faunal Habitats*

Wetlands are prime floral and faunal habitats. Most state wetland statutes include, as a permit consideration, the effect a proposed alteration would have on the habitat value of a wetland. Beyond wetland statutes, 20 states include special protection measures in their management programs which deal with important, unique or endangered flora and fauna. For example, *Delaware* includes its Natural Areas Preservation Act as part of the management program. Additional funds provided through 306 grants will contribute to better enforcement of these acts. Under *Maine's* Critical Areas Program, 203 areas important to flora and fauna, such as colonial bird nesting sites, have been identified and registered. As part of *Puerto Rico's* approved coastal management program, 26 important habitat areas have been proposed for Natural Reserve Designation which will provide extra protection to these areas.

Ten states have identified critical habitats for specific species as special management areas. *Hawaii* has included five Marine Life Conservation Districts in its management program in order to provide protected habitats for the marine life found in the waters off the islands of Oahu, Hawaii, Maui, and Lanai. *Alaska's* program includes protective standards for rocky islands and seacliffs as hauling out grounds for marine mammals. *California's* Coastal Act includes policies to protect rare or especially valuable plant and animal life or their habitats, such as kelp beds. *Massachusetts* has designated Sandy Neck in Barnstable as an Area of Critical Environmental Concern. The area is a prime habitat of the Terrapin Turtle. As part of *North Carolina's* implementation of its Coastal Area Management Act, areas that are of environmental concern (AECs) because they contain endangered species have been designated and now are subject to a Coastal Resources Commission permit. *New Jersey's* Coastal Area Facilities Review Act identifies 24 different types of areas including cranberry bogs and white cedar stands that are to be afforded special protection because of their habitat value. In *Wisconsin,* CZM funding supported the development of a scientific atlas that identifies General Areas of Management Concern (GAMCs) of important or unique floral and faunal value.

3. *Reefs*

In the 13 states and territories where protection of reefs is a significant issue, 10 of these states have measures designed to protect reefs for their own intrinsic value and as major fish habitats.

Coral reefs are important resources of all the islands in the Pacific and the Caribbean. The *Virgin Islands* prohibits the taking of coral. *Guam* protects its reef systems by regulating fishing methods. Despite the fact that most of the corals surrounding *Puerto Rico* are in waters currently within the federal domain, the Commonwealth is developing regulations to protect this resource in anticipation of regaining control over the submerged lands where the corals grow. And, three of *Hawaii's* marine life conservation districts contain important coral reefs which are protected by their inclusion in these districts.

In the Great Lakes Region, the concern with offshore reefs is primarily for their value as fish habitats. *Illinois, Michigan, Minnesota, Ohio,* and *Wisconsin* all protect these areas through their Lakebed Bottoms Permits. Illinois and Wisconsin have used CZM funds to develop fish propagation projects around the reefs.

The establishment of the Key Largo Marine Sanctuary in the Florida Keys was the direct result of the initiative and concern of the state to protect the coral reefs in the waters off Key Largo.

There are other accomplishments in surveys and assessments of reefs and shoal areas.

1. Fisheries management within state waters has received increased attention through coastal management programs. Wisconsin is undertaking a survey and assessment of reef and shoal areas to delineate spawning grounds and to establish allowable harvest levels by fish species.
2. To identify fish spawning grounds, Michigan has collected information directly from area fishermen. This innovative technique proved successful and cost-effective in gathering needed fisheries management information.
3. An additional achievement is Maine's shellfish management activities, which include reseeding depleted shellfish beds, using wardens to patrol clam flats, and conducting water quality testing.

There is a general consensus that the Coastal Zone Management Program got off the ground with its "dry" foot; that is, most of the early focus was on land-use planning, with little emphasis placed on the "wet" or aquatic dimension. The conservation of fisheries habitat, the management of interjurisdictional fisheries stocks, and the development of fisheries facilities were usually not considered in state planning efforts.

Now, through the combined efforts of OCZM, NMFS and the National Sea Grant Office, NOAA is attempting to work more closely with the states in hopes of elevating the importance of fisheries and habitat protection. This will require close coordination with state fish and game directors and much better cooperation between state coastal planners and their counterparts in state fisheries offices. The CZMA requires states submitting coastal management plans to include mechanisms for balancing competing interests. Fisheries interests, therefore, should be routinely represented and considered in state planning and management processes.

The NMFS through the Office of Habitat Protection, has biologists in each regional Environmental Assessment Branch who serve as CZM coordinators. These people provide comments to the Office of Coastal Zone Management on various phases and stages of state CZM programs. Our office is concerned over the inadequate consideration of fisheries resources in many state CZM programs. Let me review some of our concerns and suggested remedies. We believe that the basic foundation of good planning is an adequate data base. Many state CZM programs were approved prior to development of adequate "aquatic resource" inventories, a basic requirement of the CZMA. The problem is compounded further if a local government, in implementing the state CZM program, has adopted local plans without adequate aquatic inventories and with no requirement to improve the decision-making process when better data are available. Standardized, aquatic resource inventories should be required by OCZM. State fish and game agencies, with NMFS assistance, could be used to develop the inventories.

In addition to aquatic inventories, resource protection policies are needed in each state CZM program. Some states do not have comprehensive wetland protection or critical habitat protection policies. These policies and a clear understanding of how they will be implemented are necessary for adequate fishery habitat protection.

The role of state fish and game agencies in many state programs is unclear. In addition, some state fish and game personnel do not understand the impact CZM programs can have on fisheries and consequently do not consider their involvement important. Unfortunately, too, some state fish and game directors have been embittered by the CZM process and, therefore, choose not to participate. In order for state CZM programs to adequately treat fisheries issues, it is in our interest to have state fish and game personnel actively involved. Most state fish and game agencies do not have the staff to participate fully in the development and implementation of state CZM programs. The Act does allow state fish and game agencies to use funds for CZM planning activities, but those funds are prioritized and passed through the state land use agency. This funding process has further complicated the relationship between state CZM and state fish and game agencies. Alternate funding sources, such as NMFS, or a higher prioritization of fishery items in a state CZM budget, could improve the situation.

Early state CZM programs and OCZM efforts concentrated on development of processes for decision making in coastal areas. Many of those processes were general, however, and failed to specify how decisions involving fisheries resources would be made. More recent efforts to develop specific decision-making documents (Special Area Management Plans) more successfully address all interests and predict how resources will be affected in the future.

Special Area Management Plans (SAMPs) allow the predictability and specificity needed by all parties in the CZM planning process. These plans are detailed land and water use plans for areas comprising a natural system, such as an estuary. Such a plan would ideally involve local, state and federal agencies and special interest representatives in the decision-making process. Long term (20–50 years) decisions are made for habitat protection, conservation and development, thereby simplifying the permit decision-making process and providing more predictability for all interests. Grays Harbor, Washington, is one example. The State of Oregon requires Special Area Plans for all estuaries in its coastal zone.

Several significant federal resource protection laws impact the coastal zone. These include the Clean Water Act (CWA); the National Environmental Policy Act (NEPA); the CZMA, and the Fish and Wildlife Coordination Act (FWCA). Each law details a process for federal decision making and each needs to be integrated into a broader coastal zone management effort to improve the predictability of decision making in the coastal zone. For example, efforts to develop and implement the Grays Harbor Estuary Management Plan have raised troublesome questions as to how the Environmental Protection Agency (EPA) guidelines implementing Section 404(b)(1) of the CWA apply to Special Area Management Planning. Existing 404(b)(1) guidelines provide inadequate guidance to resource agencies (Environmental Protection Agency, Fish and Wildlife Service, and the National Marine Fisheries Service) for considering and applying land and water use decisions made in a Special Area Plan to the Corps' waterway permitting process.

NMFS and OCZM recently suggested that EPA modify its 404(b)(1) guidelines to better coordinate them with the SAMP process. If coordination of key federal Acts is not accomplished, local, state and federal personnel will have little incentive to participate in state CZM planning. The CZMA may also need modification to better interface with the Clean Water Act, NEPA, and the FWCA.

In order to prevent conflicts over permit decisions, 404(b)(1) guideline principles may need to be incorporated into state and local plans. Presently, some state CZM programs and local programs have elements which conflict with 404(b)(1). This has led to political confrontations between those governments and federal agencies over permit decisions.

Beginning in Fiscal Year 1979, states which have already received one or more grant awards under Section 306 of the Federal Coastal Zone Management Act must include in their annual application for funding a national issues component. OCZM is presently requiring each state to allocate 20 percent of its CZM program funds to address four national issue areas including the protection of significant natural coastal resources including wetlands, beaches, dunes, barrier islands, reefs and fisheries.

Our Coastal Zone Office has developed Coastal Fishery Assistance (CFA) guidelines to help strengthen the fisheries component of existing CZM programs. State CZM managers are encouraged by these CFA guidelines to fund coastal fishery projects in four areas:

1. The state's fisheries: identification of problems, issues and opportunities;
2. Information and data collection;
3. Objectives, policies and strategies; and
4. Implementation strategy and program.

This assistance is not a separate funding source, however, and fishery projects must compete with a myriad of other state and local priorities for limited section 306 funds. Since state CZM agencies have a great deal of latitude in addressing or not addressing living marine resources in their CZM programs, fisheries are not consistently funded with CZM funds. However, as of October 5, 1979, approximately \$3 million of the CZMA funds have been spent on fishery activities and projects. The assistance program appears to be working well in the State of Maryland. There, the state's Department of Fish and Game and the Office of Coastal Zone Management have worked out a program which is a joint collection of data on recreational and commercial fisheries. The NMFS is in strong support of this new emphasis on the "wet" dimension of CZM. Some \$1.7 million will be earmarked this year for fisheries-related projects. We hope that a substantial portion of this money will be geared to habitat protection efforts.

The annual evaluation process (Section 312) of state CZM programs has not produced many of the changes our fisheries and regional coastal zone coordinators feel are necessary. State and federal resource agencies continue to feel they are not adequately included in the process. Until recently, the same people in OCZM who helped the state develop CZM programs were also in charge of the 312 evaluation process. OCZM has now improved its annual evaluation section, and our central office CZM coordinator has been asked to participate as a NOAA evaluation team member. Regional NMFS CZM coordinators also should participate to provide meaningful agency input. We in NMFS intend to participate more fully with CZM at the central office and regional office level to assure that each state CZM program favorably considers habitat protection as well as other aspects of fisheries.

In closing, I feel that it is safe to say that much progress has been made under the CZMA in protecting living marine resources and their habitats. Through new NOAA initiatives, which better focus on the "wet" dimension of CZM, more progress will be made in the future to protect critical wetlands, estuaries, reefs, and other important habitat areas.

Nongame Research and Management

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Introduction

In recent years, wildlife professionals have begun to realize the importance of a segment of our native fauna that traditionally was neglected, harassed, or unrecognized. Remember dickey birds, trash fish, vermin, worthless snakes? Such derogatory terminology and attitudes have not evaporated, but the infusion of ecological thinking and environmental concerns into the wildlife arena has resulted in an expansion of our professional roles and responsibilities. One of the major new challenges deals with nongame wildlife.

The most recent innovations in wildlife management are characterized by an increased concern for species that have largely been ignored in the past. The main common characteristic of these species is that they are not hunted for sport nor trapped for fur. The term "nongame" has been used to designate them. We are aware of the artificiality of the term and of the problems inherent in its use, some of which were recently discussed by Brocke (1979). But we believe the term is useful in defining a group of animals within the discipline of wildlife management that now divides its subjects into categories such as waterfowl, upland game, furbearers, and big game. At the same time, we are less than enthusiastic about the term because an inherent fault of using "nongame" is relegation of these species to a *non*status, where by definition they seemingly are animals of little importance or of low priority. This is not the case.

Our objectives are to illustrate the large contribution and role of nongame in wildlife communities, to examine the support and funding for gathering status information and studying these animals, to evaluate their responses to habitat manipulations, and to campaign for the improvement of nongame programs. We purposefully include a broad range of terrestrial animals as a step toward fuller expression of ecosystem diversity, function, and dynamics.

Features of Nongame Faunas

Distinction from Game

We consider game species to be those that are traditionally taken for sport, food, or hides. In general these include among the birds, the larger rails, gallinaceous birds, larger pigeons and doves, all ducks and geese, and woodcock and snipe; among the mammals, the ungulates, rabbits, opossums, carnivores, tree squirrels, woodchuck, beaver and muskrat; among the reptiles, the large freshwater turtles and alligators; and among the amphibians, the bullfrogs and related species. In North America north of Mexico, about 78 species (11 percent) of the total breeding and migratory birds and 66 species (17 percent) of the mammals are used for game purposes. Only 20 species (4 percent) of the native amphibians and reptiles are sport animals. We counted all other vertebrates (excluding fish) as nongame.

Nongame species of course include many taxa other than the amphibians, reptiles, mammals, and birds discussed here. We recognize that fish and especially invertebrates play an enormously important role in ecosystems, and that they can be ignored by managers only at their long-term jeopardy. The present study has been arbitrarily restricted solely for pragmatic reasons and a lack of space for a discussion of the contribution of all these taxa to wildlife communities. Addition of these diverse, numerous groups to our analysis would greatly increase the importance of nongame species in wildlife biology.

Species Richness

In North America north of Mexico, there are about 1,500 species of native vertebrates (excluding fish), comprising about 455 (30.3 percent) amphibians and reptiles (Collins et al. 1978, Behler and King 1979), 395 (26.3 percent) mammals (Jones et al. 1975), and 650 (43.3 percent) breeding birds (Robbins et al. 1966). Also, about 50 additional migratory birds appear regularly and over 100 species occur accidentally or rarely.

The vast majority (89 percent) of North American vertebrates (fish excepted) are nongame species. Songbirds and raptors have received much attention (Smith 1975, DeGraaf 1978a, 1978b, DeGraaf and Evans 1979), whereas other nongame, including salamanders (more than 114 species), lizards (93 species), snakes (120), shrews (30), bats (40), and shorebirds (50), have been ignored or given little consideration as major elements of ecosystems.

Nongame Wildlife in Seven States

Although North American wildlife is among the best known in the world, regional biological information for all major taxa varies widely in quantity and quality, and some states or provinces lack data that are either adequate or recent. We selected seven states across the United States for comparison of the relative numbers of nongame and game species. We did not count extinct or hypothetical occurrences of species. For states bordering oceans, we included marine turtles, birds, and mammals as part of the faunas. Established exotic species (such as pheasants) were included. Bird lists were swelled by rarities or accidentals, but we included these in our state computations unless the species was unlikely to reoccur in the state. We attempted to correct obvious errors or changes in taxonomy. The comparisons are offered as approximations only, because it was beyond our goal to update the lists.

States and pertinent references, by major taxa (amphibians and reptiles, mammals, birds), selected for analysis were as follows: California (Stebbins 1966, Ingles 1965, Small 1974); Colorado (Smith et al. 1965, Armstrong 1972, Bailey and Niedrach 1965); Michigan (Conant 1975, Burt 1946, Wood 1951); Texas (Raun and Gehlbach 1972, Davis 1974, Hambrick 1976, Peterson 1960); Massachussetts (Lazell 1974, Godin 1977, Peterson 1947 and Robbins et al. 1966); Kentucky (Barbour 1971, Barbour and Davis 1974, Barbour et al. 1973); and Florida (all groups from Stevenson 1976).

Appreciable differences in numbers of species, relative contributions of major taxa to total fauna, and percentage of game species were observed among the seven states (Table 1). Number of species were greatest in southern states with coastlines: Texas, California, and Florida. Marine vertebrates added a wealth of species, but more terrestrial species also occurred in southern areas. In general, reptiles and amphibians increase in species richness from northern to southern latitudes (Kiester 1971, Pianka 1977). Although seldom recognized, the average number of breeding birds at sites in the southeastern states is less than the number of mammals, reptiles, *or* amphibians (Kiester 1971). The percentages of mammal and bird species increase as one proceeds northward, and birds are the predominant group in the northernmost latitudes during the breeding season. All states in the group have a high percentage of bird species, partly because we included nonbreeding migrants and rarities.

Game species constituted 11–8 percent ($\bar{X}$ = 15 percent) of the fauna in the seven states (Table 1). The highest percentages of game species were in Michigan,

Table 1. Number of species, and percentage of game species, in different classes of vertebrates (fish excepted) in representative states.

	Amphibians		Reptiles		Birds		Mammals		Total	
State	Total no.	Percent game	Total no.	Percent game	Total no.	Percent game	Total no.	Percent game	Total no.	Percent game
California	49	2.4	73	1.4	525	11.6	200	18.5	847	11.8
Colorado	16	6.3	36	2.8	437	14.9	122	26.2	611	16.2
Michigan	25	4.0	28	6.5	309	14.9	67	40.3	429	17.7
Texas	58	3.4	142	9.1	542	9.2	158	22.8	900	11.2
Massachusetts	21	4.8	29	3.4	324	15.4	84	27.4	458	16.4
Kentucky	46	2.2	59	16.9	309	15.5	64	32.8	478	16.7
Florida	52	5.8	98	19.4	416	11.5	89	24.7	655	14.0
Mean	38.1	4.1	66.4	8.6	408.9	13.3	112.0	27.5	625.4	14.9

Kentucky, and Massachusetts, the states with the fewest total species. Texas and California had the highest total number of species and the lowest percentage of game species. Game animals are generally the same in all states: ungulates, furbearers, rabbits, gallinaceous birds, and migratory waterfowl. Most game species are widely distributed; we found fairly uniform numbers of game mammals ($\overline{X}$ = 28, range 21–37) and birds ($\overline{X}$ = 53, 46–55) in the seven different states.

Human habits vary regionally and influence the kinds of game taken. Floridians consume more species of their reptile fauna (19 percent) than do people in Colorado or California (1–3 percent)—mostly because the percentage of edible turtles is higher in the South than in the West. Other than turtles, and the alligator in parts of its range, reptiles are basically not game species. Only 1–3 of the 195 species of amphibians in North America are regularly taken for human consumption.

Abundance and Biomass of Nongame at Selected Study Sites

Number of individuals of nongame species are high in most habitats in North America. The following examples illustrate the large contribution and importance of nongame in several natural communities.

Wiens (1975) reported that a series of breeding bird censuses in North American coniferous forests showed an average of 33–146 individuals per ha (65–283 g/ha). These values appear to be impressive, indicative of a rich avifauna. But in the montane forests of New Hampshire, Burton and Likens (1975) estimated that there were 2,950 salamanders per ha (1,770 g/ha); there were more salamanders than either birds or small mammals (in biomass, salamanders were 2.6 times greater than birds and approximately equal to mammals). Burton and Likens considered this finding to be somewhat surprising, because most ecologists have ignored amphibians in ecosystem energy flow and nutrient cycling, while considering birds and mammals in detail.

Studies in arid lands also have demonstrated a significant nongame fauna. At Rock Valley, Nevada, there are 24 species of reptiles, 21 of mammals, and 53 of birds (total, 98). In 1974, the five primary lizard species had a combined maximum density of 121 individuals and an estimated biomass of about 570 g live weight per ha (Medica and Turner 1975), whereas small mammals ranged from 26 to 31 individuals and from 236 to 278 g live weight per ha (Maza and Turner 1975). Principal breeding birds contributed only a few individuals (about 1.7) and biomass (about 30 g) per ha. Game animals at this site consist only of doves or, rarely, deer moving through the area. This ecosystem has been composed essentially of nongame species at relatively high densities (about 150 individuals per ha) in certain years. In the California desert, Bury et al. (1977) found small mammals and diurnal reptiles at an average density of 66 individuals per ha (2,861 g/ha) in several creosote shrub communities; density of breeding birds varied from 0.5 to 2.5 individuals per ha (9–50 g/ha).

Densities of nongame species are sometimes remarkably high. Vaughn (1978) indicated that densities of field voles (*Microtus*) may (rarely) exceed over 8,000 per ha. For reptiles, Turner (1977) reported a few examples of exceptionally high estimated densities: a lizard *(Anolis acutus)* population in the Virgin Islands, 4,200 individuals per ha; and a skink *(Scincella)* in Louisiana, 1,500 per ha (2.3 kg/ha). In

Kansas, Clark (1970) found 550 worm snakes *(Carphophis)* per ha (3 kg/ha) and Fitch (1975) estimated 1,000–1,500 ringneck snakes *(Diadophis)* per ha. These are maximum values, and some represent rare occurrences; however, more often than not, nongame species are numerous components in communities.

In many (if not most) natural communities, nongame species constitute the greatest portion of vertebrate species, individuals, and biomass, and they are energetically critical elements in the functioning of ecosystems. This abundance underscores the need for thorough sampling of communities, so that biologists understand the relative importance of game and nongame species, and how these wildlife resources can best be protected or managed.

Interest and Support for Nongame

The pursuit of nonconsumptive uses of wildlife and interest in nongame animals is substantial. Birdwatching and wildlife photography are big businesses, and persons who enjoy these activities are often prepared to spend large amounts of money pursuing them (More 1979). For example, in 1974 the estimated expenditure for the enjoyment of nongame birds in the United States totalled about $500 million (DeGraaf and Payne 1975). An estimated 22 percent of the nation's population now participates in birdwatching (Kellert 1977), and about 4 percent in wildlife photography (U.S. Fish and Wildlife Service 1977). Shafer and Moeller (1974) predicted that nonconsumptive use would be the dominant form of wildlife-related recreation by the year 2000, whereas More (1979) believed that it probably already equalled consumptive uses in the late 1970s.

Scientific and naturalistic interest in nongame is also significant, but is seldom considered for its own value or in economic terms. In California, about 2,500 scientific collecting permits are issued each year (J. M. Brode, pers. comm.)—a number that indicates that the biological study of animals involves an appreciable investment in time and money. Stebbins et al. (1977) reported that educational use during one year in the California desert totalled at least 256,900 person-days at 272 sites. Study of biology was the most frequent educational use, and nongame species were an important element because they constitute the bulk of desert wildlife, as we showed earlier. These examples clearly indicate that educational and scientific interest in nongame is appreciable.

Expenditure by governmental agencies for nongame species, however, is considerably smaller than that for consumed species of wildlife. For instance, Colorado—one of the leaders in nongame research and management—provided about $1,047,000 for nongame in 1980, as compared with $20,094,000 for game species; thus only 5 percent of Colorado's wildlife funding went to nongame projects. Another major leader is California which in the early 1970s spent only 2 percent of its wildlife budget for nongame (Bury 1975), but about 10 percent in 1980. Most of these nongame programs are for threatened or endangered species. Although precise figures are difficult to obtain or categorize on a national level, a general assessment of funding for nongame was made by the Wildlife Management Institute (1975). States and territories spent about $3.4 million and federal agencies $13.3 million for nongame projects (management, research, law enforcement). These expenditures sound encouraging, but they represent only about 2 percent of the state and territorial projects and 11 percent of federal programs for wildlife. Roughly one-third of these efforts for nongame were for threatened or endangered species. Most of the projects included high-visibility groups that are potentially threatened (for example, raptors) or nuisance species (burros and coyotes, for example), and even some former game species (tule elk).

Priority of expenditures is mostly on game, then endangered and threatened species, high-visibility birds (especially songbirds and raptors), and "other" (nongame). This order is the reality now, but as we indicated earlier, the nongame group represents a major proportion of the species and individuals present in many ecosystems. The trophic importance of these species is neglected or seldom appreciated, and relatively little or no funding is earmarked for study of these species.

Overall, current nongame programs are badly underfunded. More support should be provided for nongame species because of national trends toward greater nonconsumptive uses of wildlife, less hunting by the population (proportionally), and ecosystem approaches to management. These trends will increase the demand for nongame planning and research. At the same time, arbitrary barriers or forced conflicts between the needs of game and nongame are usually unnecessary, because programs dealing with these wildlife forms include protection and management of the animals plus their habitat. For example, game animals (especially large ones like moose and elk) are important for their aesthetic attractions, as well as for their sporting qualities (Lime 1976). Where game revenues protect habitat and foster ecological research, nongame benefits—and the reverse is also true. Thus, any schism between game and nongame or inferred competition for support is largely artificial. Both are important to the conservation community, including preservationist, naturalist, scientist, and hunter, all of whom benefit from wise management of the land and its associated wildlife.

The Fallacy of Habitat Improvement for Wildlife

The commonly expressed goal of environmental projects and management plans is the improvement of habitat for wildlife. Some land managers use the term as if there was indeed "good" and "poor" wildlife habitats, and a common assumption seems to be that most undisturbed habitats can somehow "benefit" from judicious manipulation. A dangerous corollary of this assumption is that permanent or temporary environmental alterations (such as, logging) are partly justified on the basis that they are good for wildlife. We now examine the basis for these ideas and their potential impact on wildlife—especially nongame wildlife.

The concept of habitat improvement is usually valid for single-species management. In most environments, habitat manipulation can result in more deer, quail, ducks, or other target species (including endangered species). This idea can also be applied to management for groups of game species with similar habitat requirements, such as shallow pools for dabbling ducks or forest openings (edges) for ungulates.

Recent shifts in management objectives, from an emphasis on single species or small groups of game species to the recognition that the habitat requirements of nongame species must be considered, have brought about the need for new management techniques and principles. Instead of habitat improvement for deer, quail, or turkeys, there is now habitat improvement for wildlife. But attempts to apply this concept to multispecies communities have led to management schemes for wildlife enhancement. One objective has been to obtain maximum diversity, which is almost always euphemism for the support of entrenched techniques that maintain the maximum amount of ecological edge and habitat diversity. Logging, controlled burning, water manipulation, and small-scale farming are all practices that serve the goal of maximum species diversity. The largest number of resident game species thrive in such disturbed successional mosaics, and it is assumed that the greatest number of other terrestrial vertebrate species respond similarly.

Nongame species as a group, by virtue of their sheer number of species and broader use of environments, have a different biological need than does the set of game species. Management for the maximum numbers and diversity of game animals may result in the concurrent loss of a considerable number of nongame species. Breaking up large habitat blocks enhances the species diversity and number of game animals along the edges, but the opened terrain—often most of the land—may have a decreased diversity and abundance of many other animals. For instance, logging increases forest edge but also causes an overall loss of plant volume and foliage height diversity important to many bird species (Meslow 1978, Gauthreaux 1978), besides having varied effects on the water system, food supply, and cover.

Habitat manipulation is not universally beneficial to all wildlife. Biologists know the effects of specific habitat management techniques on most game species, but know very little about the responses of nongame. The generalization can be made that most "habitat improvements," though benefiting some species, are detrimental to others. The recognition of this generality has been slow in coming. The immediate challenge is to sensitize wildlife managers and administrators to the need for closer examination of the overall effects of their management practices. There is no such thing as "habitat improvement" from a community point of view. Management produces changes that affect different species in different ways.

Informational Needs

Thomas et al. (1976) stated that most of the information needed to construct predictive models of the effects of management practices on nongame wildlife is already available. This statement is probably true for many bird species, which have been the object of widespread observations and studies, but probably not for most small mammals, reptiles, and amphibians, whose ecological reactions are often highly site-specific, depending on details of the local environment. For instance, Page et al. (1978) found that the deer mouse *(Peromyscus maniculatus)* responded differently to grazing pressure in seven Great Basin vegetation types. The critical factor appeared to be the density of ground-level vegetation: overgrazing in xeric habitats depleted the vegetation below the optimal level and mouse populations declined, whereas grazing at the most mesic sites opened up the dense vegetation and allowed mouse populations to increase.

Sedentary species such as reptiles, amphibians, and small mammals may also exhibit striking differences in habitat requirements in different parts of their range; for example, the gopher or crawfish frog *(Rana areolata)* is dependent on burrows of the gopher tortoise *(Gopherus polyphemus)* in peninsular Florida, whereas in other parts of the Southeast it uses a diverse array of subterranean retreats. Thus, management practices that affect tortoise abundance in peninsular Florida similarly affect the abundance of the gopher frog, but the same practices elsewhere may have different effects.

Given the general lack of biological information for many species—especially on the ecological variation within species—it is clear that biologists cannot at this time accurately assess or predict the effects of most types of management on a large segment of the vertebrate fauna. This informational gap can be narrowed only by adequately funded detailed studies. Most current studies are restricted to a few indicator species, and to comparisons between managed and control (unmanaged) sites. More definitive conclusions can be derived from experimental manipulations and broader coverage of the fauna.

Site-specific studies are effective indicators of population trends. The effects of management or harvest of natural resources (economic goals) on individual species or guilds of wildlife at one site can often be extrapolated to other similar areas. Such studies are also the best approach to the elucidation of responses of nongame because there are generally only small to moderate numbers of species at any given place. Thus the entire community can be examined to best understand the different effects of management on varied taxa, trophic levels, and food webs.

Conclusions and Recommendations

There is a need for a holistic approach to the study and management of complex natural systems. Land managers, researchers, and administrators should combine their efforts toward accomplishing this change in wildlife concepts and practices. Species-oriented studies and management are no longer sufficient.

Support for nongame wildlife has increased recently in both state and federal budgets but, even so, most nongame programs are seriously underfunded. We urge a greater recognition of nongame in resource planning and management to enable a comprehensive examination of wildlife communities.

Our national trends toward greater urbanization, proportionally fewer hunters, and recognition of ecosystem dynamics have increased the demand for nongame planning and research, and natural resource agencies should be responsive to these changes. The emphases of nongame programs should be adjusted to coincide with species composition rather than specializing on certain groups. This is a prerequisite to an ecosystem approach for wildlife management in natural and altered habitats. The needs of wildlife would be better met through comprehensive programs that emphasize the study and management of ecological units rather than of individual species.

We believe that every manager should protect significant and representative areas from all habitat manipulation. These areas will serve three important functions: reservoirs of species that need mature vegetation for their survival, wildlife "showcases," and biological yardsticks against which the effects of management can be measured. In many regions it is difficult to find natural areas to serve as controls in evaluating the effects of exploitation or of habitat manipulation on wildlife. Managers should also encourage experimental manipulations of habitat, which will indicate the responses of wildlife populations to land-use practices.

It is time to address the importance of nongame species both in terms of their roles in ecological communities and of the scientific and public interest in them.

Leopold (1930) advised that in the long run, lopsided programs dealing with only game, songbirds, or forests will fail because they cost too much, use up too much energy in friction, and lack sufficient volume of support.

The increased consideration of nongame species in wildlife management does not merely increase the list of species that a manager must be concerned with; it necessitates a fundamental reorientation of the principles for the management of wildlife and natural habitats. Implementation of this new wildlife management requires a much higher expenditure of effort in the collection of information on nongame species than has been customary. It is our concern that the great bulk of vertebrate species are not receiving the share of support and attention that they deserve as interesting and important members of most natural communities.

Whether or not nongame species are considered to be important on the grounds of visibility, popularity, or economic good, the professional wildlife biologist and manager must recognize, sustain, and defend these animals as critical components of natural systems. The professionals and the public should heed the warning of White (1967) that we shall continue to have a worsening ecological crisis until we reject the axiom that nature has no reason for existence save to serve man.

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Endangered Species: An Economic Perspective

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Because it is irreversible and its future implications are very uncertain, extinction of plants and animals is an important, though largely unrecognized, economic problem. After examining the economic nature of this problem more fully, the paper focuses on economic approaches to public decision making. More specifically, it will be shown that conventional benefit:cost analysis is not applicable to endangered species. An alternative, termed the SMS (safe minimum standard) approach, is then proposed. The SMS approach focuses attention on the social costs of avoiding extinction as a measure of the burden on the present generation of reducing the uncertainty that will fall largely on future generations if extinction is permitted to occur. Not a great deal is known about these costs, but economic studies relating to five species do provide some useful insights. Thus, the second half of this paper will briefly survey these case studies, which involve the California condor, the leopard lizard, the California tule elk, the snail darter, and the mountain gorilla. The final section draws conclusions from the conceptual discussion and case studies about the economic prospects for endangered species conservation.

Conceptual Issues

Extinction as an Economic Problem

Though the economic literature on endangered species is not large, some aspects of the problem have been receiving attention. These include the inability of the market system to cope with the problem (Amacher, Tollison, and Willet 1972, Bachmura 1971); the role of common property (Berck 1979); the potential importance of considering consumer preferences and relative costs in setting conservation priorities (Miller and Menz 1979); the possibility and desirability of measuring the economic values of some genetic pools (Brown 1979); the possibility that profit maximization might entail extinction for some species with low reproductive potential (Clark 1973); and the economic implications of uncertainty about whether a given action will in fact cause extinction (Smith and Krutilla 1979). Though all of these contributions are of some interest, they miss what, to me at least, is the crux of the problem.

To see what is involved, consider a basic principle of natural resource economics: resources are not, they become. In other words, various characteristics of the natural environment become resources only after humans begin to appreciate their potential usefulness (broadly defined to include aesthetic appreciation and the like). The process by which natural attributes become resources may involve changes in tastes and preferences, technological knowledge, population levels, income levels, relative prices, and policies and institutions. This process of becoming is no less true for living resources than for nonliving resources. History shows that humans have repeatedly fulfilled their needs for food, clothing, building materials, energy, paper products, medicines, and aesthetic and recreational enjoyment through living resources. The biosphere may be thought of as a vast reservoir of potential resources which become actual resources over time through changes in knowledge and in social and economic conditions.

All this is relevant to public decision making about endangered species because the processes through which natural attributes become resources cannot be predicted in advance. Elsewhere (Bishop 1978) I have pointed out that both natural and social uncertainty are present. Natural uncertainty refers to the fact that even today there are tremendous gaps in knowledge about natural attributes of the biosphere that could become resources in the future. Social uncertainty exists because the social forces impinging on the "becoming process" (tastes, technology, etc.) cannot be predicted very far into the future. Extinction of a species may mean that nothing of eventual significance has been lost *or* that what eventually would have been an important resource has been irreversibly destroyed.

All this means that if a species can be maintained at no cost to society, it should be, since it contributes to the reservior of potential future resources. However, in some cases, preventing extinction will involve costs. Then, society will face a choice. On the one hand it can bear the costs. On the other, it can avoid the costs by permitting extinction and create the possibility that large future economic losses will be incurred because an important future resource has been lost. The crux of the public decision problem is to come to grips with this choice.

The SMS Approach

One possible approach to the problem would be to attempt to define conditions for an economically efficient choice between conservation and extinction, perhaps through application of benefit:cost concepts. At least at the theoretical level, some economists, most notably Smith and Krutilla (1979), Miller and Menz (1979) and Plourde (1975), have argued that an efficiency approach yields valuable insights. I would argue (Bishop 1979), however, that an efficiency oriented approach is incorrect because it assumes away some of the most important parts of the problem. First, to estimate the benefits of maintaining a species, one must assume that the uncertainty we just finished discussing does not exist, whereas dealing effectively with that uncertainty lies at the heart of the problem. Secondly, an efficiency-oriented approach would completely ignore all issues of equity or fairness in the distribution of economic gains and losses, yet endangered species decisions must necessarily confront an important issue of intergenerational equity. While the cost of maintaining a species that will otherwise become extinct will fall largely on the present generation, the uncertainty created by extinction will fall mostly on future generations. Hence the decision problem can be restated: To what extent is it fair for the present generation to bear costs in order to reduce the uncertainty faced by future generations? An efficiency-oriented approach would completely overlook this ethical issue.

What I have proposed is an alternative approach which will deal directly with uncertainty and intergenerational equity, the SMS approach. SMS stands for the "safe minimum standard of conservation," a concept which has its origins in the work of University of California-Berkeley resource economist S.V. Ciriacy-Wantrup (1952). The theoretical roots for the SMS approach may be found in the book by Ciriacy-Wantrup and my own writings (Bishop 1978, 1979). The practical decision rule that results from these theoretical analyses is easily stated: *Avoid extinction unless the social costs of doing so are unacceptably large.*

An obvious question arises at this point: How large would costs have to be before they become unacceptably large? However, because intergenerational equity is a central issue here, economics as a science cannot answer this ethical question. There is no satisfactory scientific definition of what is fair and unfair.

At this point, many people throw up their hands as if economics has nothing at all to offer. This would, I think, be a mistaken and very unfortunate conclusion to draw from what has been said so far. Though there is no criterion for defining an economically optimal public decision in endangered species cases, the economist can still contribute to the decision-making process in two important ways. First, the economist can help the decision maker and society as a whole to realize that potential extinction is an economic issue. Economic arguments along the lines already presented in this paper are important to counterbalance short run economic interests that become so vociferous during controversies over endangered species habitat. Second, the economist can bring a fairly sophisticated set of tools to the question of how large the social costs of conservation efforts really are. As the case studies presented below will illustrate, costs are not as easily understood as the noneconomist might expect.

If the SMS approach is accepted then the next question is an empirical one: How much are existing or proposed conservation efforts likely to cost? The answer is that there has not yet been a great deal of work on this question, but some case studies can be summarized.

Case Studies

In making the transition from the conceptual level to applied economics, some introductory remarks need to be made. First, what exactly is meant by the term social costs? Two types of costs will be of particular concern. "Out-of-pocket costs" refer to actual monetary expenditures by public agencies and private individuals and groups which are directed toward species conservation. Examples would be expenditures for population monitoring, research to better understand the needs of endangered species, law enforcement to prevent theft or poaching, and public relations campaigns to better inform people about what they can do to promote survival of a plant or animal species. The other category of costs is the "opportunity costs" which may be incurred if resources of the habitat cannot be exploited or can only be exploited at higher costs if the species in question is to survive. To get at total social costs, any measurable benefits of conservation efforts must be subtracted from out-of-pocket and opportunity costs. Some species, if saved from extinction, may produce measurable recreational benefits because of their aesthetic qualities, for example. Or, habitat set aside for species conservation may also be usable for some forms of outdoor recreation. Social costs thus equal out-of-pocket costs plus opportunity costs minus the measurable benefits of conservation programs.

In examining the various case studies the reader will note that in several instances upper bounds rather than precise estimates of costs are given. The goal of economic analysis is to obtain a general assessment of costs. Precise estimates may sometimes be difficult and expensive to determine and may be of little value in public decision making. The practical solution is to estimate upper bounds that reflect the potential magnitude of costs without wasting time and effort on unnecessary refinements. Also cost estimates will normally be given in annual terms, a common practice in benefit:cost analysis. The year of each estimate will be emphasized both because of inflation and because economic conditions change. In some cases, effects of changes in economic conditions are discussed, but to fully update each of the estimates to 1980 would have required new economic studies and this was infeasible.

California Condor

Let us begin with the California condor. The condor is in serious trouble. Current numbers probably do not exceed 40 individuals. There has been an incessant downward trend in the population for more than a century. Management and public relations efforts aimed at reducing wanton shooting of condors, maintaining remaining habitat, and assuring adequate food supplies have probably succeeded in slowing this downward trend, but not in reversing its direction. A new proposal to attempt captive propagation is bogged down in a debate over whether it will help the species or hasten its extinction.

Efforts to save the condor have involved costs. Out-of-pocket expenditures probably were averaging about $100,000 annually in the mid-1970s. With recent inflation and assuming that captive propagation does get started, this figure could double. The opportunity costs, however, are probably much larger.

Unfortunately, the largest single opportunity cost is also the most difficult to measure. The best remaining condor nesting habitat also has considerable petroleum potential. How much oil and gas could be found in the area is not at all clear and further exploration to determine reserves has not been permitted because of possible harm to the condor. Such exploration might find no producible oil at all or it might show that one or more significant oil fields could be established. Given that low reproduction is the main cause of current concern for the condor's survival and given that the condor is sensitive to human disturbance in nesting areas, such exploration and possible oil production would make the condor's prospects even more grim.

Uncertainty about petroleum reserves made opportunity cost assessment very difficult. What I did was to simulate an oil field based on drilling costs in the area and experience in an existing oil field on the edge of the area in question (Bishop and Stevenson 1978). The conclusion was that the loss of oil potential in the condor habitat after allowing for potential exploration, development, and production costs was in the neighborhood of $2 million per year under 1975 conditions.

The $2 million estimate is based on an oil price of $10 per barrel, assumed constant over time. At first glance, the fact that oil prices have been rising might be taken to mean that costs have actually exceeded the $2 million estimate. A more careful analysis leads to a different conclusion. When the oil (if any) that lies beneath the condor habitat is produced and used, it is gone. Had a barrel of that oil been produced in 1971 when I began my research on the condor it would have sold for about $3.50. Instead that barrel is still in the ground and is now worth more than $12 per barrel in 1971 dollars (after allowing for inflation). Appreciation of the oil and gas means that my figure of $2 million per year based on a constant price is in fact an *overestimate* of the true social costs. While it would be necessary to re-evaluate drilling and production costs to say for sure, I strongly suspect that the social costs of barring exploration and development of oil and gas reserves in the condor habitat over the last ten years has been zero or less. Furthermore, there are good reasons for expecting that continuing appreciation in oil prices will offset at least partially costs of continuing to postpone petroleum exploration in the next several years.

A second mineral-related issue came up in conjunction with the condor. This involved a proposal to mine phosphate which has not been approved. The United States has ample phosphate resources, but none in California. Thus the social benefits of the mine would consist of the savings in transportation costs for providing California with phosphate fertilizers, as savings which I estimated to be between \$0.5 million and \$1 million per year under 1972 conditions (Bishop 1974). Since postponement and possible abandonment of the mining proposal means that society will lose these benefits, they can be taken as the social costs (benefits foregone) of choosing not to mine.

Because of inflation and rising energy costs, a re-evaluation of this proposal would probably lead to significantly higher social cost estimates under 1980 conditions. On the other hand, there is no good basis for calculating how many of these costs should be attributed to condor conservation. The mine would be located on public lands within easy driving distance of the Los Angeles Metropolitan Area. It would certainly have been controversial and might even have been rejected if the condor had not been involved. In fact, whether the mine site is critical habitat is sufficiently in doubt that biologists working closely with the condor were very hesitant to make the mine a "condor issue."

Now consider the other side of the ledger for a moment. Certain direct benefits of continuing to maintain the condor's habitat should be pointed out, even though they have not been quantified. Not the least of these are associated with the condor itself. As a bird to be seen personally or viewed in photographs and movies, the condor is generating recreational and aesthetic benefits. To the extent that habitat maintenance increases the species' longevity, these benefits will continue to accrue. Then too, mining and oil related activities that could affect the condor adversely would also damage the aesthetic qualities of the landscape which enhance recreational benefits over a broad area of public lands just north of Los Angeles. Thus, recreational and aesthetic benefits associated with both the condor itself and other natural attributes of its habitat offset to some unknown degree the out-of-pocket and opportunity costs of conservation efforts.

My final conclusion was to set the costs of efforts to prevent extinction of the condor at less than \$3.2 million annually. This includes \$2 million per year for oil, \$1 million per year for phosphate, and \$0.2 million in out-of-pocket costs for research and management. Other potential costs of condor conservation efforts were considered during the project (see, for example, Bishop 1973, Bishop and Stevenson 1978) but turned out to be insignificant. The annual social costs are set at *less than* \$3.2 million based on probable appreciation in the real value of oil and the recreation and aesthetic benefits that accrue as by-products of conservation efforts.

The Leopard Lizard

There is some question about the correct taxonomic slot for the next animal to be considered here. It has some characteristics of the blunt-nosed leopard lizard

(Crotaphytus silus), which is considered to be an endangered species in its own right, and some characteristics of the more abundant long-nosed leopard lizard *(C. wislizenii).* Whether it is a hybrid, a subspecies of the blunt-nosed, or a separate species remains to be determined (see literature cited in Stevenson and Bishop 1978), but it has been dubbed *C. silus x wislizenii.* Here, let us simply refer to it as the leopard lizard.

While the condor ranges over thousands of square miles, this leopard lizard's main known habitat is one small area of national forest land in northern Ventura County, California, known as Ballinger Canyon. The problem is off-road vehicles (ORVs) which in recent years have utilized the area in growing numbers, damaging the vegetation that the lizards need to survive.

If the habitat could be maintained, the out-of-pocket costs of leopard lizard conservation would be negligible. Thus, the main social costs would be in the loss in benefits from ORV recreation. Using 1975 data in a travel cost demand model, Stevenson and Bishop (1978) estimated that ORV use in Ballinger Canyon was generating about $140,000 per year in net recreational benefits. If it were to become necessary to halt all ORV recreation in the canyon and no alternative sites in the area were opened to ORVs, the social cost would be $140,000 per year under 1975 conditions. Continued growth in ORV use may well mean that this figure is larger today. On the other hand, a total end to ORV use may not be necessary. Fencing areas of critical habitat would be one alternative. Nearby areas could probably be opened to ORV recreation without damage to endangered species. If so, the resulting benefits would help offset losses at Ballinger Canyon. Thus, the social costs of saving this form of leopard lizard were set at less than $140,000. If additional research shows that the lizards at Ballinger Canyon are the result of mating between long-nosed and blunt-nosed leopard lizards, there will cease to be an endangered species problem here.

California Tule Elk

A third California animal has also been the subject of economic research (Ciriacy-Wantrup and Phillips 1970, Phillips 1976). The California tule elk *(Cervus elaphus nannodes)* is a subspecies of North American elk and is not presently classified as endangered. However, its prospects for survival have definitely been questionable historically and even now numbers are not sufficiently high to warrant a total lack of concern. The main herds of these elk are located on the floor of and in the mountains surrounding Owens Valley in east central California.

Ciriacy-Wantrup and Phillips (1970) showed that the tule elk were not costing very much to maintain. Non-hunting-related out-of-pocket costs borne by state and federal agencies were less than $10,000 in 1968 dollars. During the 1960s there was some public hunting to control herd size, but this was banned at least temporarily by legislative mandate in the early 1970s. Even if public hunts had been permitted, Ciriacy-Wantrup and Phillips clearly demonstrated that the benefits would have exceeded the costs.

Nor are opportunity costs large. There would be some potential for competition between irrigated agriculture and elk on the valley floor except that a large share of the water of Owens Valley is exported to the City of Los Angeles. This arrangement appears to be economically justified and institutionally stable. Los

Angeles bought up a large proportion of the valley floor to aquire water rights and a lion's share of the rest of the habitat is owned by the Federal Government. While there is some competition between elk, deer, and cattle, particularly in dry years, the economic consequences are small. Offsetting these consequences are the recreational and aesthetic benefits that the elk generate in the tourism-oriented Owens Valley economy.

Thus, for purposes of this paper, the social costs of tule elk conservation were set at zero for 1968, and there are no obvious reasons to believe that the situation is significantly different today.

The Snail Darter

The snail darter case is so familiar that its history need not be recounted here. The point to be made is that there is no convincing evidence that the social costs of saving the snail darter would be positive. In a competently performed analysis of the Tellico Project (Davis 1979), a team of economists working on behalf of the Endangered Species Committee challenged earlier findings that the benefits of completing the project exceeded the cost. There were two main areas of disagreement. First, some of TVA's benefit estimates were based on growth scenarios for the Little Tennessee Valley that many people found questionable. Even TVA admitted that there was considerable uncertainty about whether the hoped-for industrial development would actually materialize.

The second disagreement related to whether costs of private land previously acquired by the project should be treated as "sunk costs" in evaluating the benefits and costs of completing the project. Sunk costs are expenditures for resources that have already been irretrievably committed to a project.For example, in the Tellico case, the costs of the already partially completed dam were correctly ignored in evaluating the costs of completing the project. The key word here is "irretrievable." The TVA tried to argue that the investment in land to be flooded and otherwise used in the project should be treated as a sunk cost. Davis argued—correctly in my opinion—that, even though the land had already been purchased, it had not been irretrievably committed to the project since it could be returned to agriculture and other uses. Thus, land costs should not have been treated as sunk costs.

When Davis revised the benefits and costs of completing the Tellico Project to reflect more defendable growth scenarios and land costs, the annual benefits of the project turned out to be less than the annual costs. In terms developed in the present paper, this conclusion is potent evidence that the opportunity costs of maintaining the habitat of the snail darter are close to zero. If the habitat were maintained, it is hard to believe that out-of-pocket costs for snail darter conservation would amount to much. Thus, the social costs of snail darter conservation appear to be near zero.

The snail darter case provides an excellent perspective from which to judge both the value of economic analysis and its limitations. As the drama unfolded it would not have been difficult to conclude that an obscure and worthless fish was standing in the way of an otherwise highly beneficial economic endeavor. In such cases, the economist can make an important contribution by helping to establish what the true socioeconomic implications of alternative decisions are. On the other hand, economics is only one input into the decision process. Unfortunately, in my opinion, political considerations have overridden socioeconomic conclusions in this case, and work is proceeding on the dam.

Mountain Gorilla

Up to now, we have only dealt with U.S. species. Even less is known about the potential social costs of conserving species outside the United States. This is particularly unfortunate given that such a large share of the earth's species are located in tropical areas where so many of the poor countries are attempting to meet at least minimal living standards for populations which are often growing rapidly. Can such countries afford to maintain endangered species?

While quantitative cost estimates are not yet available, the plight of the mountain gorilla *(Gorilla gorilla berengi)* in Rwanda will provide some economic insights. While other small populations exist, much of the hope for survival of the mountain gorilla rests on the Virunga Volcanos region where about 240 gorillas still survive. This is substantially fewer animals than existed in this region 20 years ago, but the population has remained stable for the last 7 years. Out of the total Virunga Volcanos population, 150 gorillas are located in Parc des Volcans, a 30,000-acre (12,000 ha) national park in Rwanda.

Poaching is a serious problem, stimulated by black market trade in skulls and young. As a result of the wide publicity given to recent poaching cases, several international organizations have raised money to help Rwanda cope with this problem. Encroachment by agriculture may turn out to be a tougher problem to deal with in the long run.

The facts of the problem appear deceptively simple on the surface. Rwanda is a very small country with the highest population density in Africa and the population is expected to double by the turn of the century. Roughly 95 percent of her people subsist almost entirely on small farms that average slightly more than 2.5 acres (1 ha) per family. More and more marginal land is entering production each year. In a country where land is so scarce and living levels so low, the existence of even a small national park is precarious. In 1969, nearly 40 percent of what had been the Parc des Volcans came under cultivation and pressures are building to reduce the park even further. Whether the remaining gorillas in Rwanda could adapt is doubtful. While the areas in question would not be very productive in cultivation, they could be used to graze cattle. Furthermore, as an agricultural and pastoral society, most people in Rwanda have little apparent interest in perpetuation of wildlife. Given so much poverty and so little interest in wildlife, it is not surprising that some view continued existence of the park as an unaffordable luxury.

On the other hand, when one begins to dig deeper, this view of the problem appears to be grossly oversimplified. Even in such a small country and even if the very steepest slopes could be farmed, the land in question would only support about 36,000 people, or 25 percent of just one year's population growth. Furthermore, the cattle that would be grown in the newly created high altitude pastures would be much more important as symbols of social status for the relatively well off than as a food source for those most in need. One argument in Rwanda is that opening up the higher areas would free land in the lowlands for crop production, but whether this would actually happen is not clear. Still another consideration is the contributions to food supply of the high forested areas because of their role as watersheds. Reduced stream flows have already been observed as a result of the 1969 changes in the park's boundaries and resulting forest clearing. The probable impacts of further clearing at higher elevations on Rwanda's total food production are not well understood. Serious adverse impacts could occur. Finally, Rwanda is close to the East African tourist centers, and Parc des Volcans could offer some unique, nature-oriented activities, possibly including gorilla observation. This is an as yet almost completely neglected source of foreign exchange and local employment. It may emerge as a more economically attractive use of Parc des Volcans, particularly if governments and private agencies in the developed countries will step up efforts to help Rwanda bear the burdens of conservation.

Because of all these complexities, no attempt has yet been made to estimate the social costs of maintaining the mountain gorilla in Rwanda or elsewhere. The conclusion at this point is tentative and qualitative. Despite population growth and poverty in Rwanda, there is no clear evidence that maintaining the mountain gorilla and the other resources of its habitat in a natural state would involve large social costs either in monetary terms or in terms of human suffering.

Conclusions

This paper has attempted to demonstrate that economics can contribute positively to public decisions affecting endangered species. It can do so by helping to clarify the economic nature of the problem. Far too little is known about the attributes of plants and animals and about future social and economic circumstances to say which species can be safely discarded and which must be maintained. From an economic standpoint, the problem is to decide whether the social costs of avoiding extinction in a given case are larger than the present generation should have to bear in order to reduce the uncertainty that will be borne by future generations if extinction is permitted. Economics can provide valuable insights to the level of these costs.

From an economic viewpoint, there is little basis for arguing that all species should be saved regardless of costs. To live is to take risks. Even a society that places a high priority on stewardship of nature for future generations could quite rationally choose to extinguish a species because the costs of all alternatives are simply too large. On the other hand, existing studies which assess such costs for U.S. species show that at least under current conditions these costs may not be too great. Even for the condor, after all things (e.g., oil appreciation) are considered, the costs appear to be rather modest in an economy that measures its output in trillions of dollars. In the other U.S. cases considered here, the cost of avoiding extinction must be considered negligible. Of course, generalizations are not yet warranted by so few case studies, but it is encouraging that most endangered species are more like the snail darter and the leopard lizard than the condor in terms of habitat requirements.

As for other countries, and particularly the poorer ones with rapidly growing populations, the outlook is clearly discouraging. However, as the mountain gorilla illustrates, care should be exercised not to conclude *a priori* that species conservation efforts are going to be excessively expensive in these countries. More research is needed here.

Recent history is quite sufficient to engender pessimism about long run prospects for the earth's great diversity of life forms. A scenario of a world where there will eventually be no room for anything but people and domestic, economically necessary plants and animals is plausible. On the other hand, the tremendous yet largely unknown potential resources which must still be embodied in the biosphere warrant serious consideration of a second scenario. Here, the world is composed of people who, generation after generation, draw upon a large and diverse reservoir of living potential resources to meet not only their mundane needs, but also their needs for recreation and aesthetic enjoyment. In such a scenario, extinction would be permitted to irreversibly narrow that reservoir when the costs of doing otherwise have been carefully considered and determined to be excessive. Economic studies to date, though still too few to be conclusive, indicate that the second scenario may yet be economically feasible.

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Wildlife Management and Nonhunting Wildlife Enthusiasts

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Introduction

One of the most pressing needs facing the wildlife management profession is to broaden its base of public support. Traditionally, the group most interested in wildlife management as well as the group providing most of the revenue for management activities has been the sport hunter. Today, however, hunters are no longer the only major interest group concerned with wildlife. There is growing evidence that for many Americans, wildlife have become household concerns, whether valued for hunting recreation, aesthetic appreciation, or existence values as symbols of nature and environmental quality.

Certainly, any increase in society's concern with wildlife is a welcome development for wildlife professionals. It does, however, complicate the process of setting priorities for wildlife management. What kinds of wildlife management activities should be emphasized and, very significantly, how can these activities be financed? Although we know a great deal about the kinds of people who hunt, why they hunt, and how they feel about wildlife management (Hendee and Potter [1976] reviewed 33 articles describing hunters), research is only beginning to provide these kinds of information for nonhunting enthusiasts and for the general public (Fazio and Belli 1977, Kellert 1976, 1979).

This paper presents the most significant findings from an ongoing series of studies conducted at the University of Arizona beginning in 1976 (Shaw et al. 1978, Witter et al. 1978, Richards et al. 1979). The general purpose of these studies has been to improve our understanding of that segment of the American public which cares about wildlife but does not participate in sport hunting and of the significance of wildlife resources in providing recreational experiences.

Methods

This study utilizes a sample of individuals who visited seven prominent birdwatching sites in southeastern Arizona in 1977. The unique and diverse biota of this region attracts birdwatchers and other wildlife enthusiasts from throughout North America and many other parts of the world. These people were asked if wildlife appreciation was one of the reasons for their visit to the area and if it was, they were requested to provide their names and addresses so that an extensive questionnaire dealing with their beliefs about wildlife and wildlife management could be sent to them. Seven hundred and six people volunteered to participate. After one reminder postcard and a second mailing of questionnaires, 604 completed questionnaires were returned (86 percent). It should be stressed that these

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results are based on a voluntary sample of participants. This was a select group of very avid wildlife enthusiasts and is not necessarily representative of any other population.

Results

Sociodemographic Characteristics

The sociodemographic characteristics of nonhunting wildlife enthusiasts visiting Southern Arizona are summarized in Table 1. These people were a diverse group. The mean age of respondents was 48 years and 51 percent were over 50 years old. As a group they were quite affluent with over 50 percent reporting

Table 1. Sociodemographic characteristics of respondents.

	Percentage	*N*
Sex		
Male	67	397
Female	33	197
Age		
Less than 20 years	1	8
20–29 years	15	85
30–39 years	21	117
40–49 years	13	74
50–59 years	16	88
More than 59 years	35	197
Household income		
Under \$5,000	6	36
\$5,000–\$9,999	12	67
\$10,000–\$14,999	14	83
\$15,000–\$19,999	16	91
\$20,000–\$24,999	13	73
\$25,000–\$29,999	9	51
\$30,000–\$39,999	16	93
\$40,000–\$49,999	7	39
\$50,000–\$74,999	6	35
\$75,000–\$99,999	1	6
Over \$100,000	1	8
Size of area of residence		
Large Metropolitan (500,000 or more)	23	137
Medium Metropolitan (150,000–500,000)	23	138
Small Metropolitan (50,000–149,000)	14	84
Semi-Urban (10,000–49,000)	20	117
Semi-Rural (2,500–9,999)	9	55
Rural (less than 2,500)	10	58
Education completed		
Less than 12 years	3	16
12 years	8	46
13–16 years	36	217
More than 16 years	53	319

household incomes exceeding $20,000 and nearly a third over $30,000. Most (60 percent) resided in cities of over 50,000 and about a fourth (23 percent) were from large metropolitan areas of over 500,000. These people tended to be well-educated with nearly 90 percent having some college education and over 50 percent with more than four years of college.

Feelings About Wildlife Management

A number of items in this survey dealt with perceptions of and feelings about wildlife management. In several regards, these people were critical of wildlife management agencies. Not surprisingly, they felt that too much emphasis is put on game management and that nonhunters should have input into wildlife policy that is equivalent to that of hunters (Table 2).

However, this willingness to criticize certain aspects of contemporary wildlife management should not be interpreted as opposition to the general idea of wildlife management. Several items dealt with feelings about hunting and management for hunting and although only 7 percent of the sample were active hunters, most were not opposed to the practice. Fifty-six percent considered hunting essential to

Table 2. Feelings about wildlife management and hunting (DS = Disagree strongly; D = Disagree; U = Undecided; A = Agree; AS = Agree strongly).

	Percentage				
	DS	D	U	A	AS
Hunting is essential to prevent overpopulation of some types of wildlife.	12	23	9	48	8
Hunters should not be expected to pay the major part of nongame management costs.	7	17	15	55	7
Nonhunting wildlife enthusiasts do not have an acceptable way to help pay the costs of management of nongame animals by government agencies.	5	17	15	55	7
A good way for government to help wildlife is to ban hunting.	20	53	15	8	4
Wildlife management as currently practiced by government agencies has a good balance between game and nongame management.	20	39	33	8	0
Nongame animals are neglected by government wildlife management agencies.	2	24	21	41	13
Wildlife management as we know it today benefits mostly the hunter.	2	17	16	53	13
Nonhunting wildlife enthusiasts should have a say in government wildlife management agencies equal to the say hunters now have.	1	3	4	42	50

control some wildlife populations and only 12 percent felt that banning hunting would benefit wildlife.

Although these enthusiasts are not necessarily opponents of the wildlife management establishment, nor are they presently allies. There is a need to convince these people that existing wildlife management agencies have something to offer them. Notice throughout those questions dealing with existing wildlife management activities (Table 2) the large percentages indicating "undecided." These are individuals with very strong interests in wildlife and yet many of them have no opinion concerning wildlife management activities. They simply are not aware or concerned, for they tend to view wildlife agencies as arms of hunting interests that have little to offer nonconsumptive enthusiasts.

However, several results of this study suggest that these people might be a significant potential source of support for wildlife management agencies if they believed they could receive direct benefits from these agencies. Most respondents (82 percent) felt that hunters and nonhunters could cooperate to further wildlife welfare and they rated such a union as a high priority for emphasis by governmental wildlife agencies.

Importance of Wildlife-oriented Recreation

In many ways, nonconsumptive wildlife enthusiasts are similar to avid hunters. For both groups, wildlife appreciation is more than simply one of many outdoor recreation activities enjoyed. For most of the respondents in this study, nonconsumptive enjoyment of wildlife is the focal point of their recreational pursuits. Over 50 percent indicated that wildlife appreciation was their most enjoyed outdoor recreational activity and 79 percent listed it as one of three most enjoyable activities. On an average they spend 68 days per year engaged in nonhunting wildlife appreciation and the importance of wildlife-related recreation to these people is further reflected in their expenditures on equipment for nonhunting wildlife appreciation (Table 3). Almost 50 percent valued their equipment used for enjoying wildlife at $1000 or more. Richards et al. (1979) calculated expenditures for travel, food and equipment and found that these nonhunting wildlife enthusiasts were willing to commit significant sums of money and time to satisfy their interests. In fact, the average household cost for a trip to Southeast Arizona to enjoy wildlife was about $580 for these individuals.

Table 3. Replacement value of all equipment owned and used primarily for nonhunting wildlife appreciation.

	Percentage	*N*
Less than $100	6	33
$100–$499	26	148
$500–$999	20	117
$1,000–$1,499	16	90
$1,500–$1,999	8	46
$2,000–$2,499	6	32
$2,500–$2,999	4	21
$3,000–$4,999	8	47
More than $5,000	7	41

Although these people do not generally support wildlife management by state and federal agencies, their concern for wildlife conservation is reflected in their support of private organizations. Seventy-three percent of the respondents contributed to at least two private conservation organizations and 54 percent to three or more such groups.

Additional Studies of Wildlife-oriented Recreation

One additional study examined wildlife appreciation within the context of a real-world resource management situation with multiple demands for resources. Over 1,200 recreationists using Cave Creek Canyon in the Chiricahua Mountains of Arizona have been interviewed to determine the significance of wildlife resources to recreationists using this area (Shaw et al. 1979). Wildlife-oriented recreation was the primary activity of about 18 percent of the visitors to this area and biological resources (primarily wildlife) were cited as the most appealing characteristics by over 20 percent.

Other on-going studies are looking at the aesthetic and existence values of bighorn sheep to hikers in a wilderness area and the perceptions and behavior of wildlife observers at a wildlife refuge. The general objective of these studies is to improve our understanding of how people benefit from wildlife and of the impacts of recreationists on wildlife resources.

It has been widely acknowledged that a large segment of the American public is interested in the welfare of wild animals. What is less understood are such issues as the differences in aesthetic appeal of different animals and in the tolerance of different species to interactions with humans. These are essential issues in any attempts to manage wildlife to benefit nonhunting interests and deserve emphasis in future research. The relationship between these considerations and wildlife management options is presented in Figure 1 (Cooper and Shaw 1979).

Discussion

The participants in these studies are individuals in whose lives wildlife plays a very important role. And yet, their concerns and activities are almost entirely outside the domain of government wildlife management activities. They neither threaten existing state wildlife agencies nor support them. Given the pressures of limited financial resources and constant public scrutiny being experienced by most state agencies, the possibility of enlisting the support of these additional wildlife enthusiasts is worthy of serious consideration. This is particularly true when considering that the concerns and beliefs of these people on most wildlife issues are very compatible with the feelings of wildlife professionals and hunters. In a related study (Witter and Shaw 1979), national samples of hunters, wildlife professionals and birdwatchers were surveyed to determine the potential for cooperation among these groups. That study concluded that there exists a real potential for a union of these groups provided the appeal of state agencies could be broadened to "capture the attention of nonconsumptive wildlife enthusiasts."

Incorporating more nonhunting considerations into the programs of wildlife management agencies will undoubtedly require some compromises. Hunters may be expected to share representation on state wildlife commissions with nonhunting wildlife enthusiasts and there may be certain unique wildlife observation sites

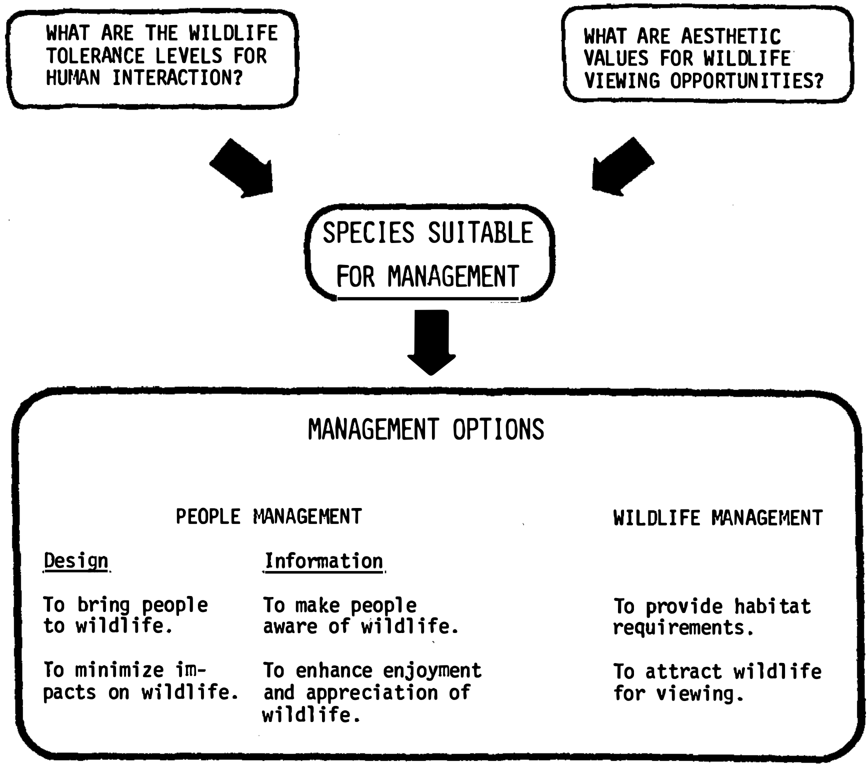

Figure 1. Guidelines for managing wildlife to provide viewing opportunities.

at which hunting is eliminated. However, the effects of such changes on hunting interests may be quite minimal and even beneficial in the long run. Habitat management or preservation benefits all types of wildlife and wildlife enthusiasts.

The real challenge is in finding new sources of revenue to support nongame management. Most of the participants in this study felt that hunters should not be expected to finance the major part of nongame management. They were, however, favorably disposed toward a number of potential funding mechanisms. If these people were convinced that they could receive direct benefits from wildlife management agencies, they might be valuable allies in obtaining new sources of funding. However, until such benefits are demonstrated, the conservation efforts of these wildlife enthusiasts will probably continue to be overwhelmingly oriented toward supporting private wildlife organizations rather than government agencies.

Some states, notably California and Missouri, already have functional mechanisms for supporting nongame management through general fund appropriations or state sales taxes. This money, plus matching funds from the Federal Government (if any of the several proposed nongame bills is passed), should provide the impetus for expanding nongame management programs and subsequently increasing support from nonhunting wildlife enthusiasts.

Other states, however, are still almost entirely dependent on sport hunters for their support. These states would be well advised to use what resources they can in publicizing existing nonhunting benefits and on nongame projects which are highly visible to the public. Most states are involved to some extent with endangered species, urban wildlife problems, conservation education, and law enforcement activities which do benefit nonhunters. The problem is that the nonhunting public is too often unaware of these activities.

Wildlife management can and should be for all types of wildlife and all types of people who care about wild animals. Incorporation on nonhunting wildlife objectives into the plans and programs of state agencies will broaden their base of public support and enhance their effectiveness in managing wildlife for public benefits.

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Consistency in Habitat Preference of Forest Bird Species

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Introduction

Studies of the relationship between habitat heterogeneity and bird species diversity (MacArthur and MacArthur 1961, MacArthur et al., 1962, 1966, Recher 1969, Karr and Roth 1971) and between habitat structure and bird species composition (Cody 1968, 1974, 1978, Wiens 1969, James 1971, Shugart and James 1973, Anderson and Shugart 1974, Anderson 1979, Whitmore 1975, 1977, Robbins 1978) have established a strong correlation between habitat physiognomy and avian community composition. The important implication from these studies for the wildlife biologist is that it should be possible to ascertain the suitability of a given habitat for a particular bird species quite accurately by considering the geometric and structural features of the habitat relative to the species' requirements. However, the predictive aspects of avian-habitat models for specific species have been little explored (but see Robbins 1978). To date most studies have been observational—quantifying habitat where the bird is present and comparing it to habitat where the bird is absent—in an attempt to establish the species' requirements. Validation of the avian-habitat models will ultimately be determined by their predictive ability.

If we assume that habitat structure supplies the individual bird with proximal cues highly correlated with the habitat's ultimate suitability, and that accurate determination of species' habitat requirements is possible, then it logically follows that bird communities can be managed by managing habitat. The success achieved with specific management strategies will indicate both how accurately species' habitat requirements have been identified and to what extent habitat management alone can insure a species' persistence.

Considerable complexity would be added to the development of specific management practices if the habitat requirements of a given species were to vary as a function of geography or change in bird community composition. For example, Noon and Able (1978) and Noon (in press) showed that in the southern Appalachian Mountains the Veery *(Catharus fuscescens)* selects habitats very different from those it occupies in New England. Shifts such as this may result from local population-genetic differences, shifts in available habitat, or changes in the species' competitive environment.

With this problem in mind, we discuss the nature and extent of geographic variation in habitat selection that we have observed in our studies of forest and forest edge birds conducted over the past seven years. Because of the limitations of both co-occurrence and a statistically valid model, our list of candidate species is considerably smaller than the potential number. In addition, because of our habitat sampling methodology, our analyses are sensitive only to rather extensive changes in a species' habitat associations. Subtle changes in a species' response to microhabitat gradients in different parts of its range would only be detected by intensive study of individual species. Such intensive study requires sampling habitat at a nest site and at several points in the environment where an individual bird is repeatedly observed, as opposed to the more general association of the bird with habitat in the immediate vicinity, the method used in our study.

The purpose of this study is to compare breeding bird populations of eastern forest habitats and determine whether common species use similar habitats in different geographic areas. To answer this question we examine bird and habitat data from ten sources. From these data we develop models of habitat preference for selected species at specific locations. Comparison of these models for a given species reveals the nature and extent of any changes in habitat preference. Observed shifts in habitat use are then discussed in terms of possible causation. Finally, we emphasize the importance of our results to the wildlife biologist concerned with avian community management in forested habitats. Specifically, we hope to give insights into the probable success of specific habitat management strategies for wide-ranging bird species.

Study Areas

To detect variability in habitat utilization, we examined bird-habitat associations from several geographically distinct areas (Table 1). The Central Maryland study area was centered in the Piedmont, and Ridge and Valley physiographic provinces of Maryland and surrounding Pennsylvania, Virginia, and West Virginia within a degree block of latitude and longitude (39° N, 77° W) at an elevation range of 135–305 m. The forest type is predominantly oak-hickory; chestnut oak *(Quercus prinus)* was the dominant species in most stands.

The Western Maryland study area was located in the Allegheny Mountain region of Maryland and Pennsylvania, centered at approximately 39° 45′N, 79° 15′W. Because of the relatively high elevation (730–885 m), birds and vegetation are more northern in character than in the adjacent oak-hickory forest type. Sugar maple *(Acer saccharum)*, red maple *(A. rubrum)*, sweet birch *(Betula lenta)*, red oak *(Quercus rubra)*, black cherry *(Prunus serotina)*, *basswood (Tilia americana)*, and eastern hemlock *(Tsuga canadensis)* were common tree species.

Study plots in Ohio were located in the hill country of south-central Ohio, centered at 39° 58′N, 84° 17′W, at elevations ranging from 200 to 335 m. The forest

Table 1. Number of plots and years sampled.

Study area	Number of plots	Years sampled
Central Maryland	67	1979
Western Maryland	95	1978, 1979
Ohio	57	1979
Tennessee	24	1972
Maine	30	1978, 1979
SeneyB	38	1978, 1979
SeneyU	36	1978, 1979
Vermont	35	1978
BBC	144	1971–1979

type is generally oak-hickory; tulip tree *(Liriodendron tulipifera),* red maple, black gum *(Nyssa sylvatica),* and elm *(Ulmus americana* and *U. rubra)* were common associates.

The Tennessee study area was located at elevations of 285–375 m on the U.S. Department of Energy's Oak Ridge Reservation at 35° 58′N, 84° 15′W. Plots were established in the four distinct forest types of the area: pine (predominantly *Pinus echinata),* tulip tree, oak-hickory, and chestnut oak (see Grigal and Goldstein 1971).

The Maine bird and vegetation data (Thomas Dwyer, unpublished data) were gathered on the Moosehorn National Wildlife Refuge (45° 10′N, 67° 20′W, elevation 30–75 m). Plots were located in forest types representative of the region. These were a coniferous forest with spruce *(Picea rubens* and *P. alba)* and balsam fir *(Abies balsamea)* as dominant species; a deciduous forest dominated by gray birch *(Betula populifolia),* white birch *(B. papyrifera),* aspen *(Populus tremuloides* and *P. grandidentata),* and red maple; and a mixed forest, in which conifers *(Pinus strobus,* spruce, and fir*)* were common associates of the hardwoods.

Both the Seney burned (SeneyB) and unburned (SeneyU) study areas were located on the Seney National Wildlife Refuge in Upper Michigan (46° 20′N, 86° O′W, elevation 204–232 m) in habitats characteristic of the region. These habitats included: a mixed forest in which white birch, aspen, red maple, and black spruce *(Picea mariana)* were the dominant tree species; a pine forest characterized by jack pine *(Pinus banksiana)* and red pine *(P. resinosa);* a black spruce forest; and a lowland forest where tamarack *(Larix laricina)* and red maple were dominant (see Anderson 1979).

The Vermont data (Inkley 1980) were collected from plots located on the Grafton Forest Resources Project study area (43° 11′N, 72° 37′W, elevation 244–549 m) in the eastern foothills of the Green Mountain Range. The area lies within the northern hardwood-spruce forest, with the sugar maple-beech *(Fagus grandifolia)*-yellow birch *(Betula lutea)* association the most common forest type.

The northeastern montane study site, Mt. Mansfield (44° 31′N, 72° 84′W, 1339 m summit elevation), was located about 65 km east of Burlington, Vermont. The forests on this elevational gradient have been described by Siccama (1968) and Able and Noon (1976).

The BBC data set consisted of those Breeding Bird Censuses published in *American Birds* (formerly *Audubon Field Notes*) that were accompanied by James-Shugart (1970) quantitative vegetation data. For this study, we considered only those data from forests of the eastern United States and Canada (east of the Great Plains); the plots used were distributed from Manitoba, Ontario, and New Brunswick south to Tennessee and South Carolina.

Methods

Sampling Techniques

Bird observations from Maryland, Ohio, Maine, and Michigan were collected using the point count technique (Ferry and Frochot 1970). Each plot was visited from two to four mornings (0530–1000 hours) during the nesting season. On each 10- or 20-minute visit, the species and number of birds heard or seen from the marked point and within the forest type were recorded. On the study areas in Vermont and Tennessee, bird use of 0.08-hectare plots was recorded during five or six 1-hour periods at different times of the day and nesting season. The spot-mapping technique (International Bird Census Committee 1970) was used to estimate the total number of territorial males present on all BBC plots; size of these plots ranged from 4 to 62 ha. Abundance estimates from these three techniques are not directly comparable; however, each provides reliable data on species presence within a stand.

Census data from Mount Mansfield, Vermont (Able and Noon 1976), are also presented. These data were collected from transect samples located at various elevations along the mountain (see Järvinen and Väisänen 1976).

Vegetation data were collected on from one to eight 0.04-hectare circles using the James-Shugart technique. A list of the variables used in this study is given in Table 2. On the Maryland, Ohio, and Maine study areas, one circle was at the counting point, with additional circles placed a distance of 50 m in the four cardinal directions from this point. In the Seney study areas, circles for sampling vegetation were randomly located within hearing range of the points, and in the Breeding Bird Censuses within plot boundaries. Vegetation on the Vermont plots was measured by a different technique (Inkley 1980), but conversion to James-Shugart variables was straightforward. In Tennessee, biomass data were determined for various vegetative structures and grouped into canopy, subcanopy, and understory tree strata (Anderson and Shugart 1974). We were unable to standardize these measurements to James-Shugart variables, but comparison of the resulting bird-habitat associations was possible. In the Mount Mansfield study area, James-Shugart vegetation data were collected only for five species of woodland thrushes; sampling locations were determined by the bird's position in the habitat (see Noon, in press, for additional details).

Statistical Techniques

For bird species that occurred in at least two geographically distinct locations, two-group stepwise discriminant analyses (Dixon and Brown 1977) were performed to establish the species-habitat associations within a region. Groups were

Table 2. Mnemonics and variables used to describe vegetation structure.

Mnemonic	Variable
AVDI	Average diameter of trees (cm)
BASNAG	Basal area per hectare of dead trees ≥ 8 cm dbh
CPCR	Percent canopy cover
DOMB	Relative basal area of the dominant tree species
GDCR	Percent ground cover
NOTR	Total number of trees ≥ 8 cm dbh per hectare
NOTRC	Number of coniferous trees ≥ 8 cm dbh per hectare
SBDY	Number of shrubs per hectare
SBDYC	Relative density of coniferous shrubs
SNAG	Number of dead trees ≥ 8 cm dbh per hectare
TALL	Average canopy height (m)
TRBA	Basal area per hectare of live trees ≥ 8 cm
TREEA	Number of small trees (8 cm ≤ dbh ≤ 15 cm) per hectare
TREEM	Number of medium trees (15 cm < dbh ≤ 38 cm) per hectare
TREEL	Number of large trees (dbh > 38 cm) per hectare

composed of habitat vectors from plots on which a species was present versus those from which it was absent. The discriminant function calculated for each species provides the linear combination of habitat variables that best separates the groups. A model was judged valid if its classification of observations exceeded the a priori classification probablity and if the function was significant at $p \leq 0.05$. This function was then correlated with each of the habitat variables (Cooley and Lohnes 1971) to produce a ranking of the variables proportional to their univariate F-statistics. Results were compared with those from other regions for the same species to look for consistency or variation in the species' response to available habitat. For instances in which group sizes differed extensively (that is, if a species occurred on nearly every plot within a region), stepwise multiple regression (Helwig and Council 1979) was also used to identify the combination of habitat variables most closely correlated with species' abundance. In these analyses, significant partial regression coefficients were considered a measure of the strength of the variables.

In addition, two-group discriminant analyses of the BBC data were performed for selected species to identify differences in occupied habitat at different latitudes. For a given species, the groups were composed of plots on which the species was present, divided into two geographical regions (that is, north-south).

To determine if observed differences in a species' habitat preference could be explained in terms of structural differences in available habitat, two-group discriminant analyses were performed on all possible combinations of the study areas. In these analyses, a group consisted of habitat vectors from all plots within a region.

Results

Community Comparisons

Observed shifts in habitat utilization of geographically distinct populations within a species' range bring up questions of causation. In general, we envision that shifts could arise from several (not mutually exclusive) pressures resulting from (1) changes in community structure, independent of large scale changes in bird species composition; (2) changes in species composition resulting in competition mediated shifts; or (3) changes in the structure of the available habitat. Shifts in response to habitat availability may simply identify a species as a habitat generalist.

Initially we determined the similarity of the bird communities that we censused. We compared communities according to several diversity indices (Table 3) and their diversity profiles (Patil and Taillie 1979). Comparison by diversity profile supplies considerably more information than point estimates of diversity. Comparing communities by two or more indices may yield conflicting results as to which is most diverse. The diversity profile is a continuous function of each community's apportionment of relative abundance across its species. It includes the information given by the above indices and sensitively reflects changes in diversity within specific abundance classes (that is, rare, intermediate, or dominant species).

There were extensive differences in avian diversity among the study areas; species richness ranged from 28 to 74, and Shannon and Simpson diversities

Table 3. Comparison and relative rank of the bird communities by several diversity indices.

Study area	Number of species	Rank	Shannon	Rank	Simpson	Rank	Shannon evenness	Rank
SeneyU	62	2.5	3.629	2	0.966	1	0.879	3
SeneyB	62	2.5	3.645	1	0.962	3	0.883	1
Maine	58	5	3.463	5	0.958	5	0.853	5
Mt. Mansfield	41	7	3.129	7	0.942	7	0.842	6
Vermont	30	8	2.706	8	0.897	8	0.780	8
Ohio	60	4	3.615	3	0.965	2	0.883	2
Western MD	74	1	3.585	4	0.958	4	0.833	7
Central MD	50	6	3.373	6	0.955	6	0.862	4
Tennessee	28	9	—	—	—	—	—	—

ranged from 2.706 to 3.645 and 0.897 to 0.966, respectively. The rankings in terms of these indices were not consistent across communities. A change in rank was detected as a cross-over in the diversity profile which, when significant, makes it impossible to unambiguously determine which community is more diverse (Patil and Taillie 1979).

A more detailed investigation of the significance of diversity differences is unwarranted. To a large extent the differences in species richness among study areas are more apparent than real. Differences arose from disparity in sampling procedure and intensity, but primarily from differences in the range and size of habitats sampled. For instance, the Vermont (Inkley 1980) and Tennessee (Anderson and Shugart 1974) study sites were confined to relatively homogeneous forest and only birds known to be within plot boundaries were recorded. Plots in the other study areas did not have fixed boundaries and birds were censused over a wider range of habitats. The high diversity of the two Seney sites, despite only moderate sampling intensities, is apparently real. This portion of Michigan's Upper Peninsula is very heterogeneous; the landscape is a mosaic of discrete habitat patches, promoting high bird species diversity.

We also compared the bird communities by plotting their rank-abundance distributions (MacArthur 1957, 1960, Whittaker 1972, Noon et al. 1979). Each study area's distribution of species' relative abundances was compared with geometric series, broken-stick (MacArthur 1957), and lognormal distributions to approximately determine the best-fit model. The biological assumptions underlying these models are ambiguous (Cohen 1966, 1968), thus it is unclear how much can be deduced about the structure of a community fit by one of these distributions. However, rank-abundance distributions, while not providing specific inferences about underlying structure, are informative as a means of community comparison (May 1975, DeVita 1979).

Most communities were accurately fit by MacArthur's broken-stick distribution. An exception was the Central Maryland study area which had more dominant and fewer rare species than predicted. Its distribution was intermediate between the broken-stick and the geometric series. Another exception was the Western Maryland study area which was best fit by a lognormal model, probably reflecting a statistical property of large sample size (Whittaker 1970, 1972).

From the general agreement of the communities' rank-abundance distributions, we infer a similarity in community organization. Similar distributions for bird communities of relatively undisturbed forest habitats have been reported by Noon et al. (1979). May (1975) has interpreted fits to the broken-stick distribution as indicating that some factor is being roughly evenly apportioned among the communities' constituent species. Tramer (1969), whose avian census data were subsequently shown to fit a broken-stick distribution (Longuet-Higgins 1971), concluded that the observed pattern of relative abundance likely resulted from the well developed intraspecific territoriality exhibited by breeding birds. During the breeding season, all species on our study areas apportioned habitat among conspecifics via territorial behaviors.

Similarity in the species composition and relative abundances of two communities can be directly determined by a variety of overlap indices. We have used the Bray-Curtis similarity coefficient (Bray and Curtis 1957) to compare our study areas (Table 4). Similarity by this index is largely a function of geography; the closer two communities are in latitude and elevation the more similar their community composition. The Central Maryland study area is the most distinct (average overlap = 0.3804) and also has the strongest southern affinities in terms of bird species composition. The Western Maryland data set has the highest average overlap (0.4924) because of its central location and the range of habitat types sampled. High elevation sites in this area sampled many northern species that extend their ranges southward down the Appalachian Mountain chain.

In summary, we feel that the different forest communities we studied are similar in their overall community structure. Differences in diversity and rank-abundance distributions largely result from sampling differences. However, the communities differ extensively in bird species composition and abundance of shared species; average overlap between northern and southern sites was less than 45 percent. We cautiously conclude that any observed differences in habitat use are not the consequence of large scale differences in community structure, but may result from changes in community composition or habitat availability.

Interspecific competitive interactions are a second possible influence on patterns of habitat use. As mentioned above, we were unable to make inferences from our data concerning the role of competition. For species showing habitat

Table 4. Similarities among bird communities based on the Bray-Curtis index.

	SeneyU	SeneyB	Maine	Mt. Mansfield	Vermont	Ohio	Western MD	Central MD
Seney U	1.0000	.7733	.6199	.4994	.4626	.3375	.4528	.2818
SeneyB	—	1.0000	.4912	.4236	.3570	.3408	.4251	.3234
Maine	—	—	1.0000	.5734	.5592	.2569	.3957	.1990
Mt. Mansfield	—	—	—	1.0000	.6046	.2327	.3641	.2358
Vermont	—	—	—	—	1.0000	.2833	.3801	.2343
Ohio	—	—	—	—	—	1.0000	.7592	.7184
Western MD	—	—	—	—	—	—	1.0000	.6701
Central MD	—	—	—	—	—	—	—	1.0000
Mean Overlap	.4896	.4478	.4422	.4191	.4116	.4184	.4924	.3804

shifts, competition is very generally discussed in terms of changes in the relative abundance of putative competitors from one study area to another.

Habitat Availability

The third possible influence that we addressed concerned structural differences in available habitat between any two areas. We compared all pair-wise combinations of study areas by two-group discriminant analysis. The results indicate the degree, significance, and nature of any structural habitat differences (Table 5).

All areas were structurally distinct. For all of the 21 possible pairwise compa risons, over 80 percent of the plots were classified into the correct study area. Significant differences were recorded for those variables significantly correlated with the canonical function discriminating the two areas (Cooley and Lohnes 1971). The extent of habitat difference between any two areas is apparent from the number of variables for which the areas showed significant differences (Table 5). For example, the Ohio and SeneyB study areas differed on 14 variables, the Western Maryland–Ohio comparison on only five variables. Thus, the SeneyB and Ohio study areas were more different in habitat structure than were the Western Maryland and Ohio study areas.

Information presented in Table 5 allows us to infer whether shifts in habitat use by a particular bird species have occurred in response to changes in available habitat. Shifts in a species' habitat use that parallel changes in available habitat may simply indicate habitat generality for the species. Shifts not accompanied by parallel changes in availability may indicate either competition mediated changes or population differences.

The extent of structural habitat difference between study areas should be reflected in a turnover in avian community composition. The more distinct the structural habitat of two areas the less similar we expect their bird communities to be. The correlation between the mean distance separating study areas along the discriminant function, an index of habitat difference, and their Bray-Curtis similarity index, $r = -0.377, p = 0.09$, supports our expectations.

Habitat Shifts

We detected few cases of geographical variation in habitat use. Out of approximately 25 valid comparisons, we discovered only two cases of habitat shifts. These were for the Black-and-white Warbler *(Mniotilta varia)* and the Ovenbird *(Seiurus aurocapillus)*.

In the Maine and SeneyU study areas the Black-and-white Warbler (BAWW) occupied open forest areas with high shrub density. However, presence-absence discriminant analysis of BBC plots from the central and southern parts of the species' range indicated that at these latitudes it selected forests with many large trees, well developed canopies, and low shrub densities. These shifts in habitat association are revealed by changes in the correlations for tree (TREEA, TREEM, TREEL, TRBA, TALL, CPCR, and NOTR) and shrub (SBDY) variables between northern (Maine and Seney U) and central and southern BBC study plots (Table 6a).

To determine if the observed shifts in habitat selection by BAWW occurred in response to a change in habitat availability, we compared the BBC plots from the central and southern part of its range (n=77) with the Maine and SeneyU study

Table 5. Structural habitat differences among study areas. Variables in each cell had a significant correlation with the canonical function discriminating the two study areas being compared. Variables in the upper triangle had significantly higher values for the column study area; variables in the lower triangle had significantly lower values for the row study area.[a]

	SeneyU	SeneyB	Maine	Vermont	Ohio	Western MD	Central MD
SeneyU		DOMB, SNAG, BASNAG,GDCR	TREEA, TREEM, TRBA,TALL, CPCR,NOTR, SBDYC	TREEM,TREEL, TRBA,AVDI, CPCR,TALL, NOTR,SNAG	TREEM,TREEL, TRBA,AVDI, TALL,CPCR	TREEM,TREEL, TRBA,AVDI, TALL,CPCR, SNAG	TREEM,TREEL, TRBA,AVDI, TALL,CPCR
SeneyB	TREEA,TREEM, TREEL,TRBA, AVDI,TALL, CPCR,NOTR, NOTRC,SBDY, SBDYC		TREEA,TREEM, TREEL,TRBA, TALL,CPCR, NOTR,NOTRC, SBDYC	TREEA,TREEM, TREEL,TRBA, AVDI,CPCR, TALL,NOTR, NOTRC	TREEA,TREEM, TREEL,TRBA, DOMB,AVDI, TALL,CPCR, NOTR	TREEA,TREEM, TREEL,TRBA, AVDI,TALL, CPCR,NOTR	TREEA,TREEM, TREEL,TRBA, AVDI,TALL, CPCR,NOTR
Maine	DOMB,SBDY, SBDYC	DOMB,SBDY		TREEM,TREEL, TRBA,AVDI, DOMB,TALL, CPCR	TREEL,AVDI, TALL,CPCR, SBDY	TREEM,TREEL, TRBA,AVDI, TALL,CPCR, SBDY	TREEM,TREEL, TRBA,AVDI, TALL,CPCR
Vermont	NOTRC,SBDY, SBDYC	DOMB,SNAG, SBDY	TREEA,NOTRC, SBDY		SBDY	SBDY	TREEL,AVDI, TALL,CPCR, SBDY
Ohio	DOMB,NOTRC, SBDY,SBDYC, GDCR	NOTRC,SNAG, BASNAG, SBDY,GDCR	TREEA,DOMB, NOTR,NOTRC, SBDYC	TREEM,TRBA, DOMB,NOTR, NOTRC		TREEM,TRBA, DOMB,NOTR, SNAG	TREEM,TREEL, TRBA,AVDI, TALL,CPCR

Western MD	DOMB,NOTRC, SBDY,SBDYC, GDCR	DOMB,NOTRC, SNAG,SBDY, GDCR	TREEA,NOTR, NOTRC	TREEM,TRBA, DOMB,NOTR, NOTRC,SNAG	None Significant		TREEL,AVDI, TALL,CPCR
Central MD	TREEA,DOMB, NOTRC,SBDY, SBDYC,GDCR	DOMB,SNAG, BASNAG, SBDY,GDCR	TREEA,DOMB, NOTR,NOTRC, SBDYC	TREEA,TREEM, TRBA,DOMB, NOTR,NOTRC, SNAG	TREEA,GDCR	TREEA,DOMB, NOTR,NOTRC, SNAG,SBDY	

[a]See Table 2 for definition of variables.

Table 6. Correlations of habitat variables with the canonical function discriminating: (a) presence vs. absence data for the Black-and-white Warbler (BAWW); (b) BBC plots from the BAWW main range vs. SeneyU and Maine; and (c) presence vs. absence data for the Ovenbird (OVEN).

Species	(a) BAWW			(b) BAWW		(c) OVEN					
Study Areas Variables	Maine	SeneyU	BBC[c]	BBC vs. SeneyU	BBC vs. Maine	Central MD	Ohio	Maine[d]	Vermont	SeneyU	SeneyB
TREEA	(−)[a]	(−)	+	−	−	(−)		+		+	+
TREEM	−	−		−	−	(+)	+		−	+	+
TREEL			(+)	+	+	(−)	+	(−)		−	
TRBA	−		(+)	+	+	(−)	+	(+)	(−)		+
AVDI			−	−	−	(+)	+				
TALL	−		(+)	+	+	(−)	+	(+)		+	(+)
CPCR		(−)	+	+	+	−	+	(−)		(+)	+
DOMB	(+)					(+)	+		(−)		
NOTR	−	(−)	+	−	−				(+)	+	+
NOTRC	−			−	−	(−)		−		(+)	+
SNAG	nm[b]	(+)	+	−		(−)	+	nm	−	(−)	(+)
BASNAG	nm		nm	nm	nm	(+)	+	nm	nm	−	
SBDY	+	+	−	−	+	(−)	−	(−)	+	−	
SBDYC	−	+	nm	nm	nm	(+)	(−)	(−)	nm		+
GDCR	nm		−	−	nm	(−)		nm	+		

[a]Correlations in ( ) are significant at $0.05 < p < 0.25$; all others significant at $p \leq 0.05$.
[b]nm = not measured.
[c]Presence - absence discriminant analysis from the central and southern part of the species range.
[d]Significant coefficients from a multiple regression model.

areas (Table 6b). The BBC plots contrasted sharply in habitat structure, particularly for those variables indicative of forest structure (TREEL, TRBA, TALL, and CPCR). This result implies that well developed forests are more available to the BAWW in the central part of its range.

The Ohio and Western and Central Maryland study areas also lie well within the range of the BAWW. All these areas have forests dominated by large trees and high, closed canopies relative to the Maine and SeneyU study areas (Table 5). Although areas of high shrub density represent the bird's preferred habitat in Maine, shrub density was significantly lower there than in either the Ohio, Western Maryland, or BBC study areas. The BAWW was rare or absent from our southern study areas, most notably from Central Maryland where its complete absence may be the result of sampling fragmented forests (Robbins 1979). However, when detected on the other study sites it was consistently in closed forest habitat.

It is not clear that the BAWW shows geographic variability in habitat selection simply in response to a change in habitat availability. The mature deciduous or mixed (pine) forests preferred by the species in the center of its range are much rarer at the latitude of our northern study sites. However, areas with high shrub density are available on forest edges in the center of its range. These habitats may remain unoccupied because they are suboptimal, and breeding densities may never be high enough to force birds into these areas.

In light of our uncertainty, we tentatively interpret the bird's pattern of habitat selection to be the result of both population density effects in the south and changes in habitat availability in the north. We have no evidence of any competition effects. The most likely foraging competitors, Red-breasted *(Sitta canadensis)* and White-breasted *(S. carolinensis)* Nuthatches have comparable abundances (the two species combined) across our study sites.

We also detected evidence of geographic variation for the Ovenbird (OVEN). Throughout its range the bird occupies mid- to late-successional forests with well developed canopies (Table 6c). The negative correlations for the Central Maryland study area for the variables TREEL, TRBA, TALL, and CPCR appear to contradict this pattern. However, all sites from this area were in well developed forests differing primarily in size. Ovenbirds were found exclusively in the larger woodlots (C. S. Robbins, unpublished data) which had relatively lower values for these variables. In the central and southern part of its range, the species reaches its greatest abundance in deciduous forests and is considerably less abundant in mixed and coniferous forests. There are local exceptions to this pattern; in some southern pine forests the species may be abundant (see Oelke 1966).

In the Central Maryland, Ohio, Maine, and Vermont study areas, OVEN selected deciduous forest stands and avoided mixed and coniferous forests even when available (Maine and Vermont, Table 6c). In Maine the forests with largest values for TREEL, AVDI, and CPCR were coniferous habitats that were largely avoided by the OVEN. However, at both Seney sites, OVEN habitats were positively associated with coniferous trees (NOTRC). Despite shifting to coniferous forests at Seney, the birds were consistent in establishing territories in habitats with high, closed canopies (TALL and CPCR, Table 6c).

We interpret the divergent pattern of OVEN habitat selection as a response to shifts in habitat availability. The Seney sites have greater availability of coniferous forests than our southern study areas (Ohio and Maryland, Table 5), and conversely decreased availability of deciduous forests. In Maine and Vermont, both habitat types were available but the species preferred the more deciduous forests, perhaps in response to suitability differences between habitat types coupled with moderate to low population densities.

Transect counts of birds along mountains in both the north (New York and Vermont) and south (Great Smoky Mountains) showed OVEN to be confined to deciduous forests below the deciduous-coniferous ecotone (Able and Noon 1976, Noon and Able 1978). Thus, when both habitat types are available, OVEN appears to prefer deciduous forests. However, in areas of high population density (center of range) or low availability of optimal habitat, the species may select coniferous forests.

The OVEN's pattern of habitat selection could be affected by competition from species with similar ecologies. However, we have no evidence of any direct interspecific interactions and the ground-foraging guild (thrushes, wrens, and several fringillids) was well represented in all areas.

We detected a few other instances of minor habitat shifts within a species' range. A north-south comparison of BBC plots occupied by the Cardinal (CARD, *Cardinalis cardinalis*) revealed clear differences in habitat structure. Southern populations are frequently found in mid- to late-successional forests, while in the north CARD are restricted to forest edges and hedgerows. Edge habitats are also heavily occupied in the south, but not to the exclusion of forest habitats. Dow (1969) reported this same pattern of habitat shift and attributed it to the distribution of dense patches of low shrubs and vine tangles used as nesting substrate. In the south these dense patches of vegetation are not restricted to forest ecotones or hedgerows as in the north. Southern forests often have dense understories of honeysuckle (*Lonicera* spp.), poison ivy *(Rhus radicans),* greenbrier *(Smilax* spp.*)*, and Virginia creeper *(Parthenocissus quinquefolia),* particularly along stream borders or in flood plains. Dow also argued that forests are the optimal habitat for CARD and it is only because of very high densities in the center of their range that they secondarily move into forest edges and hedgerows.

Models of habitat selection for the American Robin (AMRO, *Turdus migratorius*) from the Seney sites, Central and Western Maryland, and a BBC north-south comparison revealed a great deal of variety in the structure of the AMRO's preferred habitat, but showed a pronounced shift to coniferous habitats in the north. This shift is clearly in response to changes in availability (Table 5). AMRO also showed variability in habitat preference at single locations. For example, in the Great Smoky Mountains and in the Green Mountains of Vermont AMRO breeds along the entire elevation gradient, occupying deciduous, mixed, and pure coniferous forests (Noon and Able 1978).

Given sufficient data we feel that we would have detected additional shifts into coniferous habitats in the north for those species with wide distributions. The most likely interpretation of these shifts would be a passive response by a habitat generalist to changes in habitat availability.

Habitat Consistencies

We found considerably more instances of uniformity in habitat preference than shifts despite extensive differences among study areas (Table 5). The extent of uniformity in habitat preference was largely a function of the species' range and, in general, was inversely related to the distance between study areas.

Models of habitat preference for the Eastern Wood Pewee (EWPE, *Contopus virens*) were derived from both southern and northern study areas (Table 7a). The EWPE consistently selected deciduous forests with high, closed canopies (TALL, CPCR), large trees (TREEL), and open understories (TREEA). An identical pattern of habitat use was also reported for Tennessee. We interpret the EWPE's selection of forests with open understories to be dictated by its foraging behavior; it uses high perches in the canopy and sallies into the subcanopy to catch flying insects. EWPE preference for open habitats agrees with the conclusions of Hespenheide (1971). However, our models of habitat preference do not concur with Hespenheide's conclusion that the EWPE is an edge bird.

Uniformities in habitat selection for species from our southern study areas included the Acadian Flycatcher (ACFL, *Empidonax virescens*), the White-breasted Nuthatch (WBNU), and the Kentucky Warbler (KEWA, *Oporornis formosus*) (Table 7b-d). Models of habitat preference for these species were supported by presence-absence analysis of BBC plots within their breeding ranges and, for the WBNU, by the Tennessee data.

All three species showed strong preference for well-developed deciduous forests (positive correlations for TREEL, TRBA, AVDI, TALL, and CPCR, and negative for NOTRC). As a consequence we expect them to have a high probability of co-occurrence. However, both the KEWA and the ACFL respond positively to forest interior patches of high shrub density (SBDY), areas apparently avoided by the WBNU.

Agreement in habitat preference also occurred in our northern study areas, most notably for the Yellow-rumped Warbler (YRWA, *Dendroica coronata*) (Table 7e). The YRWA consistently selects coniferous forests throughout its breeding range. At all study sites it preferred the most mature coniferous habitat available. At both Seney locations the YRWA is positively associated with TREEA only because coniferous forests with large dbh trees are not available.

The Veery prefers deciduous or mixed forest habitats with high shrub density in Maine, Seney, Vermont (Mount Mansfield) and Connecticut (Bertin 1977). Additional conformity in habitat preference from the northern study areas was detected for the Canada *(Wilsonia canadensis),* Cape May *(Dendroica tigrina),* and Blackburnian *(D. fusca)* Warblers, species that are largely coniferous forest specialists.

Discussion

Defining habitat suitability as the average potential contribution from that habitat to the gene pool of succeeding generations of the species (Fretwell 1972:82), and assuming that genetic variability is associated with the process of habitat selection, it follows that species will evolve to select the most suitable habitat available to them. Less suitable habitat will not be selected until the best habitats have lost their selective advantage because of density dependent effects (Fretwell and Lucas 1970). Species that occur in areas with a wide range of potentially occupiable habitat may be found only in the most suitable areas because densities are never high enough to force them into suboptimal habitats. This pattern is illustrated by the north-south contrast in habitat preference shown by the BAWW.

Table 7. Correlations of habitat variables with the canonical function discriminating plots where present from plots where absent for selected species. Symbols as in Table 6.

Species	a) EWPE						b) ACFL				c) WBNU				d) KEWA			e) YRWA				
Study Area Variables	Maine	SeneyU	Western MD	Ohio	Central MD	BBC[a]	Western MD	Ohio	Central MD	BBC[a]	Western MD	Ohio	Central MD	BBC[a]	Ohio	Central MD	BBC[a]	Maine	Vermont	SeneyU	SeneyB	BBC[a]
TREEA	–	–	–	–	(–)	–	–	(–)		–	–	–					–	–	–	+	+	+
TREEM	–	+	(+)	(+)				+	(–)	(–)		(+)		(+)		–			+	+	+	+
TREEL	(+)		+	+		+	+	+	(+)	+	+	+	+	+	(+)	(+)	(+)	+	+			+
TRBA	–		+	+		+	(+)	+		+	+	+	+	+				+	+		+	+
AVDI	(+)	+	+	+		+	+	+		+	+	+	(+)	+	+		+	+	+	(+)		
TALL		+	+	+	(+)	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+
CPCR	(+)			+	–	+	(+)	+	+	(+)	(+)	+		+	+	+	(+)				+	(+)
DOMB		(+)		+	+		(+)		–		+	+	+		–	–		–	+	+		
NOTR		(–)	(–)		–	–	–		(–)	–	–	(–)					–					+
NOTRC	–	(–)	–	–		–	–	–	(–)	(–)	–			–	–		–	(+)	+	+	+	+
SNAG	nm	(–)	+		+	–	–	(+)							(+)		–	nm	+	–		–
BASNAG	nm	(–)				nm		+		nm				nm	(+)		nm	nm	nm	–		nm
SBDY		–	–		(–)	–	(+)		(+)		–	–		–	+	+		–		(–)		(–)
SBDYC		+		(–)		nm		(–)		nm	nm			nm	(–)		nm	+	nm		+	nm
GDCR	nm		+	–		(–)	+		+			(–)	–	–	(–)	+		nm	(–)			+

[a]Presence-absence discriminant analysis from the center of the species' range.

On the edge of a species' distribution, the range of potentially occupiable habitats may be reduced and the species may select habitats not occupied near the center of its distribution. Therefore, habitat suitability is a function of availability as well as density. Habitat preference in these areas may represent nothing more than a passive response to changes in availability or, alternatively, it could represent real geographic differences in selection.

In practice it is very difficult to untangle all the possible influences on a species' habitat preference. For those species showing geographical variation in habitat selection, influences from competition (direct or diffuse), changes in habitat availability, population-genetic differences, or all of these may be involved. For the species considered here, neither competitive effects nor genetic differences were rigorously treated. Clearly, to address the importance of these influences would require in-depth, single species studies. When shifts in both habitat preference and habitat structure occurred in parallel, these changes were most easily understood as responses to availability. As a consequence, the more important influences may have been overlooked.

Most species for which we detected habitat shifts have extensive north-south breeding distributions. The Veery is an exception, but note that it shows extensive habitat shifts only in an outlying population restricted to upper elevations of the Great Smoky Mountains. The logical interpretation is that the most likely candidates for extensive habitat shifts are those species exposed to the greatest variety of habitat types. However, this is not a totally satisfactory explanation because many species, such as the BAWW and OVEN, are exposed to a wide range of occupiable habitats at single locations, yet locally restrict themselves to only a few habitat types.

We theorize that possessing both a wide distribution and geographical variation in habitat preference may be characteristic of species that exhibit extensive between-population genotypic variability. Individual populations may be specialized in habitat preference, but when all populations are considered collectively the species appears very generalized in habitat preference (cf. Roughgarden 1974). For the biologist involved with the management of a species with these characteristics, the task may be formidable. Fortunately, for forest birds such cases are probably rare.

The species we detected as showing habitat consistencies had fairly restricted breeding distributions. The ACFL and KEWA have southern distributions, whereas the CMWA, BLWA, and CAWA have primarily northern distributions. In general, restricted distributions may be indicative of habitat specialization. However, both the EWPE and the WBNU have extensive north-south breeding distributions and are unusual in being habitat specialists as well as being widely distributed. WBNU were detected in our northern study sites, but at too low an abundance to model their habitat preferences. However, all observations in northern areas occurred in habitat types comparable to those described by the models. Both these species are specialized foragers and we suggest that this may restrict their habitat options.

Local population densities may have pronounced effects on habitat selection. In areas where population densities exceed the carrying capacity of the most suitable habitat, we predict a more generalized model of habitat preference. The CARD apparently illustrates this pattern of habitat use in the center of its range (Dow

1969). Determining the habitat requirements of birds that show extensive annual fluctuations in abundance may be particularly difficult. If studied during years of particularly high abundance it may erroneously appear that their habitat requirements are easily met.

We substantiated only a few cases of geographical variation in habitat preference. To the extent that our sample is indicative of eastern North American forest bird populations in general, we conclude that the proportion of species showing extensive habitat shifts across their breeding ranges may be quite low. Noting the limitation that we did not assess microhabitat gradients, the implication is that the majority of bird species appear to be stereotyped in terms of their general habitat requirements. High structural habitat fidelity may result from specific nesting requirements, foraging behaviors, food requirements, or predator avoidance behaviors, to name a few.

Conclusions

The important management conclusion that follows from our results is that the habitat requirements of most forest bird species, although quite specific for each species, apply generally throughout their breeding ranges. Thus a habitat management program that proves beneficial in one part of the breeding range of a species has a high likelihood of success in an area hundreds of kilometers away.

Site-specific programs may be necessary for successful management of species whose habitat preferences change across their range. Alternatively, geographical variation in habitat use may indicate that a species' habitat requirements are easily met and that effective management for the species is more readily attained. Close monitoring of a species' response to specific management programs will be required to resolve whether species showing geographic variation in habitat preference are habitat specialists or simply habitat generalists with varying responses to habitat structure.

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Island Biogeography and the Conservation of Nongame Birds

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Introduction

Biogeography is a complex science encompassing several disciplines—geography, biology, ecology, taxonomy, among others. It also is an old science rich in the descriptive geography of plants and animals. During the last decade, biogeographic theory has assimilated new concepts and has emerged as the conceptual focal point in the design of preserves for wildlife (Wilson and Willis 1975). Although resource management is often more art than science (Goeden 1979), biogeographic theory may aid in the decision-making process; thus, the intent of the present paper is to review the concept as a management tool in the conservation of birds. The emphasis is on inland islands—prairie relicts, forests interspersed among agricultural lands, mountains rising above low lying areas, cemeteries or parks isolated by urban development. Nearly all inland nongame bird habitats are insular in character, clearly distinguished from surrounding unsuitable habitat and recognized as distinct by the birds utilizing them.

Equilibrium Model

The equilibrium model of MacArthur and Wilson (1967) proposes the number of species held by an island reflects a dynamic equilibrium between immigration rates and extinction rates influenced by isolation between islands and island area (Figure 1). Perhaps no other ecological theory has generated as much recent interest, for over 100 articles involving the theory are included in recent reviews (Simberloff 1974, Stenseth 1979). The crowning achievement has been the extensive application of island concepts to the design of refuges for tropical birds to include which species will be maintained and for how long (Faaborg 1979).

According to the model, species turnover (immigrations and extinctions) should be high on small islands while total number of insular species remains relatively constant (Figure 1). In Illinois, Whitcomb et al. (1976) reviewed Kendeigh's annual breeding bird censuses of a small isolated (22 ha) forest preserve and reported high turnover. In that study, only 9 of 62 total species were represented in each of 48 censuses since 1927 and 6 others only bred sporadically. Three birds, normally characteristic of the interior of eastern deciduous forests, were not recorded. Total number of breeding species, however, remained relatively constant, thus in general agreement with the equilibrium model.

Support for the impact of isolation comes from comparisons of species numbers breeding in eastern forest islands isolated by agriculture or urban development (fewer bird species) to those islands similar in size and vegetation but near extensive forests (more bird species [Whitcomb et al. 1976]). Declines of 35 to 87 percent in neotropical migrants are evident in metropolitan parks in the District of Columbia or Maryland as urban growth has increased their isolation from similar

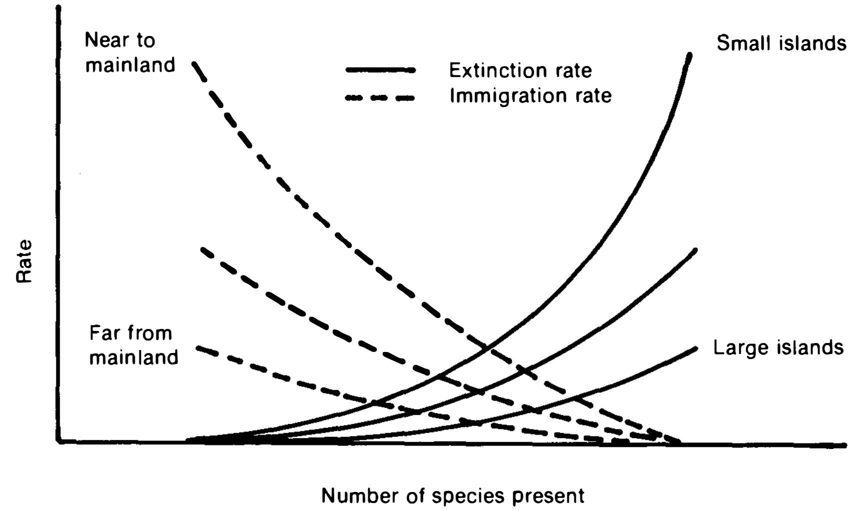

Figure 1. The equilibrium model of island biogeography explains species numbers in terms of immigration rates, extinction rates, island isolation, and area. Large islands have high immigration rates and low extinction rates, as do islands near mainland (after MacArthur and Wilson 1967).

habitat. In a study I conducted in Missouri in 1978 and 1979, a 30.2-ha tallgrass prairie in the southwest where relicts are clustered held 15 breeding species versus 12 (1977) or 13 (1978) on an isolated 31.4-ha relict.

Thus, available evidence suggests land managers should view inland insular bird communities as dynamic entities changing in species composition and influenced by rates of immigration and extinction and extent of isolation from similar habitat.

Island Area

Extensive evidence indicates that the number of plant or animal species in a particular habitat island is strongly influenced by size of that habitat. For example, the area of Great Basin montane "islands" is significantly correlated to number of permanent boreal bird species (Brown 1978). In Montana, montane insular area predicted the number of bird species breeding in forests, grasslands, and other habitats more than habitat heterogeneity, topography, or relief in the Sweet Grass Hills (Thompson 1978). On a local scale, insular area but not internal heterogeneity of mixed oak patches of varying size in New Jersey was a significant factor in predicting number of breeding bird species (Galli et al. 1976 [Figure 2]). Avian use of Illinois lowland hardwoods (Graber and Graber 1976), Wisconsin northern hardwoods (Tilghman 1977), Seattle urban parks (Gavareski 1976), Chicago cemeteries (Lussenhopp 1977), and South Dakota shelterbelts (Martin 1978) is influenced by insular area. In my study in Missouri, insular area, not habitat heterogeneity or food, had a significant influence on number of bird species breeding on 12 tallgrass prairies.

Emerging from local species–area studies is a relatively new concept, the habitat size-dependency of many bird species (Table 1). It is clear that extensive contiguous habitats are important to the long-term survival of many populations of birds (Whitcomb et al. 1977, Robbins 1979). Nearly 50 percent of the birds breeding in New Jersey mixed oak patches were habitat size-dependent (Galli et al. 1976) as were 50 percent in Appalachian forests (Robbins 1979). Nearly two-thirds of all species breeding on tallgrass prairies are habitat size-dependent (Table 1).

Support for the habitat size-dependent concept comes primarily from two sources, the species–area studies (Figure 2) and the observed localized extirpations of species. Declines of 20 to 92 percent in numbers of size-dependent warblers and vireos occurred during the last four decades as large eastern forests have been fragmented (Lynch and Whitcomb 1978). Formerly widely distributed prairie species, the Henslow's sparrow, upland sandpiper, and greater prairie chicken, are now on state rare or endangered species lists as their habitat has been converted to other purposes. Most species on the Blue List regularly reported in *American Birds* are either colonial nesters or habitat size-dependent species.

Importantly, there are clear biological correlates to the habitat size-dependent concept. Habitat size-dependent eastern forest species are primarily neotropical migrants, nest on or near the ground in forest interiors, and raise a single brood from a small clutch. Several size-dependent prairie species share these patterns. Habitat size-independent species—the starling *(Sturnus vulgaris),* gray catbird *(Dumetella carolinensis),* common grackle *(Quiscalus quiscula),* American robin *(Turdus migratorius),* rufous-sided towhee *(Pipilo erythrophthalmus),* and others—differ biologically and have not been negatively affected by habitat fragmentation. They are permanent residents or short distance migrants, have two or more broods per year, nest in the edge or higher in the forest habitat, and generally have a greater chance for reproductive success (Robbins 1979). Unfortunately, minimum habitat size requirements for nongame birds breeding in riparian forests and grasslands, western montane forests and meadows, deserts, short or mixed grass prairies and other major ecotypes are not known.

Use in Management

The intent of the present paper is to contribute toward a management policy for North American nongame birds, specifically the preservation of all naturally occurring North American species. In recent North American Wildlife and Natural Resources Conferences, two major management thrusts for nongame birds have been addressed, habitat diversity and a species-centered approach.

Habitat diversity is a major consideration in managing north-central forests (Siderits and Radtke 1977). Its objective, to establish the greatest diversity with a desirable mixture of habitat components, results in a forest with different vegetative species, age stands and habitat types.

More than 60 species of nongame birds breed in north-central forests, 80 percent migrate annually, and the most abundant are warblers. Few of these are common species and the overall species richness is dependent on presence of uncommon species (Temple et al. 1979). As noted before, there is increasing evidence that many migrants (particularly warblers) nesting in the interior of forests are habitat size-dependent, requiring a large contiguous habitat area for

Table 1. Examples of preliminary estimates of minimum size of habitat required to maintain viable breeding populations (Galli et al. 1976, Robbins 1979, Samson unpub. data).

Minimum area (ha)	Eastern deciduous forest species	Tallgrass prairie species
1–10	Yellow-billed cuckoo (*Coccyzus americanus*)	Horned lark (*Eremophila alpestris*)
	Black-billed cuckoo (*C. erythropthalmus*)	Bluebird (*Sialia sialis*)
	Red-bellied woodpecker (*Melanerpes carolinus*)	American goldfinch (*Carduelis tristis*)
	Hairy woodpecker (*Picoides villosus*)	Dickcissel (*Spiza americana*)
	Downy woodpecker (*P. pubescens*)	Savannah sparrow (*Passerculus sandwichensis*)
	Eastern wood pewee (*Contopus virens*)	Grasshopper sparrow (*Ammodramus savannarum*)
	Black-capped chickadee (*Parus atricapillus*)	
	Tufted titmouse (*P. bicolor*)	
	White-breasted nuthatch (*Sitta carolinensis*)	
	Blue jay (*Cyanocitta cristata*)	
>10–100	Red-shouldered hawk (*Buteo-lineatus*)	Marsh hawk (*Circus cyaneus*)
	Wood thrush (*Hylocichla mustelina*)	Upland sandpiper (*Bartramia longicauda*)
	Yellow-throated vireo (*Vireo flavifrons*)	Scissor-tailed flycatcher (*Muscivora forficata*)
	Red-eyed vireo (*V. olivaceus*)	Short-billed marsh wren (*Cistothorus platensis*)
	Prothonotary warbler (*Protonotaria citrea*)	Henslow's sparrow (*Ammodramus henslowii*)
	Northern parula (*Parula americana*)	Vesper sparrow (*Pooecetes gramineus*)
	Louisiana water thrush (*Seiurus motacilla*)	Lark sparrow (*Chondestes grammacus*)
	Scarlet tanager (*Piranga olivacea*)	
	Summer tanager (*P. rubra*)	
>100	Black-and-white-warbler (*Mniotilta varia*)	Greater prairie chicken (*Tympanuchus cupido*)
	Worm-eating warbler (*Helmintheros verminovorus*)	
	Ovenbird (*S. aurocapillus*)	

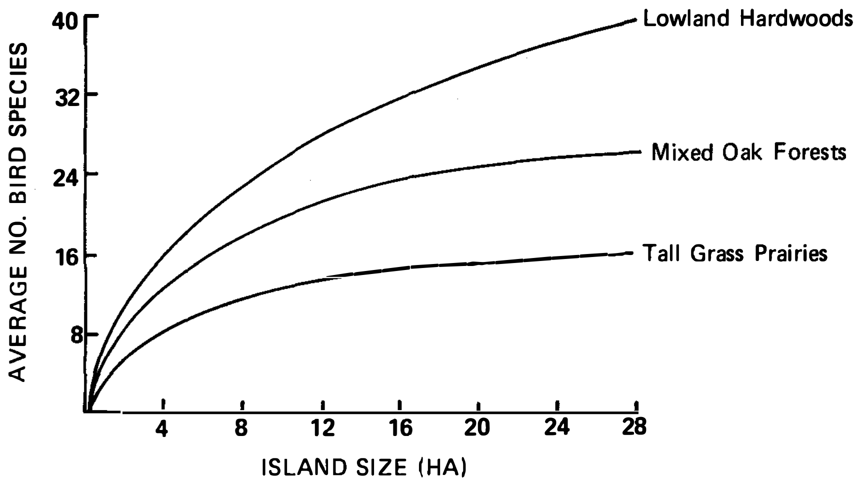

Figure 2. Examples of avian species–area relations in lowland hardwoods after Graber and Graber (1976); mixed oak forests, Galli et al. (1976); and tallgrass prairie, Samson (unpub. data).

long term survival. If habitat diversity is achieved by subdividing large contiguous habitats, then a clear possibility exists for the local or regional loss of habitat size-dependent species. If the management goal is to maintain all naturally occurring species, large tracts need to be maintained (Temple et al. 1979). Lastly, there also are other issues related to this approach. No relation between habitat diversity and number of breeding bird species exists in some habitats (Tomoff 1974), definitions of diversity differ, and extensive data on songbird habitat use suggest maximizing habitat diversity is hardly a valid objective for nongame bird management. These issues have been discussed elsewhere (Webb 1977).

The second management approach centers on a species either featured, sensitive or indicator. Featured species management has been recommended for southern forests (Gould 1977). The species sensitivity approach (Webb 1977) is directed toward avoiding drastic consequences for selected songbirds. An indicator species is often used by land management agencies to monitor the effect of land use changes.

To identify this species, I suggest the habitat size-dependent species requiring the largest minimum area in the habitat under consideration be selected from a species–area curve (Table 1). By doing so, the integrity of an entire bird community and its habitat is maintained; the effect of habitat perturbation, particularly loss, is monitored; and the emphasis is on the long-term survival of all species, both habitat size-dependent and independent. To illustrate, a tallgrass prairie in Missouri with a viable greater prairie chicken population, the species with the largest minimum area (Table 1), also held all other species. An exception may be if a rare or endangered species occurs on an area. However, many of these species have large minimum area requirements; thus both minimum area and rarity may emerge as useful in the species approach.

The species–area approach also has land use applications. On a species–area curve, a minimum area point is reached where a 5-percent increase in number of species requires a doubling in habitat size. This point is reached at 20 ha in Missouri oak-hickory forests (M. R. Mitchell, pers. comm.), at 40 ha in New Jersey mixed oak forests (Forman et al. 1976), at 98 ha in Missouri tallgrass prairies, but few estimates for other habitats are available.

Lastly, not all management units, parks or refuges may need to include all species. Thus, the minimum area point may be useful in balancing habitat needs for the majority of the species in a community and economic or esthetic considerations, whether they be size of timber harvest in managed forests, cost of land acquisition, or the design of urban, suburban or rural parks and refuges.

Summary

First, habitat for nongame birds is becoming increasingly isolated by agricultural or other human activities, thus more insular in character. The number of species on these islands is influenced by area, distance between islands and rates of immigration and extinction. These factors should be considered in the conservation of nongame birds. The need is urgent because the process of habitat fragmentation is escalating and generally irreversible.

Second, to date no study has shown that a nongame bird breeding in North America is restricted to small habitat islands while many are habitat size-dependent, requiring large contiguous habitats. Thus, I reiterate the suggestion of other authors (Whitcomb et al. 1976, 1977, Robbins 1979) that size of habitat be emphasized in the conservation of nongame birds. This does not exclude preservation of small, unique or diverse habitats needed for any taxa that survive in these areas.

Third, I concur with Webb (1977) that a species-centered approach may be the most useful for nongame bird management. In practice, the species–area concept may aid in the selection of the species, and the concept also has application in land use planning. The challenge now is to implement a widely accepted viable ecological theory in the management of nongame birds. Its usefulness in the management of game birds (Fritz 1978), big game (Picton 1979) and a host of other nongame taxa is already evident.

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Bald Eagles and the Management Program at Swan Lake National Wildlife Refuge

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The development of national wildlife refuges and state wildlife areas throughout the United States has markedly affected the winter distribution and concentration of bald eagles, *Haliaeetus leucocephalus* (Sprunt and Ligas 1966, Spencer 1976:131). Many of these areas provide food and protection to migrant and wintering waterfowl. Bald eagles associate with these waterfowl concentrations and feed on naturally dying, diseased, and presumably healthy waterfowl (Snow 1973). Regulated waterfowl hunting, permitted on some areas, increases the eagle food resource in unrecovered dead and crippled waterfowl (Spencer 1976). Many waterfowl refuges support fish populations also utilized by wintering eagles.

Biologists and refuge managers have provided reports about bald eagles associating with wintering waterfowl (Spencer 1976). Numerous studies document waterfowl in the diets of wintering bald eagles (Munro 1938, Wright 1953, Swisher 1964, Southern 1964, Steenhof 1976, and others). Yet, little detailed information is available concerning eagle–waterfowl relations on wildlife refuges. Such information is desirable for refuge management programs for bald eagles. Furthermore, this information could assist the U.S. Fish and Wildlife Service in meeting its Engangered Species Section 7 consultation requirement that all federal agencies relate any management activity to potential effects on endangered species. The potential effect of waterfowl hunting on federal lands where bald eagles are present is a case in point.

The present study was designed to help meet these information needs. It was conducted on and near Swan Lake National Wildlife Refuge (NWR) in north-central Missouri. Data on buildup of wintering waterfowl and bald eagle populations at three other national wildlife refuges in the Midwest are included for comparison.

Swan Lake NWR harbors a large wintering population of Canada geese *(Branta canadensis)*, and hosts a large winter concentration of bald eagles. Controlled goose hunting is permitted in state-managed blinds inside the refuge perimeter. Many factors that influence eagle numbers and activities at Swan Lake NWR are similar to those at other waterfowl refuges.

Study Area

The study area encompasses about 100 square miles (260 km²) in Chariton, Carroll, Linn, and Livingston counties, north-central Missouri. It includes Swan Lake NWR and Fountain Grove Wildlife Management Area (WMA) and the

Grand River between Swan Lake and Fountain Grove (Figure 1). The entire study area lies within the Swan Lake Zone, a 1,400-square mile (3,600 km^2) Canada goose management unit, including both government and private lands.

Swan Lake National Wildlife Refuge

Swan Lake Refuge is located 1.9 miles (3 km) east of the Grand River, and 14 miles (23 km) north of the confluence of the Grand and Missouri rivers. It is an 11,000 acre (4,450 ha) area developed and managed by the U.S. Fish and Wildlife Service.

Swan Lake Wildlife Management Area

This area is a strip 0.25 mile (0.4 km) wide lying within the perimeter of Swan Lake NWR. It has been leased and managed for goose hunting by the Missouri Department of Conservation in cooperation with the Fish and Wildlife Service since 1955.

Fountain Grove Wildlife Mangement Area

Fountain Grove WMA is located 7 miles (11.3 km) northwest of Swan Lake NWR. It is a 5,400-acre (2,200 ha) tract of state-owned land managed intensively

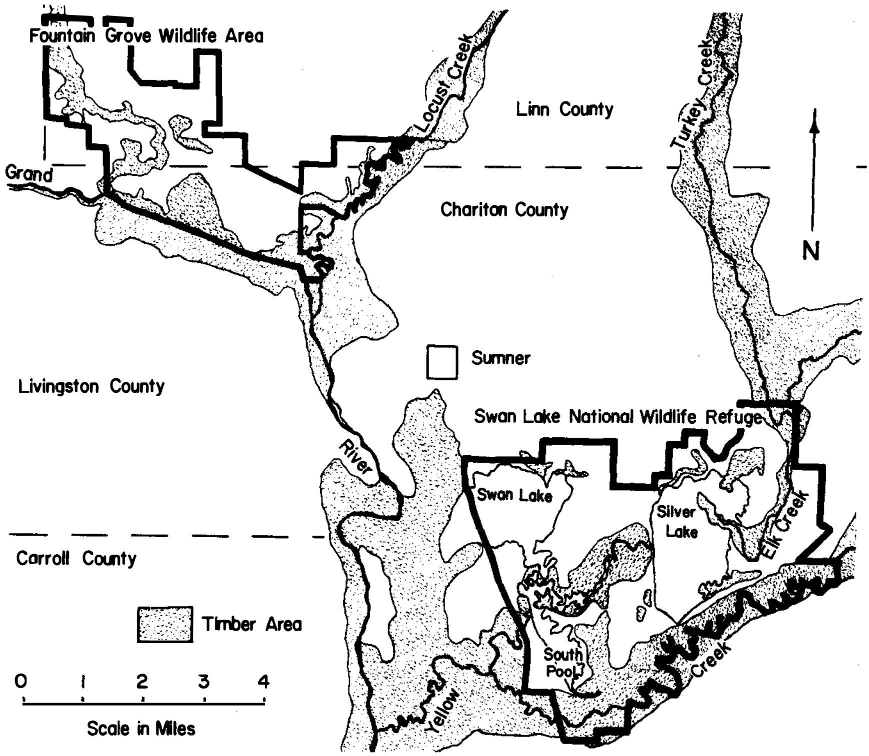


Figure 1. The study area and its environs, north-central Missouri.

for waterfowl by the Missouri Department of Conservation, and serves as a public hunting area. It includes 2,000 acres (810 ha) of shallow water in three major pools.

Methods

Wintering bald eagles were observed at Swan Lake NWR and adjacent areas in north-central Missouri during winters 1975–1978. Weekly counts of eagles were made on the refuge from October through March when weather and wildlife disturbance considerations permitted. Counts were made from a vehicle with binoculars or a scope.

Aerial waterfowl inventories were conducted periodically during the three winters by the Missouri Department of Conservation. Canada goose, snow goose *(Chen caerulescens),* and duck inventories were made within the 1,400-square mile (3,600 km^2) Swan Lake Zone between September and January during each field season.

Feeding activities of eagles were observed throughout the study period. Roosting sites and feeding perches were periodically searched for discarded food and cast pellets. Night roost areas were found by tracking radio-tagged eagles. The presence of large numbers of castings further verified the roost sites. Cast pellets were analyzed by the methods of Errington (1932).

Data on the numbers of bald eagles and Canada geese occurring on the refuge before this study were obtained from refuge narrative reports and from Vaught and Kirsch (1966).

History of Swan Lake National Wildlife Refuge

Swan Lake NWR was established in 1937 to protect and preserve geese, ducks, and prairie chickens *(Tympanachus cupido)*. Construction of dikes and levees formed three large impoundments: Swan Lake, Silver Lake, and South Pool, which provide about 4,940 acres (2,000 ha) of potential wetland. During 1937–1948, fewer than 1,000 acres (405 ha) of refuge were farmed (Vaught and Kirsch 1966). Since that period, land cultivated for wildlife food production has increased to 3,000 acres (1,200 ha). Major crops are corn, milo, and winter wheat.

The Canada Goose Population

Canada geese were rarely seen at Swan Lake before the refuge was established. The earliest documented Canada goose observation was in 1939 when 150 geese were recorded. The first wintering Canada goose populations on Swan Lake were observed in 1941, when 800 geese used the area (Vaught and Kirsch 1966). Wintering Canada goose populations in the Swan Lake Zone have since increased to a peak of 241,000 birds in 1977–1978 (Missouri Dep. Conserv., unpubl. data on file in Columbia, Mo.).

From 1955 to 1978, estimated annual goose harvest in the entire 1,400-square mile Swan Lake Zone ranged from 4,200 to about 28,000 geese. Since 1962, hunter trips in the Zone ranged from 20,402 to 64,096 per year (Missouri Dep. Conserv., unpubl. data on file in Columbia, Mo.). The crippling loss in the area is estimated to be 20 percent of the total Canada geese harvested (Vaught and Kirsch 1966).

The result is a number of carcasses, concentrated on and near the refuge, available as prime winter food for bald eagles.

The Bald Eagle Population

Narrative reports indicate that wintering bald eagles were not seen at the refuge until 1941, when seven birds were observed. Numbers of wintering eagles have increased to a 1978 peak of 128 birds.

The increases have corresponded closely to growth of Canada goose populations at Swan Lake NWR. Although goose hunting in the Swan Lake WMA augmented the food base for eagles, this additional food was not solely responsible for increasing numbers of bald eagles in and near the refuge. Before 1955, when public hunting was initiated, both geese and eagles were increasing at Swan Lake (Figure 2).

Similar trends in waterfowl and eagle populations have occurred at other national wildlife refuges in the Midwest where waterfowl hunting may contribute less directly to the eagle food resource. These include DeSoto NWR in southwest Iowa and Mingo NWR in southeast Missouri. The same trends in eagle and waterfowl numbers are also observed at Squaw Creek NWR in northwest Missouri (Figure 2). However, eagles at Squaw Creek rely heavily on dead waterfowl resulting from hunting outside the refuge.

Initially, increasing eagle concentrations at these refuges occurred when continental bald eagle populations were declining (Sprunt 1968). Habitat destruction by stream alteration projects, especially on the Missouri, Arkansas, and Mississippi rivers undoubtedly had adverse effects on areas utilized by wintering waterfowl (Babcock et al. 1978). Waterfowl habitat development and the subsequent changes in waterfowl distribution appear to have had a significant impact on bald eagle distribution.

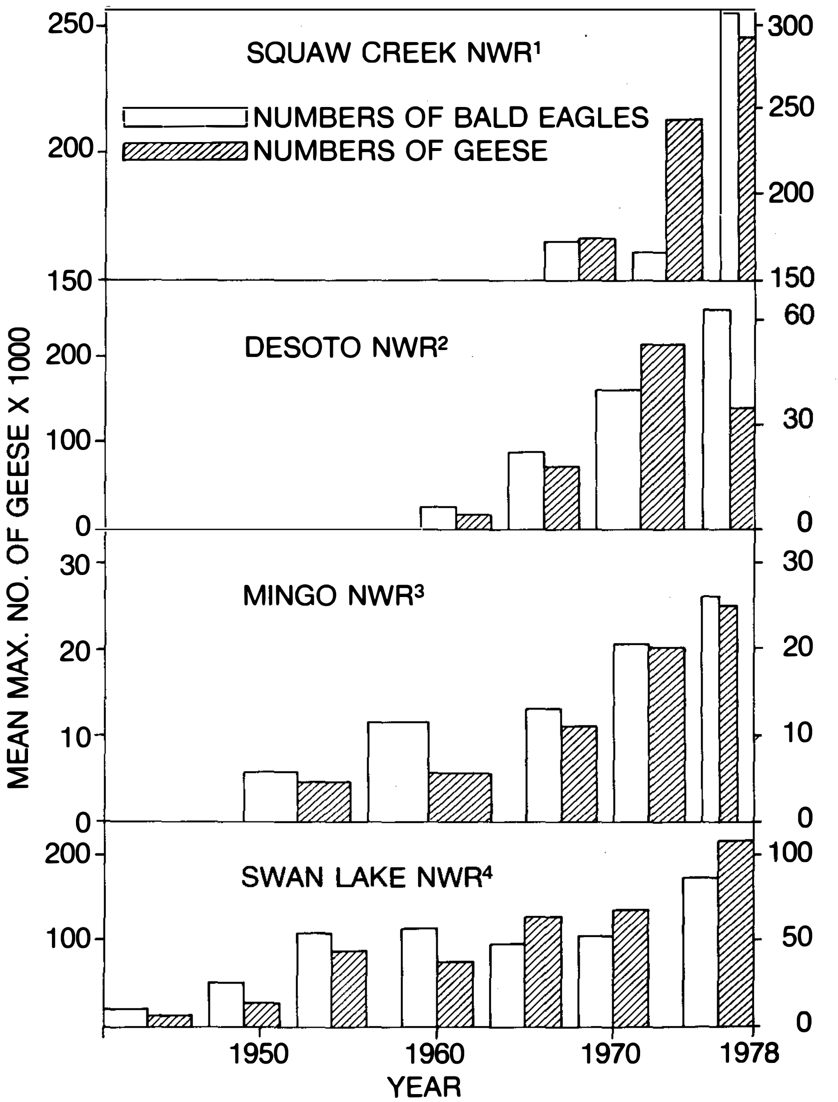
Present Relations Between Bald Eagles and Waterfowl at Swan Lake National Wildlife Refuge

Waterfowl

The Swan Lake Zone hosts the largest concentration of the Eastern Prairie Population (EPP) of Canada geese in the Mississippi Flyway. The Swan Lake NWR and the Fountain Grove WMA provide a habitat base for these geese during the fall hunting season (Babcock et al. 1978).

Geese of the EPP begin arriving at Swan Lake in mid-September from their breeding grounds in northern Manitoba. Numbers increase until December or early January when peak numbers exceed 200,000. Snow geese and ducks, primarily mallards *(Anas platyrhynchos),* also utilize the Swan Lake area. Wintering waterfowl in the study area roost on the refuge impoundments and the Grand River and feed in the surrounding upland fields.

Waterfowl distribution and concentration in the Swan Lake vicinity are affected by weather, habitat conditions including water and food availability, and hunting pressure. Once the waterfowl hunting season begins, geese tend to concentrate on the refuge. With closure of the hunting season, onset of severe winter weather, or depletion of food supplies, the waterfowl move to the Missouri and Grand rivers or to other locations outside the Swan Lake Zone.



1. Numbers of snow geese. 2. Numbers of snow geese. No bald eagle data available for 1970. 3. Numbers of Canada geese. No bald eagle data available for 1950 or 1964. Questionable bald eagle counts for 1952 and 1959-61 omitted. 4. Numbers of Canada geese. No bald eagle data available for 1943, 1957, or 1973.

Figure 2. Chronological relationships between mean maximum numbers of geese and bald eagles at Swan Lake, Mingo, DeSoto, and Squaw Creek National Wildlife Refuges. (Widths of bar-couplets reflect spans of years used to compute means. Five-year means were used when possible.)

Bald Eagles

Bald eagles begin arriving at Swan Lake NWR in early October, and numbers increase to more than 100 birds in early to mid-December. This peak in eagle numbers occurs shortly after the main buildup of Canada goose and other waterfowl populations in the area. Smaller peaks in eagle numbers occur throughout the remainder of the winter.

Eagles move about the refuge, Fountain Grove WMA, and adjacent habitat in response to waterfowl movements, and associate closely with major night and day waterfowl roosts. When waterfowl move out of the area, eagle numbers also decline. Eagles leave the refuge in the spring about the time waterfowl leave on spring migration.

Eagles utilize two primary food resources: waterfowl and fish. Mammalian prey is used to a much lesser degree. Eagles feed on waterfowl from October through the winter until the spring thaw. In a sample of 600 cast pellets collected on Swan Lake NWR during this study, 598 contained waterfowl remains (Griffin 1978).

Eagles feed primarily on abundant Canada goose carcasses and the less abundant remains of snow geese and ducks. Eagles feed on carcasses along refuge impoundment shorelines or frozen in the ice. When these are consumed, eagles rely heavily on the waterfowl carcasses in the refuge fields which are mowed in mid-January.

Crippled and diseased waterfowl, especially Canada geese, are another important food resource. Weakened geese are attacked and eaten.

Although numerous eagle depredation attempts on apparently healthy waterfowl were noted each winter, we saw only five successful attempts. However, we believe eagles prey on live waterfowl regularly at Swan Lake.

Fish replace waterfowl as the primary food resource for eagles when winter fish kills occur on the refuge. The availability of fish carcasses varies with the time of first thaw. Severe winter weather and poor water conditions (high turbidity and low dissolved oxygen) cause large fish kills in some winters. In the winter of 1975–1976, about 200,000 winter-killed fish were available to eagles at Swan Lake NWR. In 1976–1977, the figure was 100,000 (Griffin 1978). When thaws begin to expose fish frozen in the ice, eagles ignore the waterfowl and feed on fish almost exclusively. In winters when a fish kill does not occur, eagles continue to feed on waterfowl until spring migration.

Potential Dangers for Wintering Bald Eagles

Waterfowl hunting in the Swan Lake Zone indirectly provides food for wintering bald eagles, but also can pose some dangers to eagles. These include human disturbance at feeding and roosting sites, shooting, and lead poisoning from the ingestion of lead shot in tissues of prey. Swan Lake management practices have reduced or minimized these dangers while continuing to provide extensive public benefit in the form of goose hunting. These management practices are outlined below.

Disturbance

The Swan Lake refuge interior is closed to public access from October 1 to March 1 and the potential for disturbance to eagles is significantly reduced.

Placement of hunting blinds at the refuge perimeter further diminishes human disturbance. Stalmaster and Newman (1978) demonstrated that vegetation buffer zones on wintering grounds can reduce human disturbance to eagles. At Swan Lake, hedgerows, timber, and cropland between blinds and areas of eagle concentration provide such buffers.

Goose hunting at Swan Lake does not appear to disturb the eagles, or at any rate, to prevent their increased use of the area. Numbers of goose hunters at Swan Lake WMA tripled from 1972 through 1978. Maximum numbers of wintering eagles more than doubled in the same period.

Shooting

Shooting has been the most frequent single cause of death among autopsied bald eagles from Missouri (Griffin 1978) and from the entire United States (Coon et al. 1970, Kaiser et al. 1980). At Swan Lake, the potential for hunting mortality to eagles appears to be great because of the large concentration of hunters and eagles (about 15 percent of the state's wintering eagles are found there). However, from 1968 through 1979, only two eagles were shot at Swan Lake, representing about 5 percent of reported eagle deaths in Missouri. Even this percentage may be inflated because surveillance at Swan Lake is much more intensive than it is elsewhere in the state.

Controlled hunting conditions at Swan Lake WMA provide excellent opportunities for hunter education and intensive surveillance and enforcement. Federal and state agencies promote hunter awareness and protect eagles through information programs. The presence of eagles and their protected status are illustrated by a slide presentation during daily hunter check-in at the state headquarters. Identifying characteristics of adult and immature bald eagles and the penalties for shooting eagles are outlined. Hunters are warned during their check-in and by posters in the blinds that eagle shootings could jeopardize all public hunting near the refuge. The continuance and expansion of these hunter information programs will likely reduce the number of eagles shot in the state each year.

The Missouri Department of Conservation hosts special statewide interpretive programs called Eagle Days (Witter et al. 1980). The public is invited to observe wintering eagles at several concentration points in the state. Films and lectures are presented at weekend programs. Hunter education is not the purpose of Eagle Days, but hunters made up 32 percent of the attendees in 1978–1979. The proportion of hunters participating was more than twice their proportion in the state population (Maupin and Wilson 1979). Swan Lake is one of the sites for Eagle Days.

Lead Poisoning

Concern has arisen about the effects that the ingestion of tissues containing lead shot from migratory waterfowl may have on bald eagles (Hennes et al. 1979). Experimental studies show that lead shot can be fatal to eagles if retained, but they often regurgitate ingested shot. Continual reexposure through the ingestion of additional shot increases the likelihood of death by increased absorption (unpublished data, Patuxent Wildlife Research Center, Laurel, Md.). In a nationwide survey of bald eagles found moribund or dead from 1975 to 1977, lead poisoning accounted for nine (7.4 percent) of the 122 assigned causes of death (Kaiser et al. 1980). The true percentage may be greater than this, for recent experimental work at Patuxent Wildlife Research Center has shown that critical levels of lead in eagle livers are lower than those used by Kaiser et al. (1980) in assigning causes of death (O. H. Pattee, pers. comm.). Long-term effects from continual year-to-year exposure are unknown, as is the importance of sublethal effects on eagles.

At Swan Lake NWR, substantial numbers of Canada geese carry lead shot. Of 20,759 adult geese trapped and fluoroscoped before or after the hunting seasons, 1966–1976, 42.7 percent carried at least one shot. The comparable figure for immatures was 12.4 percent of 9,945 geese sampled (computed from Slagle 1978).

In the present study, 9 percent of 1,206 eagle cast pellets collected at the refuge contained lead shot. Thus, there is ample evidence that eagles at Swan Lake are being exposed to lead shot by feeding on geese, and that the eagles are indeed ingesting some shot. No instances of debilitating or lethal lead poisoning of eagles have been detected at Swan Lake, but our methods would not have permitted detection of subacute cases.

Although relatively few bald eagles are known to have died from lead toxicosis in the United States, and we have detected no obvious threat to eagles wintering at Swan Lake, the potential for some eagle mortality from lead poisoning exists. This potential will diminish only with continued lead shot restrictions for waterfowl hunting.

The Swan Lake Zone was designated a steel shot zone in 1978. Preliminary analyses show increased incidence of steel shot in gizzard samples of geese killed at Swan Lake since 1978. Furthermore, about 70 percent of the goose hunters sampled at Swan Lake and Fountain Grove WMA in 1977 and 1978 reported using 12-gauge shotguns with steel shot (D. D. Hamburg, pers. comm.). These ingestion rates and steel shot use data may presage a safer environment for bald eagles in the Swan Lake Zone. Retention of steel shot regulations and their vigorous enforcement should reduce future lead poisoning problems for both waterfowl and eagles.

Other Management Considerations for Bald Eagles

Management programs affecting wintering bald eagles should function to send the maximum number of eagles back to the breeding grounds in good physiological condition. This requires safe, adequate, and attractive habitat (Steenhof 1978). The importance of hunter education, legal protection, and restrictions on human disturbance has been discussed. However, maintenance of a food supply and vegetative habitat are also important elements of any management program for wintering bald eagles. Current management practices at Swan Lake NWR apparently provide all of these elements; we feel Swan Lake NWR might serve as a good model for other refuges that attract wintering waterfowl and bald eagles. The importance of food supply and vegetative habitat for eagles at Swan Lake NWR is outlined below.

Food Supply

The most important feature of the biology of wintering eagles at Swan Lake NWR is food supply. As described, eagles utilize dead, crippled, and healthy waterfowl.

The refuge provides another important food resource for eagles, winter-killed or live fish in shallow pools. Water levels suitable for large populations of rough fish are maintained in refuge impoundments. Floods of the Grand River ensure periodic restocking. Impoundments also provide habitat for other eagle prey such as American bitterns *(Botaurus lentiginosus),* coots *(Fulica americana),* muskrats *(Ondatra zibethica),* and raccoons *(Procyon lotor)* (Griffin 1978).

Brushpiles, shelterbelts, and uncultivated fencerows on Swan Lake NWR furnish cover for upland game, an alternate food for eagles. This diversity of food resources on the refuge helps maintain a food supply for eagles through much of the wintering period.

Vegetative Habitats

Swan Lake NWR has timbered areas used as diurnal perches and night roost sites by wintering bald eagles. Most diurnal perching areas are adjacent to feeding sites, and offer protection from weather. Eagles usually perch in large trees. All tree perches selected by eagles have an open area on at least one side, providing unobstructed landing routes for the eagles. Timbered areas along creeks and impoundments on the refuge have suitable edges and are used as eagle perching areas. Maintenance of perching areas may attract eagles away from the refuge perimeter where potential hazards of human disturbance and shooting are greatest.

The major communal night roost for bald eagles is in the center of the Swan Lake NWR. Like the diurnal perches, the night roost site is adjacent to an open area. The roost encompasses 0.9 acre (0.36 ha) along a creek channel. Perches available in large trees afford protection from northerly and westerly winds. Average tree height at the roost site is 63 feet (19.2 m), and the average diameter at breast height is 14.5 inches (37 cm) (Griffin 1978). The closest hunting blind is more than one mile (1.6 km) away. This roost site is being preserved and alternate roost sites have been identified on the refuge.

Three additional night roost areas are known in the Swan Lake Zone. Two, located along the Grand River on Fountain grove WMA, are being preserved for wintering eagles. However, the third roost site is on private land near the Grand River west of the refuge. Protection for this roost by land purchase or easement would be desirable.

Continued maintenance and enhancement of timbered areas for diurnal perch and night roost sites will help ensure safe and attractive habitat for wintering bald eagles in the Swan Lake area.

Summary

The development of Swan Lake NWR provided wintering habitat for bald eagles. As the number of waterfowl wintering in the area increased, so did the number of bald eagles. Similar trends in numbers of waterfowl and eagles have been noted on three other wildlife refuges in the Midwest. Eagles are attracted to the Swan Lake NWR not only by large numbers of wintering waterfowl, but also by the abundance of other food.

Several current management measures in the Swan Lake area are beneficial to bald eagles. Canada goose hunting on the perimeter of the refuge enhances the eagle food supply. Wintering eagles not only utilize the dead and crippled waterfowl resulting from hunting, but also prey on healthy waterfowl and other aquatic and upland birds and mammals. Live fish and winter-killed fish provide another important food resource. Existing and potential eagle roost sites are being preserved on the refuge, but are threatened on private land nearby.

Although human disturbance of eagles, shooting, and lead poisoning are potential threats to bald eagles, none appears to affect seriously bald eagle populations in the Swan Lake area. Closure of the refuge interior to public access during the winter and placement of hunting blinds on the refuge perimeter minimize disturbance by hunters near areas of eagle concentrations. Designation of the Swan Lake area as a steel shot zone is reducing lead poisoning dangers for both waterfowl and eagles. Hunter awareness and education about eagles is promoted, and intensive surveillance enhances protection of eagles.

In general, management practices at Swan Lake provide good food sources, attractive habitat, and adequate protection for bald eagles. At the same time, extensive public benefits are provided in the form of public goose hunting, and we perceive no serious conflicts between these functions of the refuge.

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Status of Grizzly Bears in the Yellowstone System

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Introduction

In 1975 the grizzly bear *(Ursus arctos)* south of Canada was declared a "threatened" species. Under the Endangered Species Act of 1973 federal agencies must avoid destruction or adverse modification of grizzly bear "critical habitat." Compliance with this provision was hampered by the lack of data on both habitat requirements and current populations of Yellowstone grizzly bears. Earlier research on grizzly bears within Yellowstone National Park provided data for the period 1959–1967 (Craighead et al. 1974). Changes in bear management policies beginning in 1967 (Meagher and Phillips 1980) altered some population parameters.

The Interagency Grizzly Bear Study was initiated in 1973 to define and evaluate the population dynamics of the Yellowstone grizzly bear. Specific objectives of the study were to determine the status and trend of the population, the use of habitats and food items by the bears, and the effects of land management practices on the population. The study area and methods were described by Knight et al. (1978).

Several aspects of the ecology of the Yellowstone grizzly bear have been intensively studied since 1975 when logistic and telemetric problems were overcome and techniques were standardized. A backlog of movement and habitat data is now in the process of analysis or publication (Judd et al., in prep., Blanchard 1980, Kendall 1980, Knight and Judd 1980). Population data has been gathered since 1975; this phase is still in progress.

Population Size

Accurate estimates of the number of grizzly bears inhabiting the Yellowstone system have eluded us for several reasons. The study area covers 7,700 square miles (20,000 km^2) of rugged, often isolated terrain which is 70 to 75 percent timber covered. Even our most optimistic population estimate of 350 places the density of grizzlies at only one per 20 square miles (50 km^2). The most pessimistic estimate of 84 or less (Craighead et al. 1974) places the density at one bear per 95 square miles (245 km^2). Given these natural low densities, nocturnal habits of Yellowstone grizzlies, and the physiography of the study area, accurate estimation of the entire population is difficult.

Only a small proportion of the grizzly bear population is observed during any one year. During routine flights to radio-track instrumented grizzlies, collared bears were aerially observed without the aid of the radio an average of only once every 33.5 hours. Unmarked grizzlies were observed an average of once every 7 hours of flight time. This indicates that only a small portion of the Yellowstone grizzly bear population has been trapped and marked during this study.

Radio telemetry is the only effective method to gather significant volumes of data on grizzly bears. Early attempts to identify individual unmarked bears were unsuccessful, except for family groups. Annual observations of grizzlies have varied substantially due to weather patterns, plant phenology, and seasonal food source abundances (Knight et al. 1978, Blanchard 1980, Meagher and Phillips 1980). Even the number of instrumented bears we are able to locate varies daily.

Population consultants (Eberhardt, pers. comm.; Caughley, pers. comm.) concluded that a Lincoln index would be the most statistically sound method for estimating the size of the Yellowstone grizzly bear population. The sampling procedure would require a minimum of 20 marked animals and need to be replicated at least nine times. During the fall of 1977 we had the required number of marked animals, but weather conditions prevented an estimate. Despite the limiting factors, we will still attempt to make an estimate.

Indices of population trends may be more meaningful and measurable than any "number" in this situation. Trends are a function of production and survival; therefore, accurate estimates of grizzly bear mortality and cub production may provide the means to monitor the stability of the population. In the future this study will be placing more emphasis on this aspect rather than a numerical estimate.

Population Parameters

The grizzly bear population is dependent upon the rates of reproduction, death, immigration, and emigration. Movement of grizzly bears in and out of the Yellowstone system is essentially zero due to the political boundary lines and intensity of human activity surrounding the study area. Calculation of reproductive rate requires knowledge of the sex and age structure of the population.

Reproduction

The female reproductive rate is the number of young produced per breeding female per year. Several methods can be used to calculate this rate (Table 1). The most identifiable segment of the population is marked bears. Since this is a very small sample, we feel the most meaningful data can be obtained from the next most identifiable segment, which is females with young-of-the-year. From this data we can calculate female reproductive rates.

Craighead et al. (1974) used known reproductive histories of 30 marked or otherwise recognizable females followed through one to four complete reproductive cycles to obtain an average rate over a 9-year period. We can use this same method, but we have only five individual females over a 4-year period on which to base our calculations. McCullough (1979) thought this method underestimated the reproductive rate.

Reproductive rate can also be calculated by dividing the total number of cubs observed in the population during a year by the estimated number of breeding females in the population that year. The number of breeding females is estimated over a 3-year period since we have calculated a 3-year average reproductive cycle per female.

Using either method, it is evident from Table 1 that the female reproductive rate of Yellowstone grizzlies is lower today than during the 1959–67 period.

Since the 1959–67 population was not considered "threatened," current equivalent parameters would indicate a point of recovery for the grizzly bear. A recovery plan will have to address means of reaching this point.

Table 1. Comparison of reproductive parameters between the periods 1959–67 and 1974–79.

	Female with cub groups	Mean litter size	Female reproductive rate[a]	Female reproductive rate[b]	Reproductive cycle
1959–67[c]	14.8	2.2	0.648 (30)[d]	0.740 (130)	3.4
1974–79	12	1.9	0.555 (5)	0.632 (72)	3.0

[a]Calculated from known life histories of marked females; cubs-of-the year/number of females with cubs (average reproductive cycle).
[b]Observed cubs-of-the-year/breeding females in the population.
[c]From Craighead et al. 1974.
[d]Sample size.

The nonthreatened population was characterized by an annual average observation of 14.8 females with cubs. This was at a census efficiency of 58 to 77.3 percent (Cowan et al. 1974, Craighead et al. 1974), indicating 25.5 to 19.4 females with cubs were actually present each year. From 1974 through 1979 we have monitored an average of 12 females with cubs annually. We have not yet determined what proportion of the total population this represents, although observability of instrumented bears indicates that it is significantly less than 77 percent.

Changes in other population parameters will change the relationship between reproductive rate and population level and stability. During the 1959–67 period the average age for the first breeding of females was 4.5 years. Data from seven females from 1975–79 indicate an average age at first breeding to be 5.5 years. An increase in breeding age will lengthen the mean generation time and dampen the rate of increase for the population.

Average litter size during 1959–67 was calculated to be 2.2 cubs per litter for a population with a high-energy food source available at garbage dumps. The 1974–79 average litter size was 1.9 cubs/litter, which is probably not going to change under present conditions. Black bears feeding on garbage have been found to reproduce at younger ages and have higher reproductive rates than those feeding on natural foods (Rogers 1977). Similar results may be expected with the Yellowstone grizzly bear.

Survival and Mortality

Survival of young is an important factor in determining the relationships between reproductive rate and population stability. During the 1959–67 period, Craighead et al. (1974) documented an average annual cub mortality of 20 to 25 percent. Mortality of cubs associated with radio-collared females during the 1975–79 period was 7 percent. Comparison of cub:female observations with yearling:female observations the following year indicates a cub mortality of 5 percent. Dumps with rich food supplies probably resulted in initially high cub production during 1959–67, but also created stressful bear concentrations resulting in high cub mortality. A higher rate of cub survival will lower the reproductive rate needed for a stable population.

Mortality, especially for females, directly affects the reproductive rate, population size, and population stability, and is the only parameter that we can directly alter. The known man-caused mortality for the last 5 years has averaged 11 grizzly bears. During any one year approximately one-third of these deaths have been confirmed and documented by other agencies. The remainder were made known to us through concerned individuals and the investigative work of our employees. The number of deaths remaining unknown cannot be estimated, although it is probably substantial. These unreported mortalities can be largely attributed to sheep herders (Knight and Judd 1980), poachers, and outfitters.

If current population parameters are below the desired level, the only effective method of altering them is through reduction of man-related mortalities. Until sufficient data are available to calculate the population status and trend, we recommend that annual mortality in the Yellowstone population not exceed five grizzlies.

Future Research

Beginning with the 1980 field season, the Interagency Grizzly Bear Team will be focusing research efforts on needs dictated by a recovery plan. Methods to monitor the trend and status of the population will be developed, in addition to continuing efforts to estimate the population size. To supplement field efforts, computer programs are being developed to analyze and progressively update population dynamics and trends as new data are obtained. Emphasis will be placed on behavior, especially aggression and its relation to human–grizzly encounters.

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Deficiencies and Training Needs in Nongame Wildlife Management

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The expansion of wildlife management to encompass nongame species has required that wildlife biologists conduct field studies of many poorly known species. Such studies often require expertise and techniques unfamiliar to these biologists. The validity of such studies is critically dependent on the suitability of field methods and the accuracy of identifications and data records. I present here some examples of deficiencies in nongame wildlife studies.

Two years ago I received 66 frozen small mammals for preservation as study skins and skeletons. All but one were live-trap casualties from a mammal population study on a forest experiment station. In checking the identifications I was surprised to find that 44 were chipmunks and ground squirrels and only 21 were nocturnal species. Upon questioning the project leader, I learned that the traps were checked only once each day in the morning. I told him that such excessive mortality invalidated his mark–recapture population estimate, and that the mortality could be prevented by protecting the traps against the sun and running them two or three times a day. He replied that his summer aides, who were allowed to work only 8 hours a day, were too busy studying vegetation plots. He had neither the time nor adequate help to do the job right.

In another forest-wildlife study the technician did not save any specimens of the critical species, but he did save a few easily recognized specimens. He assumed that all the chipmunks caught and released in the area belonged to a species not actually known to occur in the study area, although two other species of chipmunks may occur there. The forest researcher in charge was interested only in the population of "chipmunks," not in their systematics. Unfortunately, information on a misidentified species is worse than useless.

Such basic deficiencies are not confined to government agencies. A Ph.D. candidate who had been working two years on a study of wildlife food chains brought some specimens to me for identification. One was a very poorly prepared study skin of a chipmunk, and three unlabeled skulls. When I asked him which skull belonged with the skin, he pointed to one, but the association was suspect. Since he did not properly label specimens essential to his research, I wonder how much confidence one could have in the rest of this food chain data.

When I later examined his dissertation, I found that his population and food habits data did not distinguish between the three species of chipmunks or the two species of cottontails in the area, nor did he save any voucher specimens by which identifications could be made or verified. Lumping the food habits data of two kinds of cottontails is no more useful than the lumping of food data for whitetail and mule deer in the same area. Unfortunately, many graduate students are similarly unguided because their graduate advisors are too busy or lack the expertise required.

In my experience, mammal specimens saved by wildlife biologists have rarely been prepared or preserved in the field and have often been unlabeled. If field data were available, they were usually recorded in a haphazard and unintelligible manner, and often were not associated with individual specimens. It is not uncommon for frozen specimens to be improperly packed for shipment, and to arrive in decomposed condition. These shortcomings are so commonly observed by systematic zoologists that many of them have come to protect themselves by refusing to provide identifications of specimens that do not meet certain minimum standards. Others engage in a considerable amount of "salvage zoology" as a service to the organization or in hope of bringing some improvement to the field studies involved.

All of these aspects of the poverty of basics in nongame programs came to light with the transfer of an irreplaceable collection of native fishes of the Colorado River Drainage to the National Fish and Wildlife Laboratory. Hundreds of hours of sleuthing for original data, labeling, and restudy of the uniquely valuable specimens have been performed by four visiting ichthyologists in order to salvage the great zoological potential of this collection and resolve systematic problems with some of these fish species. We still have a freezer half-full of endangered Colorado squawfish *(Ptychocheilus lucius)* with tag numbers but no field data, because the collector has not responded to our requests for a copy of his original records. Much of this confusion and lost time could have been avoided if the original contracts for study of the ecology of these species had been given to an ichthyologist with the required background and expertise.

To summarize, the following basic deficiencies are often encountered in nongame wildlife programs conducted by wildlife biologists with inadequate training in vertebrate zoology:

1. Field crews lack experience in collecting various kinds of vertebrates.
2. Those running live-trapping operations are unable to identify many animals released.
3. Live-trapping census efforts suffer from excessive mortality of captured animals.
4. Trap casualties are not preserved for identification and other use.
5. Field and lab workers do not keep good permanent records usable by other workers.
6. They do not know how to prepare study skins and depend too much on freezer storage of carcasses.
7. They do not use durable rag paper and permanent ink for labels and field records, with the result that tags and notes subjected to formalin, alcohol, ammonia, or even rainwater become illegible.
8. Stored specimens are neglected, with the result that alcoholic specimens are destroyed by dehydration, and frozen specimens are spoiled by thawing or dessication.
9. Voucher specimens are not deposited in public collections under dependable curatorial responsibility.
10. Specimens that are preserved are not mentioned in the study report, or their place of deposit is not reported.

Most of these problems, though widespread, are not difficult to overcome, because the means to correct them are well known, if one knows where to go for help. Unfortunately, progress in many nongame wildlife programs has come mainly by painful experience. The following recommendations are offered to help avoid costly mistakes and to bring the quality of nongame wildlife work more quickly to the level of the better field programs in vertebrate biology.

1. Broaden the training of wildlife biology students to include methods of study of species not traditionally considered wildlife.
2. Award contracts for nongame studies only to principal investigators with high competence and field experience in the area of vertebrate biology involved.
3. For conducting independent field work, hire only trained workers with experience in the kind of work planned.
4. For field assistants, have knowledgeable team leaders assigned to train field crews and supervise work in the field.
5. Hold training workshops for the benefit of wildlife project leaders and game managers who are assigned to nongame work without having previous background in basic vertebrate zoology.
6. Provide all field leaders and workshops with good literature guides, supplies, and equipment as needed for work in mammalogy, ornithology, herpetology, and ichthyology.
7. Require preservation of voucher specimens, not an arbitrary number of each species, but as many as good judgment may indicate to be needed.
8. Require comprehensive permanent field and lab records in understandable form.
9. Assign responsibility for the temporary custody of specimens and designate a repository for their long-term preservation.

Since many field offices involved in nongame wildlife work do not have access to good reference literature, any agency can easily benefit its nongame program by giving wide distribution of E. R. Hall's pamphlet "Collecting and preparing study specimens of vertebrates" (Misc. Publ. No. 30 of the University of Kansas Museum of Natural History, Lawrence, Kansas). This paper costs only $1.25 and can be ordered from the Museum, with a discount of 40 percent in quantities of 50 or more. A condensation of this paper might usefully be reprinted in the next edition of The Wildlife Society's techniques manual.

A more difficult but better long-term way to improve basic capabilities is through recruitment of employees with the needed competence in the particular field of study. The needed qualifications can be more easily found among graduates of zoology or biology departments having strong programs in vertebrate systematics and natural history.

As wildlife management expands to cope with wider environmental problems, we can better meet these needs by reaching outside the discipline of wildlife management in its traditional scope and drawing on the diverse resources of expertise already available in the bioscience community.

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Preservation of Mature Forest Seral Stages to Provide Wildlife Habitat Diversity

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Situation

Wildlife biologists are greatly concerned over the drastic decline of older forest seral stages in western Oregon. Current forest management practices on lands under the control of the Bureau of Land Management (BLM) are rapidly converting the remaining stands of older forest seral stages of predominantly Douglas-fir *(Pseudotsuga menziesii)* into an even-aged second growth with a planned rotation age of 80 years.

Loss of older seral stages and the projected short-termed cutting cycle of young second growth and associated intensive management practices will have an adverse effect on many species of wildlife. Retention of well distributed stands of older seral stages exhibiting some decadency is required to benefit cavity dwellers, several species of raptors and other wildlife. An admixture of mature conifers is also a necessary part of most riparian zones in western Oregon. This structural and vegetal component is necessary to maintain the integrity of the riparian ecosystem. Currently, merchantable timber in many riparian zones is being harvested.

Unfortunately, in the case of old growth perpetuation, forest management clashes with wildlife habitat requirements for those species of birds, mammals, reptiles and amphibians that require the large size, conditions of decadency, understory diversity, and multilayered canopies found in older forests. These stand characteristics are at the opposite end of the scale as envisioned by foresters under a mandate to produce a high volume of merchantable trees for structural materials and paper production. Projected timber supply shortages and spiraling housing costs are placing increased pressure on the harvest of both old growth and younger, overmature forests. The dependence of industry on the BLM as a source of raw materials has intensified these demands. Figure 1 illustrates current age classes of timber lands in western Oregon. Note that only significant acreages of

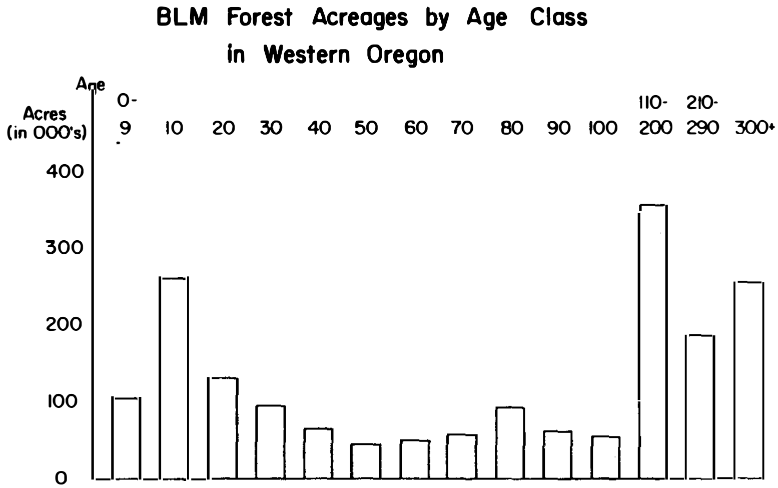

Figure 1. **BLM forest acreages by age class, western Oregon.**

very young and mature stands remain. Table 1 illustrates seral stage characteristics.

A forest growing at its sustained yield capacity is characterized by a relatively equal distribution of age classes, ranging from zero to rotation age. The rotation age is based on the age of maximum timber growth which in western Oregon presently averages about 80 years. Under these conditions, the forest will be growing at its sustained yield capacity and annual cut and annual growth will be equal (Andrus 1979). This style of management does not contemplate retention of old growth forest lands. At the current rate of cutting, old growth forests on BLM lands in Oregon will be harvested in the next 20 to 30 years and, in some districts, within the next 10 years. In addition to regular forest stands, much of the old growth found in western Oregon lies in riparian zones and streamside corridors important for the preservation of water quality, perpetuation of rare plants, anadromous and resident fish habitat, and crucial terrestrial wildlife habitat. These riparian zones provide travel lanes for birds and mammals, escape and thermal cover for big game and areas of snags or dead and dying trees for cavity dwellers. They are the most productive of all wildlife habitats. Retention of mature trees insures preservation of the riparian integrity through the provisions of shade, temperature control, and the retention of multi-layered canopies of both evergreen and deciduous species.

Past efforts to provide suitable habitat for species dependent on old growth and mid-aged stands have been through provisions for single species management or for small groups of species. An example is in the provisions for northern spotted owl *(Strix occidentialis caurina)* habitat. This large owl breeds and feeds principally in older growth forests of the west coast from northern California to British Columbia. In a 1977 letter to the Oregon Endangered Species Task Force, Forsman indicated that a mean of 1,200-acre (486 ha) habitat per pair, including a 300-acre (120 ha) core area of old growth timber, is necessary for survival of this non-migratory species. Interagency efforts have proposed that a 400 pair minimum breeding population of this owl be retained principally on BLM and

Table 1. Coniferous forests can be stratified into various seral stages that reflect total vegetative structure, as illustrated for western Oregon in the table.

Seral stage	Approx. age	Some key characteristics
1-Grass/forb	0–10	Vegetation dominated by grasses and forbs
2-Shrub/seedling	10–20	Vegetation dominated by shrubs and seedlings
3-Sapling/pole	20–80	Closed canopy of sapling to pole-sized trees
4-Young mature	80–120	Trees still vigorous with pointed tops
5-Mid-age	120–200	Rounded tree tops, increased decadence in live trees
6-Old growth	200–400	Flattened and broken tree tops, many snags and large down logs

Forest Service lands in western Oregon. Preservation of these habitat requirements has been agreed upon by BLM and the Forest Service. Obviously these scattered habitats also provide food and shelter for many other wildlife species having requirements similar to the spotted owl, including their prey base.

With the decline in old growth forest lands, remaining stands are becoming isolated from other similar habitats. If the present trend continues, the remaining tracts of older forests will generally be of small size, not sufficient to encompass the territorial requirements of attendant wildlife.

This fragmentation or isolation of the older seral stages will result in relic, non-viable populations of native wildlife separated by considerable distances. Fragmentation of the forest land habitat of many forest interior-dwelling birds is predicted over time to cause a decline in avian abundance and diversity. This theory, called "insularization" or habitat isolation, is well described in the literature as it pertains to eastern forests and offshore islands (Lynch and Whitcomb 1977, Whitcomb 1977). In brief, the long term result of habitat isolation is local and regional extinctions, blocking of gene interchange between new migrants, and a general decline in avifaunal composition and richness. The first group of birds impacted by this phenomenon are the forest interior species such as the goshawk, northern spotted owl, pileated woodpecker and Vaux's swift *(Chaetura vauxi).* Several mammalian species are also adversely affected by extensive fragmentation of habitat; examples include the marten *(Martes caurina),* fisher *(Martes pennanti),* northern flying squirrel *(Glaucomys sabrinus)* and the red-backed vole *(Clethrionomys californicus).* The predicted impacts caused by the loss of these older seral stages include local and regional extinctions and reductions of population levels of endemic wildlife.

Certain species of wildlife are adapted to climax or older plant communities and have specific habitat requirements. The pileated woodpecker *(Dryocopus pileatus)* nests only in extensive old growth forest in snags of specific size. Mannan (1977) found that in western Oregon, cavity-nesting birds utilized Douglas-fir for nesting and foraging that averaged 24 inches (61 cm) diameter at breast height and over 49 feet (15 m) tall, and were found in forests over 70 years of age. Without older forests, the recruitment of new snags will not occur.

The role of woodpeckers as primary excavators in producing nesting holes for secondary hole-nesting birds has been described by Haapanen (1965) and Jackman (1974). In western Oregon, 39 secondary hole-nesting birds are dependent on 14 primary excavators. Management suggestions for snag retention for cavity dwellers through the leaving of individual trees or small leave-sites are often thwarted by state safety and industrial accident provisions that require the felling of these "danger trees," before subsequent logging, road construction, or other activities involving persons working within the falling radius of these snags can be accomplished.

Another species requiring older timber stands is the Roosevelt elk *(Cervus elaphus roosevelti).* This big game animal seeks out the oldest stands available for thermal cover in both summer and winter. During the occasional storms that bring deep snow, elk utilize these stands for survival. Large trees catch and retain snowfall, provide warmth, drop lichens high in protein, and have a ground cover that serves as forage during this critical period (J. A. Harper, pers. comm.: 1979).

A Proposal

In an effort to avoid further single-species management criteria, and to meet BLM's mandates for ecosystem management, an ecosystem or habitat diversity proposal has been developed aimed at the retention of mid-aged and old growth forest lands to provide wildlife requirements for the 400+ wildlife species in western Oregon.

The management of forests for timber production, if done properly, can benefit most wildlife species. The proposal is to structure the timber management program to provide for naturally self-sustaining populations of all native wildlife species. The key to achieve this goal is vegetative diversification. It is proposed, therefore, to manage forest lands so that all vegetative successional stages are adequately represented over time. This proposal would counter the current decline of older seral stands by allotting or planning for a portion of all forest lands to remain in the mid-age and old growth seral stages in perpetuity. A model would be developed for each forest management area to achieve this objective over time.

Managed tracts would be maintained in two categories:

1. A lesser portion of all forest lands in any one planning area would be maintained in mid-aged and old growth seral stages for the benefit of secretive, sensitive and wide-ranging species such as northern spotted owl, pine marten, fisher, and mountain lion *(Felis concolor).* These stands must be blocked or contiguous to provide adequate territory sizes for these species and must be of suitable habitat quality. At least one block or contiguous area of 640 acres (256 ha) or more would be maintained in each management area to provide for the habitat requirements and distribution of secretive species. These areas can be extensions of existing spotted owl management zones or other suitable "withdrawn" areas. Where such stands are not presently available, management efforts will be directed towards their development over time from the oldest existing stands (Franklin 1979). Franklin identified 15 vertebrate animals which find their optimum habitat in old growth Douglas-fir-western hemlock *(Tsuga heterophylla)* forest ecosystems.

Examples of wildlife requiring larger territories include:

Fisher–1.4 to 6.4 sq. miles (3.6 to 16.6 km^2) per pair

Marten–1 to 2 sq. miles (2.6 to 5.2 km^2) per pair

Cougar–25 to 31 sq. miles (64.8 to 80.3 km^2) per cougar

Spotted Owl–1 to 2 sq. miles (2.6 to 5.2 km^2) per pair

Northern Goshawk *(Accipiter gentilis)*–4 to 8 sq. miles (10.4 to 20.7 km^2) per pair

Many of the above species are sensitive to human disturbance and fragmentation of habitat. The establishment of these large tracts will incorporate areas presently committed to spotted owl management.

2. A larger portion of each management area would be in mid-aged and old growth seral stages, averaging 80 acres (32 ha) or more per tract which would be maintained at intervals of approximately one (1) mile (1.6 km), if possible. These stands should encompass the full range of topographic and site conditions. Where such stands are not presently available, management efforts would be directed towards their development over time from the oldest existing stands.

Many researchers have documented that bird species have different minimal habitat size requirements needed to successfully accomplish the two major life functions: reproduction and feeding. Lynch and Whitcomb (1977) have stated "There appear to be no bird species that are restricted to small habitat patches, although there are many that occur only in large patches." This points out an important fact that some birds will not use small tracts and that no bird use is specific to small tracts. The number of species in a particular habitat is strongly influenced by the size of that habitat. However, this will vary to some degree because of differences in home range requirements of some species.

The 80 acre (32 ha) specification is based on such studies as those of Thomas et al. (1978) who illustrated that habitat and that maximum species' richness occurs when the average habitat size is 84 acres (33 ha). Also, McClelland (1977) states that "a minimum of about 100 acres of contiguous old growth is considered necessary for suitable long term nesting habitat for a pair of pileated woodpeckers in the western larch *(Larix occidentalis)*/Douglas-fir cover type."

Whitcomb et al. (1977) point out that "some wide ranging species such as barred owl *(Strix varia)*, redtailed hawk *(Buteo jamaicensis)* and pileated woodpecker require large acreages of forest. Such birds are residents of small tracts only if the tracts are part of a large forest system that contains, overall, an area sufficient for their territorial requirements." They also conclude that some forest birds will breed in habitats as small as 35 acres (14 ha) only if these smaller tracts are subsidized by larger forested areas.

At least one-half of the stands in (1) and (2) above would be in old growth. Old growth includes forests 300 years old or older, exhibiting some signs of decadence. These stands may include riparian zones, wetlands, fragile sites, streamside corridors, commercial forest lands and withdrawn forest lands provided they are (1) biologically suitable and (2) useful in distributing these seral stages throughout the full range of site conditions. Protection and enhancement of other resource stages representing the habitat requirements of indicator species such as pileated woodpeckers must be distributed over time and space to allow interchange between individuals and thus prevent genetic isolation. The distribution of habitats provides travel or migration corridors to allow dispersal of progeny or emigration of new individuals.

Many other benefits are associated with the maintenance of scattered tracts, such as: protection of threatened or endangered species, providing big game cover, winter ranges, calving and fawning areas, and perpetuation of a quality gene pool for forest tree species.

This concept can be modified to present alternatives. These alternatives may range from accommodating full habitat diversity as proposed above, to a greatly reduced retention of older forest stands used for single species management that would only accommodate the northern spotted owl, state- and federal-listed threatened or endangered species, elk thermal cover requirements, and protection of riparian habitat and streams. Normal timber management would take place on the remainder of the management area.

One alternative incorporates a "corridor" approach limiting the principal area of old growth retention, such as spotted owl habitats, to travelways created by maintaining interspersed blocks of habitat. An example would include riparian habitat along streams and rivers, using smaller sized blocks of mid-age and old growth stands that would allow travel to larger blocks.

The value of corridors and minimization of isolation, while preserving biotic diversity, is well illustrated by McClintock et al. (1977). Their studies of forest tracts of different sizes in Maryland showed that avifaunal use of small isolated tracts usually reveals that such an island was connected to larger tracts by a disturbed corridor and in proximity to a much larger forest system.

Under a corridor concept, retention of mid-aged and old growth habitat would comprise only a small percentage of the western Oregon forestland base. In comparison to the full habitat diversity concept, the corridor alternative would result in constricted spatial distribution and high fragmentation and isolation of habitats for most non-mobile wildlife species. In addition, fewer cavity-dwelling wildlife requirements can be met, and most riparian habitat would be degraded through the harvesting of old merchantable trees.

While the corridor alternative does not preserve as much of the mid-aged and older seral stages as under full diversity, it is much better than the current situation which is based on management by individual species' habitat requirements.

At this time, no decision has been made by the BLM as to the acceptance or rejection of the habitat diversity concept. Some individual forests under the U.S. Forest Service jurisdiction in Oregon are managed for the preservation of 5 to 7 percent of old growth conifers to accommodate the habitat requirements of attendant wildlife species. In the case of the BLM, accelerated harvesting of older stands necessitates a similar decision on habitat diversity as soon as possible.

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Coordinating Forestry and Elk Management

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The Montana Cooperative Elk-Logging Study was initiated in 1970 as a cooperative investigation of the influences of logging and road construction on the behavior, movement, harvest, and survival of Rocky Mountain elk *(Cervus elaphus nelsonii)* in Montana. Cooperators include the Montana Department of Fish, Wildlife, and Parks; the Intermountain Forest and Range Experiment Station and Region 1, USDA Forest Service; the Forestry School, University of Montana; and the USDI Bureau of Land Management.

With the completion of 10 field-research seasons, most of the original objectives of the cooperative study have been satisfied. The responses of elk to timber harvest and road construction have been evaluated, and influences of road and area closures have been quantified for both elk and elk hunters. Apparent elk habitat requirements and the important characteristics of effective elk habitat have been identified; and several elk behavioral patterns have been documented and related to habitat requirements. Most importantly, however, these results and other recent research in North America now provide an information base for the development of comprehensive elk-habitat guidelines. Throughout the Northern Rockies, on both public and private forest lands, managers now have positive prescriptions for maintaining and enhancing elk habitat within timber management programs.

Conduct of Research

During our 10 years of investigation, many different scientists and degree-candidate students conducted studies within a comprehensive program coordinated by the participating senior scientists. Preliminary results were summarized in limited-distribution annual reports with recommendations that have been transmitted to land managers. Several papers describing individual studies were published, and five initial recommendations were presented at a previous North American Wildlife and Natural Resources Conference (Lyon 1975). While some studies are still in progress and additional papers remain to be published, much of our research is now incorporated in coordination of forestry and elk management in Montana.

Rocky Mountain elk are found throughout the mountainous western half of Montana (Rognrud and Janson 1971) in a variety of forested habitats. Within this range, we selected representative study areas for both intensive and extensive investigation in three broad subject areas: (1) timber harvesting and road construction; (2) road design, management, and area closure; and (3) elk habitat requirements and behavior. Each study is described in brief summary as follows:

Sapphire Mountains, 25 miles (40 km) southeast of Missoula.
Area: 76 square miles (197 km^2).
Methods: Radio tracking, observations of marked and unmarked elk, 1970–1976.
Investigators: Ream, Stehn, Marcum.

Data: Elk habitat selection, response to existing clearcuts and roads and to timber harvesting activities on a summer range.

Sapphire Mountains, 25 miles (40 km) southeast of Missoula.
Area: 16 square miles (40.5 km^2).
Methods: Radio tracking, winter backtracking, and pellet-group distributions, 1969–1973.
Investigator: Beall.
Data: Elk behavior and habitat selection in response to winter weather and timber harvesting activities on a winter range.

Burdette Creek–Deer Creek, 25 miles (40 km) west of Missoula.
Area: 80 square miles (215 km^2).
Methods: Pellet-group distributions, radio tracking and observations of unmarked animals, 1970–1977.
Investigators: Lyon, Bohne, Zahn, Lemke.
Data: Elk response to road construction and timber harvesting and to open roads and postlogging road closure.

Long Tom Creek, 25 miles (40 km) southwest of Butte.
Area: 36 square miles (58 km^2).
Methods: Pellet-group distributions, radio tracking, and observations of unmarked animals, 1972–1979.
Investigators: Allen, Lonner.
Data: Elk response to road construction and timber harvesting activities with the newly constructed road system closed to public access.

Chamberlain Creek, 35 miles (56 km) east of Missoula.
Area: 9 square miles (23 km^2).
Methods: Radio tracking, pellet-group distributions, 1971–1979.
Investigators: Ellison, Marcum, Scott, Lieb, Lemkuhl.
Data: Elk behavior and habitat use in an undisturbed drainage and elk response to road construction.

Ruby River, 40 miles (64 km) southeast of Dillon.
Area: 112 square miles (290 km^2).
Methods: Hunter interviews at checking stations and radio tracking, 1970–1973.
Investigators: Allen, Lonner.
Data: Elk and hunter response to an area closed to vehicle access during the hunting season.

Judith River, 24 miles (39 km) northeast of White Sulphur Springs.
Area: 268 square miles (694 km^2).
Methods: Hunter interviews at checking stations, 1970–1973.
Investigator: Basile.
Data: Elk and hunter response to an area closed to vehicle access during the hunting season.

Statewide on elk summer ranges.
Area: 87 different clearcuts.
Methods: Pellet-group distributions, 1973 and 1975.
Investigator: Lyon.
Data: Characteristics of clearcuts that determine elk use.

Timber Harvesting and Road Construction

The immediate responses of elk to disturbances associated with timber harvesting were investigated in five different studies. By varying our study designs, we also attempted to assess the separate effects of road construction, logging, and recreational traffic during the timber sale period. In all studies, elk either avoided the area of activity (Ream 1973, Marcum 1975, Lyon 1975, 1979b, Lonner Ann. Rep. 1979[1]) or moved away from the disturbance (Beall 1974).

Measured displacements ranged from 1 to 5 miles (1.6–8.0 km), with the greatest movement detected when heavy equipment on a ridge-line between Deer Creek and Burdette Creek was visible over a large area (Lyon 1979b). Most often, the distances elk moved appeared to be the minimum necessary to avoid visual contact with men and equipment. Individual animals, however, demonstrated a considerable tolerance toward logging activities, and ". . . in no case did a disturbance result in complete abandonment of a subunit . . ." (Lyon 1979b:11). The response also appeared to vary seasonally and in relation to topographic differences near logging areas. Movement distances on the Sapphire Mountain winter range, for example, were somewhat restricted by the extent of the area available, while the increased area and larger topographic scale allowed greater movement on the Sapphire summer range (Marcum 1975).

Patterns of return movement to logged areas further confirmed the variability of the response and the temporary nature of the displacement. Beall (1974) reported elk moving back to a logged area on the Sapphire Mountain winter range within two days after logging ended. He also detected several animals drifting back to a cutting area while logging was still in progress. The more common sequence on summer range, however, was that elk did not return until the disturbance ended and men and equipment were removed (Marcum 1975, Lyon 1979b, Lonner Ann. Rep. 1979). Lonner found that elk use of Long Tom Creek in the first postlogging year was similar to prelogging use. Lyon noted, however, that full recovery to prelogging use in Deer Creek was delayed when roads remained open and planting and burning crews were active. Based on a comparison of five different timber sales in the Burdette Creek–Deer Creek area, Lyon concluded that continuing sporadic disturbance in a sale area could eventually condition elk to avoid logged areas for one or more years after all activity ended.

Recommendations

Although our results suggest that displacement of elk during road construction and logging is temporary, there are some hidden costs. Allen (1977) has pointed out that displacement means a reduction in usable habitat and an increase in stress. Permanent displacement would be detrimental. However, the manager has

[1]Findings of Lonner described in the progress reports of the Montana Cooperative Elk-Logging Study. These reports are limited in distribution.

a number of alternatives that can help reduce the distance moved and the total time of displacement. We have recommended provision of an undisturbed security area adjacent to the area of activity, concentrating management activity into the shortest possible time, and confining the disturbance to a single drainage at a time.

Road Design, Management, and Area Closures

After roads are constructed for timber harvest or other purposes, subsequent management of those roads has proved to be extremely important to elk. We have completed two specific studies of road closure during the hunting season, an indirect evaluation of hunter attitudes concerning roads, and other studies in which roads proved to have significant influence on elk use of available habitat.

Travel restrictions during the hunting season were evaluated in simultaneous studies on two different areas. Initially, elk and hunter distributions were determined during 2 years of unrestricted vehicle use. Many roads were then closed and off-road vehicle travel was restricted for 2 years. The effects of these restrictions provided a strong contrast between situations with different forest cover conditions (Basile and Lonner 1979). The Judith River area is two-thirds forested while the Ruby River area is nearly two-thirds open grasslands and sagebrush. In the Judith, travel restrictions resulted in increased hunting pressure, more foot travel, and more elk seen and killed per hunter. However, elk did not leave the study area in appreciable numbers and elk distribution reported by hunters was little affected by the closure. In the Ruby, travel restrictions produced more foot travel by hunters, but hunting pressure and numbers of elk seen and killed per hunter declined in the restricted area. Most important, however, "With travel restrictions in force, elk no longer left the Ruby area en masse for other areas . . ." (Basile and Lonner 1979:159).

Imposed travel restrictions were apparently well accepted in all areas where hunters were contacted. Stankey et al. (1973) found that successful elk hunters in the Sapphire Mountain area rarely hunted from roads and considered excessive road development to be undesirable. Basile and Lonner (1979:159) reported unsolicited hunter opinions of the Judith and Ruby closures ". . . were to the effect that the experience had been enhanced." They also noted, however, that the restrictions may have attracted hunters already favorable toward closures. Some of their data for the Ruby area suggest that closures may simply transfer hunting pressure to unrestricted areas.

In studies not limited to the hunting season, elk demonstrated an avoidance response wherever roads remained open to vehicle traffic. Marcum (1975) reported elk in the Sapphire Mountain area avoiding system roads and the area within 150 yards (137 m). In Burdette Creek–Deer Creek, Lyon (1979a) found elk use within 0.1 mile (161 m) of open roads reduced by 60–80 percent with depressed use extending to over a mile (1.6 km) in some cases.

The degree to which any specific road may reduce elk use of adjacent habitat varies by season and according to the size and the location of the road, amount of traffic, and cover availability. In the Sapphire Mountains, open spur roads and jeep trails with little traffic were not avoided except during the hunting seasons. Elk favored roads closed to vehicle traffic (Marcum 1975). Roads in the Burdette Creek–Deer Creek area were 2 to 3 times as disruptive for elk feeding in openings as for elk located in any kind of tree cover (Lyon 1979a). And in central Montana, roads passing through clearcuts depressed elk use of the openings by up to 90 percent (Lyon and Jensen 1980). Seasonally, Marcum (1975) found that elk were more tolerant of roads in June and July, increasingly intolerant through August to October, and more tolerant again in November. Throughout most of the year, however, vehicle traffic on forest roads measurably reduced habitat effectiveness for elk.

One additional phenomenon, potentially related to roads, was not originally programmed as a part of our research. Allen (1973) and Lonner (Ann. Rept. 1978) have repeatedly detected a strong negative response by elk in the Long Tom area when cattle appear on summer range. In situations where the construction of a new road makes a previously inaccessible range available to cattle, habitat effectiveness for elk may be seriously impaired.

Recommendations

Unlike the temporary displacement of elk by logging activity, displacement by roads is likely to be continuous as long as the roads are open to vehicle traffic. Permanent closures or gates provide one method of reducing this habitat loss, but other alternatives are available. For instance, displacement can also be reduced through road designs based on low-standard, single-track construction and through road locations that do not impede elk movement. Preferred locations avoid existing game trails or movement routes. Preferred roads have frequent dense cover patches and no windrowed slash.

Road management can be used to control or enhance hunter access, to significantly modify the perceived quality of the hunting experience, and to increase or decrease effective utilization of available habitat by elk. While closures can produce desirable results, blanket road closure is no panacea in elk management. We have recommended that all road closures be based on clearly defined management goals.

Elk Behavior and Habitat Requirements

Throughout our 10 years of cooperative research, we have been increasingly impressed with the behavioral adaptations exhibited by elk in various Montana forest habitats. Most of our studies included a provision for detecting habitat preferences—the assumption being that preferences can be interpreted as a demonstration of requirements. Many of our analyses, however, have confirmed Allen's (1977) contention that a new perspective in habitat management is needed—one that includes information about elk behavior within the existing physical environment.

Data from several study areas (Marcum 1975, 1976, Lonner 1976), confirm Scott's (1978:53) observation that all available habitats are used at one time or another, but that elk ". . . become much more selective during periods of stress." Further, some habitat components ". . . which receive little regular use may be critically important . . . during brief periods" (Marcum 1975:129). In short, while selective use of one habitat component may, indeed, demonstrate a habitat requirement for elk, the same requirement is sometimes satisfied elsewhere by different behavior within existing habitat components. In preparing the following summary of study results, I found the category "cover" extremely inconvenient as a descriptor of elk requirements and have, instead, used security, shelter, food, and water as the apparent needs indicated by elk. In addition, Terry Lonner (Ann. Rept. 1979) suggested that performance of traditional distribution and movement behavior may eventually be recognized as an essential requirement.

Security

Although we lack any clear definition of "security," other than freedom from disturbance, most of our studies have indicated that full utilization of available elk habitat does not occur where security is inadequate. The influences of timber harvesting and roads have already been mentioned as disruptive of habitat use. In a different context, both Beall (1974 and Lyon (1976) found that elk use of logged areas was depressed where slash restricted elk movement. Lyon and Jensen (1980) also noted that elk use of clearcuts is greatest for smaller openings, for openings with good cover at the edge or internally, and for openings where roads are closed. During the hunting season, we recorded increased elk use of dense tree cover (Marcum 1975, Bohne 1974, Allen 1977, Lonner Ann. Rept. 1978) and movement to less accessible areas (Lyons 1979b).

Evaluation of this requirement is essentially subjective because we have no studies in which elk were unable to leave areas considered inadequate. Nevertheless, recorded movement does suggest less than potential utilization of favored habitats and concurrent crowding in less desirable situations. "Security is important to elk year around, . . ." (Allen 1977:200) and should be one of the basic considerations in elk habitat management. Hiding cover alone, however, is not necessarily secure, and several investigators (Allen 1977, Basile and Lonner 1979) have concluded that both topography and size of undisturbed area can contribute to increased security.

Shelter

As used here, the requirement for shelter is indicated by elk response to changing weather conditions. Daily movement and seasonal habitat selection patterns on most of our study areas demonstrated few situations in which habitat selection by elk was not oriented to the weather. Beall (1973) reported that elk on winter range continuously seek the most moderate area they can find and proposed that " . . . other welfare factors are secondary to ambient meteorological conditions, as influences on habitat selection and use" (Beall 1974:2). Similarly, on summer range, Lyon (1979b:10) concluded that "Maintenance of body temperature at some relatively constant level may be comparable to feeding as a daily preoccupation for elk."

Evidence of the importance of energy conservation on winter ranges is provided primarily by Beall's work (1973, 1974, 1976) on the Sapphire Mountain area. In both the Sapphires and the Burdette Creek–Deer Creek areas (Bohne 1974), the first heavy snowfall resulted in elk movement to open slopes and lower elevations. Beall (1974) proposed that elk winter range may be limited as much by the energy expenditure required in deep snow as by available forage.

Once elk reached the winter range, they sought dense timber clumps on the upper third of slopes for bedding (Beall 1974) and then selected bedding areas as a direct response to ambient air temperatures (Beall 1976). These selections were so specific to ambient conditions that the location of bedding areas on north or south aspects and even the north or south side of timber clumps could be predicted. Specific bedding sites were usually located beneath the largest available tree (Beall 1974). In all situations on winter range, Beall (1976:97) found that elk ". . . react to changing ambient air temperature . . . by selecting bedding sites which enhance control of body temperature"—even if this selection requires abandonment of areas with the best forage.

Site and cover selections during the summer provided similar evidence of strong response by elk to ambient conditions. The often noted preference for moist areas (Marcum 1976, Scott 1978, Allen 1973, Lonner 1976) is partially related to forage productivity, but several observers report a preference for cool northerly aspects in warm weather (Marcum 1975, Scott 1978, Lyon 1979b), and Stehn (1973) found radio-marked elk in the Sapphire Mountains at consistently higher elevations at midday than at daybreak. In all cases, the recorded responses are consistent with a continuous active search for moderation of body temperature. Both topography and tree cover are utilized year around in this search for moderate conditions.

Food

Selection of habitats for forage production alone was a far less specific requirement of elk than selections for shelter and security. Feeding activity usually occurred in more open timber types and meadows (Allen 1973, Lonner 1976, Marcum 1975). However, elk use of forage produced in openings was often limited, always highly variable, and usually influenced by overall security in the study area. Lonner (1976) reported that elk in Long Tom Creek selected dry parks in early summer, wet parks in midsummer, and dry parks again in the fall. Scott (1978) found that north-aspect clearcuts in Chamberlain Creek were heavily utilized by elk. In both of these areas, vehicle access was limited and security for elk was high.

By contrast, in the Sapphire Mountains, the road network is extensive. Stehn (1973) used 24-hour ground-tracking techniques to record only 6 of 408 elk locations in clearcuts. In this same area, Marcum (1975) found that aerially-monitored elk were completely avoiding clearcuts and treeless openings; and in a statewide study of clearcuts, Lyon and Jensen (1980) found that pellet-group densities averaged 37 percent lower in openings than in the adjacent uncut forest.

While it is usually accepted that openings in forested areas provide more and better forage for wildlife, these findings emphasize the importance of adjacent cover in determining forage availability. Allen (1971:5) suggested that ". . . pattern and juxtaposition of cutting units may be more important than . . . quantity . . ." and Marcum (1979:60) has pointed out that elk apparently can ". . . obtain the . . . forage they need . . . in the absence of . . . seral openings on the summer range." Thus, while openings do improve forage conditions, we have been unable to demonstrate either beneficial or harmful effects of logging and clearcuts (Marcum 1976, Lyon 1976).

Water

Elk preference for cool, moist habitats has been detected on most of our study areas (Allen 1973, Lonner 1976, Marcum 1975, Scott 1978, Lyon 1979b). Because these areas provide opportunities for regulation of body temperature and lush forage, the role of surface water in elk habitat has not been particularly clear.

Marcum (1975) detected a preference for areas within 350 yards (320 m) of water. Allen (1973) reported elk bedding in 4 to 6 inches (10–15 cm) of water, and Scott (1978) found that areas greater than 450 yards (411 m) from water were avoided. Scott also noted that 90 percent of the Chamberlain Creek area is within a quarter-mile (400 m) of standing water. Commonly, on most of the productive elk ranges in Montana, surface water is readily available to elk as long as security is adequate.

Recommendations

Of the four habitat requirements identified, security and shelter appear to be the more basic—but all are inseparable. Productive forage areas and moist sites can be selectively protected to enhance elk habitat, but such areas may be only marginally available to elk where poor cover interspersion, high road densities, or slash reduce accessibility. Likewise, the availability of forage in clearcuts is increased by slash treatment, road management, and the presence of hiding cover. In the same context, appropriate interspersion of thermal cover areas is needed if we are to realize full utilization of available elk range. We have recommended selective protection of certain habitat types and moist areas on summer ranges, criteria for slash disposal and road management on clearcuts, and protection of thermal cover on winter ranges. More important than individual recommendations, however, is the concept that productive elk habitat cannot be evaluated in separate parts. On both summer and winter ranges, it is important that all recognized components of elk habitat be considered simultaneously.

Coordination With Forestry

One problem for any research organization is transfer of results to management action. The Montana Cooperative Elk-Logging Study is assisted in this area by the continuing efforts of many biologists not involved in the research. When Black et al. (1976) and Thomas et al. (1976) published elk management guidelines for the Blue Mountains of Oregon and Washington, they provided a format for locally applicable management guidelines throughout the West. In many different areas, representatives of the USDA Forest Service, USDI Bureau of Land Management and Fish and Wildlife Service, state game departments, universities and private timber companies have cooperated in writing such guidelines. We are aware, for example, of general coordinating guidelines for the Eastside Forests and Central Zone in Montana; for Northern and Central Idaho; and of specific guidelines for the Bitterroot, Kootenai, and Bridger-Teton national forests. In most of these, the timber/elk relationship is the initial consideration, but several guides also treat specific local problems, such as long migration routes between summer and winter ranges or special treatment of areas near winter feed grounds.

The major strength of the team approach to management planning is that results from many different studies of elk can be integrated with local knowledge of habitats and elk behavior. Research in Montana is generally confirmed by other studies in North America, but the local guidelines represent a further level of precision and, possibly, a judgment by managers concerning the relative importance of elk behavior. Almost without exception, prescriptions for maintaining productive elk habitat now include both the physical components (thermal cover, hiding cover, foraging areas) and some components related to elk behavior within the physical environment (cover interspersion, road density, and livestock management).

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Experimental Management of Michigan's Deer Habitat

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Introduction

Michigan's white-tailed deer *(Odocoileus virginianus)* habitat management study evaluates the response of wildlife, plants, and people to various levels of intensive habitat treatment. Costs and benefits are computed. Very little controlled research on effects of habitat manipulation has been done on a large scale. Most wildlife research to date has dealt with habitat analyses, census methods, life histories, and population dynamics. Much information on history, harvest, and range conditions has been gathered and mapped by management personnel. Cover inventories and range evaluation are being provided by field biologists, foresters, and range specialists. Wildlife management experts have long known that range having openings, shrubs and seral stages of plant succession interspersed in the forest usually supports the highest numbers of deer (Leopold 1933, Trippensee 1948). Hopefully this habitat management study will answer the question that logically follows—"What is the shape of the curve that describes this relationship?" The intolerant stage of succession is disappearing in much of Michigan. We need to pinpoint its value and determine how much we want to maintain.

The development of a deer habitat research program became possible when our Wildlife Division set a deer harvest goal giving us a well-defined base and direction for the research unit. Along with the goal came a change in license fees making money available for research to determine the maximum numbers of deer produced and the cost of producing them under different levels of gross habitat manipulation.

Many people may not be aware of the effort necessary to plan and execute a study of this magnitude, an accomplishment in itself. In the initial stages of planning, the team approach concept was instituted, with individual team members assigned phases for development. Pilot runs were conducted on areas of different sizes to determine the optimal land area per sampling unit that would meet our needs. After determining that 9-square mile (23.3 km^2) units were most practical, six had to be found with public ownership sufficient for the cutting, and where no unit was closer than 3 miles (4.8 km) to another.

The value of the study was contrasted with cost and presented to the management people to acquire the cooperation and funding. As forest treatment progressed, opposition to the study had to be minimized, new procedures instituted, markets found for the timber, cutting and follow-up treatment schedules adhered to, and coordination between several different administrative groups maintained.

Each research team member had an area of responsibility and sub-objectives to meet. Their data collection phases were designed in the planning stage and allowed for including other related objectives of their choosing. In that framework, studies requiring less time than required for the total project were started, completed, and reported. It is difficult to keep interest high on a single project over a 10-12 year period.

Methods

Eight research units, one-quarter-township or 9-square-miles (23.3 km^2) each, in the northern Lower Peninsula of Michigan were chosen. They were divided into four pairs and each pair assigned a different level of treatment. On three pairs the level was a set percentage of each 9-square-mile (23.3 km^2) area; 25, 50 and 75 percent, respectively. The treatment consisted of clearing all standing trees from that percentage area. The range of treatment levels was necessary for two reasons: (1) the treatments must be large enough to over-ride activity on adjacent lands (especially on adjoining private land over which we have no control) and (2) the difference between levels of treatment must be large enough to measure responses by deer even with our crude tools, if in fact differences exist. Treatment started on these six units in the winter of 1972-73, and was completed by June 1975. These units are located in Roscommon and Kalkaska counties within a 20 mile (32 km) radius of the Houghton Lake Wildlife Research Station in the central portion of the northern Lower Peninsula.

The fourth pair of units was to receive ongoing normal forest and wildlife management practices. Our Forestry Division's "normal forest practice" policy was to treat approximately 3½ percent of the total forest each year. This policy, new at the inception of our study, had been ongoing for a few years only on the Pere Marquette State Forest situated in Lake County in the southwest portion of northern Lower Michigan. The fourth pair therefore was located on this forest some 50 miles (80 km) southwest of Houghton Lake. Historically there have been high deer populations in this area as well as in the Roscommon County area. Fluctuations there may well have been more rapid and extreme in the past than in the Roscommon County area. But it was hoped that meaningful comparisons could be made. This fourth pair of units will hereafter be referred to as the normal forest practice (NFP) or Lake County units. The other three pairs will be referred to as the 25, 50, and 75 percent or Roscommon County units.

On the NFP units, continuing forest treatment ranges from clearcutting, selective sawlog sales, to clearing of old openings followed by cultivation, fertilization, and rye planting.

The first priority method of treatment on the 25, 50 and 75 percent units was by commercial timber sales. Residual and non-merchantable stands were leveled by hand-cutting, bulldozer with a tree cutter K-G blade, rolling chopper, and/or fire, with each method being applied to at least 15 percent of the total area treated.

First priority for type to be treated was mature aspen. This was followed by northern hardwood, oak, jack pine, mixtures, and lastly upland brush. Had enough of the mature aspen type been present to fulfill the target percent treatment on a unit, little other type would have been cut. In no instance was this even remotely possible. All swamp conifer and most stands of upland conifers were left untouched for winter cover.

Table 1 shows the treated and untreated cover type composition of the four pairs of research units.

The sub-objectives assigned to individual team members follow:

1. To determine the deer herd response to different magnitudes of habitat disturbance; specifically herd size distributed by time and space, herd composition, and herd physical condition.
2. To determine the total yearly production of forage resulting from forest cuttings of different magnitudes and to determine the degree of utilization by deer.
3. To determine cost by acreage, by time and type of treatment, of the forest treatment completed on the eight quarter-township research units.
4. To determine benefits by acreage, by time and type of treatment, of the forest treatment completed on the eight quarter-township research units.

Table 1. Cover type composition (percent) of the four pairs of research units.

Cover type	Experimental treatment level			
	NFP	25%	50%	75%
Aspen				
Untreated	33	15	5	4
Treated	3	14	28	13
Oak				
Untreated	40	22	11	5
Treated	6	12	12	55
Pine				
Untreated	5	14	7	7
Treated		1	8	1
Northern hardwood				
Untreated	2	<1	<1	
Treated				1
Upland brush				
Untreated	1	1	<1	1
Treated				5
Forest opening				
Untreated	4	<1	2	4
Treated	1			
Forested lowland				
Untreated	3	8	18	1
Treated	1			
Non-forested lowland	<1	11	7	2
Water		1	1	<1
Non-vegetated	1	1	<1	1

5. To determine the attitudes of deer hunters towards each of four levels of habitat manipulation and types of forest treatments, and determine the proportion of hunters having a quality experience for each level, on the basis of deer seen and deer killed, during the firearm deer season.
6. To determine how habitat manipulation for deer management influences the nature and extent of year-round recreation occurring on the research unit, attitudes of recreational groups towards the level and type of habitat manipulation, and how the number of deer seen influences the quality of recreational experience.
7. To determine how residents living near the research units feel about the levels of forest treatment, recreational use on the area, and deer numbers.

Data collection will continue at least through deer season of 1981.

Deer Populations

Three different field surveys are employed to monitor changes in deer populations. Spring pellet group surveys (Eberhardt and Van Etten 1956) estimate overwinter populations. Summer roadside track counts (Daniel and Frels 1971) reflect summer density, habitat selection, overwinter mortality, and reproductive success. Deer hunting season performance surveys measure hunting pressure and success, kill distribution, yield, and physical condition of deer. This effort involves intensive full time patrol of the research units during the entire 16-day firearm season. We record locations and license plate numbers of all vehicles, make direct hunter contacts, distribute postcard questionnaires, and examine deer carcasses for sex, age, physical data, etc.

Vegetation

Production and utilization of available deer forage were sampled in each cover-treatment type combination in each of the eight research units. Available deer forage has been defined in this study as all herbaceous vegetation below 5 feet (1.5 m) and all woody vegetation less than 0.20 inch (5 mm) diameter and below 5 feet (1.5 m).

Approximately 10 sample locations were randomly selected for each cover-treatment combination in each unit. At each sample location, two 3.3 feet (1.0 m) square plots, similar in terms of species composition and abundance and typical of that location, were selected. Deer were excluded from one of these plots by a 5 foot (1.5 m) high wire exclosure. The second plot, or control, was exposed to deer foraging. Differences found in herbaceous forage between these plots will be used to determine utilization of herbaceous material.

One treatment level was sampled each year since 1973, but for this preliminary report only data on the last 4 years are included (NFP-1976, 25 percent-1977, 50 percent-1978, 75 percent-1979). For the 25 percent, 50 percent, and 75 percent levels, this meant that this sampling followed five growing seasons after completion of treatment.

The sampling procedure consisted of using a grid to visually estimate the area of herbaceous vegetation for each species. For woody vegetation we measured number of twigs and diameter by species, number of twigs browsed, and the diameter at point of browsing. These procedures were used on all exclosure and control plots. On every second exclosure plot, herbaceous and woody vegetation were collected by species, dried to a constant weight at 110°F (43°C) for 84 hours, and weighed. The relationships between twig weight and twig number (Schafer 1963), and the relationships between herbaceous weight and herbaceous area derived from these clip plots will be used to estimate vegetation weights for the remaining exclosure plots and the control plots. Utilization of woody vegetation will be determined using twig weight-diameter curves similar to those described by Telfer (1969). All the data needed to determine these relationships will not be available until after the 1980 sampling is completed. Only vegetation production estimates based on the clip plots will be presented in this paper.

People

Three separate studies were created to analyze the people response to clearcutting. The first was concerned with attitudes and recreational behaviors of property owners living near the treated areas. Samples of landowners in Roscommon County were selected from 1974, 1976, and 1978 tax rolls. These individuals were sent mail questionnaires during the summer of each sample year. Two reminders were mailed to those individuals who did not respond initially.

The second people study measured the changes in the quality and quantity of recreational use of the research areas at times of the year besides firearm deer hunting season. These surveys were done every other year (1 December 73—14 November 74, 1 December 75—14 November 76, and 1 December 77—14 November 78). Sample days were selected within two strata: weekdays and weekends. The research areas were then patrolled on sample days and recreationists using the areas were contacted. If they were in the vicinity, names and addresses of all individuals in the party were recorded. If recreationists were not available, a postcard, requesting names and addresses and recreational activity, was left on the vehicle windshield. The names and addresses of all individuals using the research areas on sample days were then gathered by direct interview, from returned postcards, and from license plate registration checks of recreationists who did not return postcards. These sample individuals were sent mail questionnaires about 3 months after their visit to the research areas.

The third people study measured the change in the quality and quantity of firearm deer hunting on the research areas. The areas were intensively patrolled during every day of the 1972-1979 firearm deer hunting seasons. A systematic sample of hunters was drawn by sampling a random hunter in every eighth vehicle. Names and addresses were obtained from camp permits, returned postcards left on vehicle windshields, and from license plate registration checks. Sample individuals were sent mail questionnaires about 3 months after their visit to the areas.

Results presented in this preliminary paper were based on the responses of 1,413 firearm deer hunters (80 percent of those receiving questionnaires), 2,522 other forest recreationists using the areas (58 percent return of questionnaires) and 352 landowners with property near the research areas (66 percent response rate).

Cost

Aerial photos, 1″ = 1320′ (2.5 cm = 400 m), of the eight research units were taken in late July 1975. They were used to compute the total acreage treated on the 25, 50 and 75 percent units and on the NFP units up to that time. Acreage by time and type of treatment was then broken down by combined use of forest treatment proposals, treatment completion reports, and the aerial photos.

Results

Deer Populations

Winter Deer Populations. To date, trends in spring pellet group surveys indicate an inverse relationship between cutting level extremes and ability of the units to hold wintering deer (Figure 1). The heavily treated 75 percent units showed only a 30 percent increase between 1974 and 1977. Greatest gain was on the 25 percent units with a 481 percent increase between 1972 and 1978 (Table 2). The 50 percent pair showed a 226 percent increase from 1973 to 1979, while the NFP units were intermediate with a 341 percent gain over the same period. Figure 1 also shows that mean winter density within the surrounding district was somewhat higher than on the 75 percent units, but more stable and well below that of the other three treatment levels.

Estimates of actual overwinter density have ranged from 10–20 deer per square mile (2.59 km^2) in 1972 to 80–90 in 1979.

Low winter use of the extensive early successional stages is not surprising in the light of casual field observations and other studies dealing with deer behavior and the winter deer-food-shelter relationship (Nudds 1976, Ozoga and Gysel 1972). From a managerial standpoint, there are definite limitations for which optimum

Table 2. Percent change in deer, vegetation, and people measures as a function of cutting intensity.

Variable	Measure	Cutting level			
		NFP	25	50	75
Winter deer density[a]	pellet count	341	481	226	30
Summer deer density[a]	track count	113	120	129	88
Deer harvest[a]	buck kill	43	94	20	125
Hunting pressure[b]	vehicle contacts	135	91	74	76
Quality of deer hunting[b]	% good-v. good ratings	19	75	10	209
Hunter attitudes about cutting[b]	Likert scale score	1	4	4	15
Hunting success[b]	buck kill/vehicle contacts	−24	3	−30	27
Total recreational[c] use[d]	use index	21	−20	162	−44
Total recreational[c] quality[d]	% good-v. good ratings	−1	1	17	−7
Total recreational[c] benefits[d]	benefit index	21	−34	118	−26
Vegetation production attributed to cutting[e]	dry weight of vegetation	14	33	51	89

[a]Initial value = mean of 1972-1974; final value = mean of 1975-1979.
[b]Initial value = mean of 1972-1974; final value = mean of 1975-1978. Percent is ratio of agreement.
[c]Canoeists deleted, firearm deer hunters included.
[d]Initial value = 1974; final value – mean of 1976 and 1978.
[e]Initial value = production weighted by pre-treatment acreage.
Final value = production weighted by post-treatment acreage.

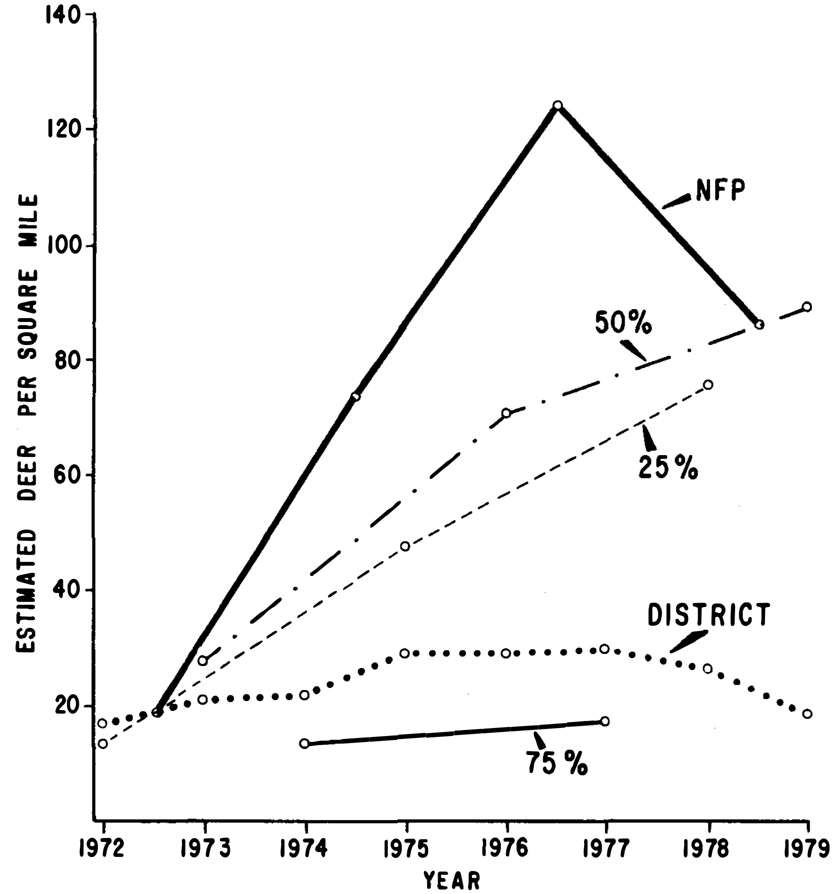

Figure 1. Trends in overwinter populations on habitat research units and locale according to spring pellet group surveys, northern Lower Michigan.

food (browse) can be traded off for shelter. There is little doubt that winter density has been depressed on the heavily disturbed 75 percent units. The degree of impact on the individual units appears to vary with amount and distribution of residual coniferous shelter both within and adjacent to the unit. Figure 1 also reflects the high winter mortality observed on the Lake County units during the severe winters of 1977-78 and 1978-79.

Summer Deer Populations. Summer deer density, as measured by roadside track counts, has also risen steadily over the study period. The extensive 75 percent treatment appears to have limited summer use, as well as winter, at least in these early successional stages (Figure 2).

The incidence of fawn tracks on the survey routes may reflect differences in productivity levels between units and cutting levels. The average fawn track index of 4.25 found on the Lincoln Bridge Unit in Lake County is almost 80 percent higher than the average for the other six units. Between treatment pairs the figures

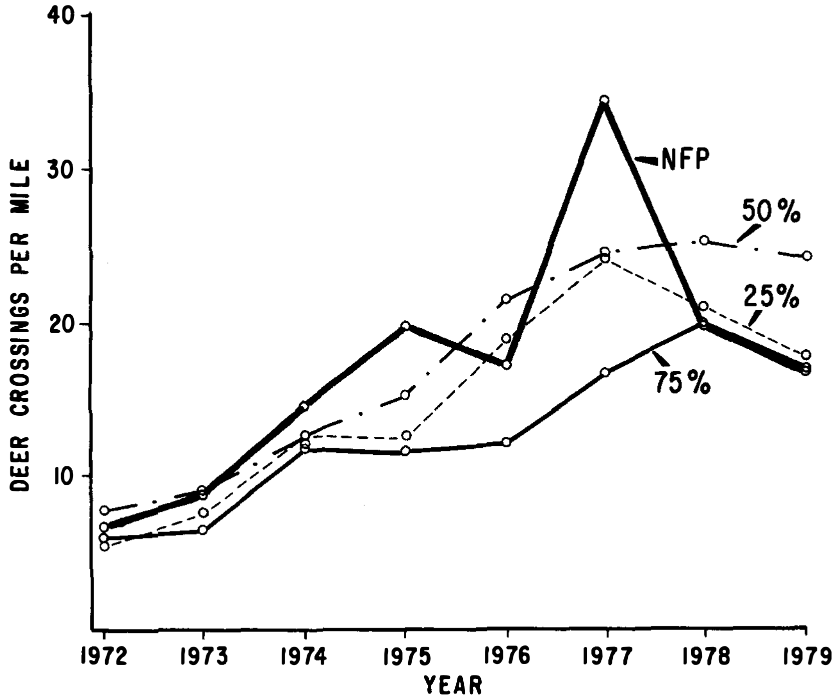

Figure 2. Summer deer population trend on habitat research units as shown by roadside track surveys, northern Lower Michigan.

are 2.57, 2.53, and 2.02 respectively for the 25's, 50's, and 75's. Preliminary evidence indicates these differences are related to both weather and habitat, specifically, time of spring break-up and relative abundance of acorns produced by residual oak stands.

There is close agreement in performance ranking of the treatment levels with regard to both winter and summer population trends (Figures 1 and 2). The sharp decline in track activity on the Lake County unit in 1978 and 1979 probably reflects winter mortality. Summer populations expressed as percent change are similar (Table 2), with the greatest increase found on the 50 percent pair, followed by the 25's, NFP, and 75's.

Deer Hunting Season Performance. While both pellet surveys and summer track counts provide references to population response, hunting season performance must be the ultimate test. This has also been the most difficult statistic to collect and analyze. To confound matters, hunting of antlerless deer has been applied to the units in varying degrees since 1976.

In terms of yield, the Lake County units have led (Figure 3) with an average kill of 5.71 bucks per square mile (2.59 km^2) compared to 3.10 for the 50's, 2.91 for the 25's, and 2.38 for the 75's. Thus we find that the Lake County units have exceeded the other three levels in (1) winter density and summer density, (2) fawn production, and (3) hunting yield. Figure 3 indicates that in the early treatment stages prior to 1974, the 50 percent units exceeded both the 25's and 75's in yield, but fell off following completion of treatment. This may well have been due to the large

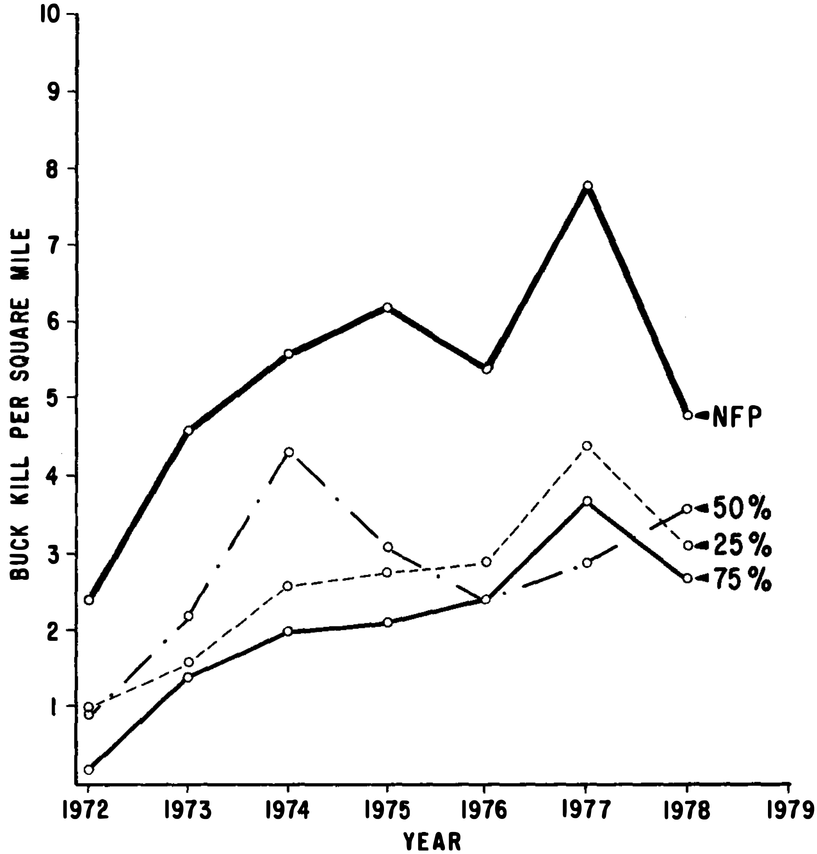

Figure 3. Buck yield per square mile on habitat research units as determined by field and postcard surveys, northern Lower Michigan.

volume of mature oak removed in order to meet the required treatment acreage level. Extensive loss of canopy and potential mast supplies appeared to have a negative impact on the distribution of deer, while the checkerboard pattern of the lower cutting levels contributed to improved distribution of deer and increased vulnerability to hunting.

A comparison of pre- and post-treatment kill shows that the 75 percent level units have increased on the order of 125 percent, followed closely by the 25's with a 94 percent increase (Table 2). Increase in yield on the NFP and 50's has been less spectacular.

Hunting pressure has been inversely related to cutting intensity with the Lake County units absorbing roughly three times greater pressure than the 75 percent units. Peak hunter density on opening day has risen from an average of 11 per square mile (2.59 km^2) in 1972 to 48 in 1978. The heavily hunted Lake County units have carried 70-90 hunters per square mile (2.59 km^2) on opening day since 1975! Hunting pressure, as measured by vehicle contacts, has increased over 300 percent during the course of the study.

Kill per unit of effort, based on buck kill per 1,000 vehicle contacts, tells quite a different story with the 75 percent units outstripping all others following completion of treatment in 1975. Hunting success appears to be a function of cover characteristics involving both treatment levels and residual forest cover.

Michigan's 16-day deer season, opening on November 15, is essentially a 3-day affair. Research data show that over one-half the total season's hunting pressure and about 90 percent of the total kill occurs during these first 3 days. With effort and yield telescoped into this relatively brief period, factors like weather and acorns can have a dramatic effect on hunting success.

Vegetation

Preliminary estimates of total available forage for the two major treated cover types, aspen and oak, were similar, approximately 2,200 pounds/acre (2,464 kg/ha). Estimates of total forage for the untreated aspen and oak cover types were 1,075 and 775 pounds/acre (1,204 and 868 kg/ha), respectively. These estimates suggest a greater percentage increase in total forage production in the oak cover type following treatment. It should be pointed out, however, that these forage production estimates do not include fruit production. Acorns would substantially increase total forage production in the untreated oak cover type in certain years.

Although total available forage production was similar in the treated aspen and oak cover types, there was greater variation in production between forage classes. Production of hardwood twigs, including shrubs over 18 inches (45.7 cm) high, was approximately 525 pounds/acre (588 kg/ha) in the aspen type and 350 pounds/acre (392 kg/ha) in the oak type. Production of hardwood leaves was similar in the aspen and oak types at approximately 500 pounds/acre (560 kg/ha). Aspens *(Populus grandidentata, P. tremuloides),* black cherry *(Prunus serotina),* and oaks *(Quercus alba, Q. rubra)* were the dominant hardwood species in both cover types. Twig and leaf production of shrubs less than 18 inches (45.7 cm) high was 700 pounds/acre (784 kg/ha) in the oak type and 500 pounds/acre (560 kg/ha) in the aspen type. Blueberry *(Vaccinium spp.),* wintergreen *(Gaultheria procumbens),* sweet fern *(Comptonia peregrina),* and blackberry *(Rubus alleghaniensis)* accounted for 80-100 percent of the small shrub production in both cover types.

Production of forbs was approximately 400 pounds/acre (448 kg/ha) in the treated aspen type and 275 pounds/acre (308 kg/ha) in the treated oak type. This difference was primarily due to higher production of bracken *(Pteridium aquilinum)* in the aspen type. Production of grasses and sedges was higher in the oak type at 400 pounds/acre (448 kg/ha) than in the aspen type which yielded 225 pounds/acre (252 kg/ha).

The preliminary estimate of total available forage in the treated jack pine cover type was 1,850 pounds/acre (2,072 kg/ha), somewhat lower than that for either the treated aspen or oak cover types. Untreated jack pine yielded 1,325 pounds/acre (1,484 kg/ha) which was higher than either untreated aspen or oak. These estimates suggest that cutting in the jack pine cover type produces the lowest increase in forage production. Much of the increased production in the jack pine cover type was due to blueberry which increased from 625 pounds/acre (700 kg/ha) on untreated areas to 1,050 pounds/acre (1,176 kg/ha) on treated areas.

Estimates of the percentage increase in deer forage production resulting from treatment were computed for each of the four treatment levels. Production estimates were weighted by the cover type percentages listed in Table 1. The production estimates of the untreated cover types were weighted by the pre-treatment cover type acreages to obtain pre-treatment production estimates. The production estimates used in these computations were the combined means of the four treatment levels. At the present time an insufficient number of samples has been analyzed within each treatment level to allow use of individual treatment level means. Based on these calculations, available deer forage production increased 14, 33, 51, and 89 percent on the NFP, 25, 50, and 75 percent levels respectively (Table 2). Winter forage, as measured by hardwood twig production, increased 21, 56, 89, and 177 percent over the NFP, 25, 50, and 75 percent levels.

People

Attitudes and beliefs about clearcutting among property owners in Roscommon County remained constant between years. About 44 percent of the property owners agreed with cutting, 26 percent were undecided, and 30 percent disagreed. Since attitudes did not change, despite increased amounts of cutting, it is likely that individuals hold certain pre-existing beliefs which are reinforced, rather than changed, when cuttings are encountered. Predominant beliefs of these property owners were that much of the wood was wasted by not utilizing slash, that cutting of oaks and pines was not acceptable, and that vegetation regenerated quickly after cutting (Langenau et al. 1977b).

The primary reason that the attitudes and beliefs remained stable was that the recreational behavior of property owners did not change. Attitudes were most related to the patterning and diversity of forest recreational activities that the property owners engaged in on state land. The attitudes were not dependent upon the education level, occupation, length of property ownership, or age of property owners. The only demographic variable related to attitude was the sex of property owners, with females being more opposed to clearcutting than males. In addition, increased cutting did not cause more people to perceive cuttings: a constant 78 percent indicated that they saw cutting on state land in the county regardless of the amount cut (Levine and Langenau 1979).

Forest recreationists, using the research areas at times of the year other than firearm deer hunting season, had a great deal of experience with the area. About 70 percent of these individuals had visited the same research area during the former calendar year. They made an average of 7.4 trips per year to the research area and for a variety of recreational activities. For example, 48 percent of the small game hunters returned to the same area during deer hunting seasons, 19 percent snowmobiled, 9 percent rode trailbikes, and 30 percent hiked, picked blueberries, or were involved in other recreational activities on the area. A majority (79 percent) of these forest recreationists said they saw clearcutting on the research area, yet they still reported high ratings of enjoyment: 50 percent very good, 37 percent good, 11 percent average, 2 percent poor, and 0 percent very poor.

Another significant finding from the recreational use surveys has been the inconsistency of response. For example, anglers, rabbit/hare hunters, and grouse/woodcock hunters have had the most positive attitudes toward clearcutting. Snowmobilers, campers, and trailbike riders have been most opposed to cutting. In contrast, canoeists, campers, and trailbike riders have reported the highest enjoyment levels. Rabbit/hare hunters, firewood cutters, and firearm deer hunters have reported the lowest enjoyment levels.

Firearm deer hunters have generally responded more to increases and decreases in deer numbers than to the level of clearcutting. Cutting has changed the population of deer hunters on the areas by increasing immigration and emigration (Langenau and Jamsen 1975a) but the return rate has been dependent upon deer numbers (Langenau and Aldrich 1979). Deer hunters' ratings of enjoyment have closely followed changes in deer kill on these research areas (Langenau and Aldrich 1979).

Deer hunters have shown different responses to the type of treatment. On-site interviews showed no difference in attitudes toward manually cut or burned sites but they disliked areas with mechanical treatment (Langenau et al. 1977a). These interviews also showed that attitudes toward clearcutting are related to cover types utilized by deer hunters. Hunters interviewed while hunting in oak stands and cedar swamps were most opposed to cutting, while those in mature pine stands preferred cuttings. Deer hunters using different cover types have different success rates, sighting rates, experience, and characteristics (Langenau and Jamsen 1975b). It has been speculated (Langenau et al. 1977b) that the behavior of deer during the hunting season varies by cover type and that different cutting techniques may alter the behavior of deer differently in various cover types.

Final conclusions about the effect of cutting on recreationists were made by combining one-half of the firearm deer hunter samples from 1974, 1976, and 1978 with the sample of forest recreationists (Langenau et al. 1979). Canoeists, who appeared on only one level of cutting were not included in the concluding analysis. Results showed that quantity of use was different by cutting level: recreational use on the NFP areas increased, use on the 25 percent and 75 percent areas decreased, and use on the 50 percent areas increased. Enjoyment ratings remained constant on the NFP and 25 percent areas, increased on the 50 percent areas, and decreased on the 75 percent areas.

Recreational benefits or costs of cutting cannot theoretically be assessed by measuring quantity or quality independently. For example, an increase in the amount of use, at low quality levels, may actually be a recreational cost. Similarly, a decrease in use with a dramatic increase in quality of recreation may represent a recreational benefit. To handle this problem, a benefit index was derived by multiplying the amount of use by the enjoyment level (percentage of good and very good ratings). This benefit index, although difficult to directly interpret, considers effects of quantity and quality simultaneously.

Recreational benefits were relatively stable on the NFP areas, decreased and then increased on the 25 percent areas, increased on the 50 percent areas, and dropped on the 75 percent areas (Figure 4).

Cost

Total cost of all treatment on the 25, 50, and 75 percent units combined (20,045 acres; 8,122 ha) was $232,177.26. Revenue from timber sales on these units during this period was $253,303.03. The average cost per acre (0.4 ha) ranged from a low of $8.91 on one of the 75 percent units to a high of $11.00 on one of the 25 percent units. By type of treatment, bulldozer with a K. G. treecutter blade was most expensive at $15.54 an acre (0.4 ha). The rolling chopper was slightly less at

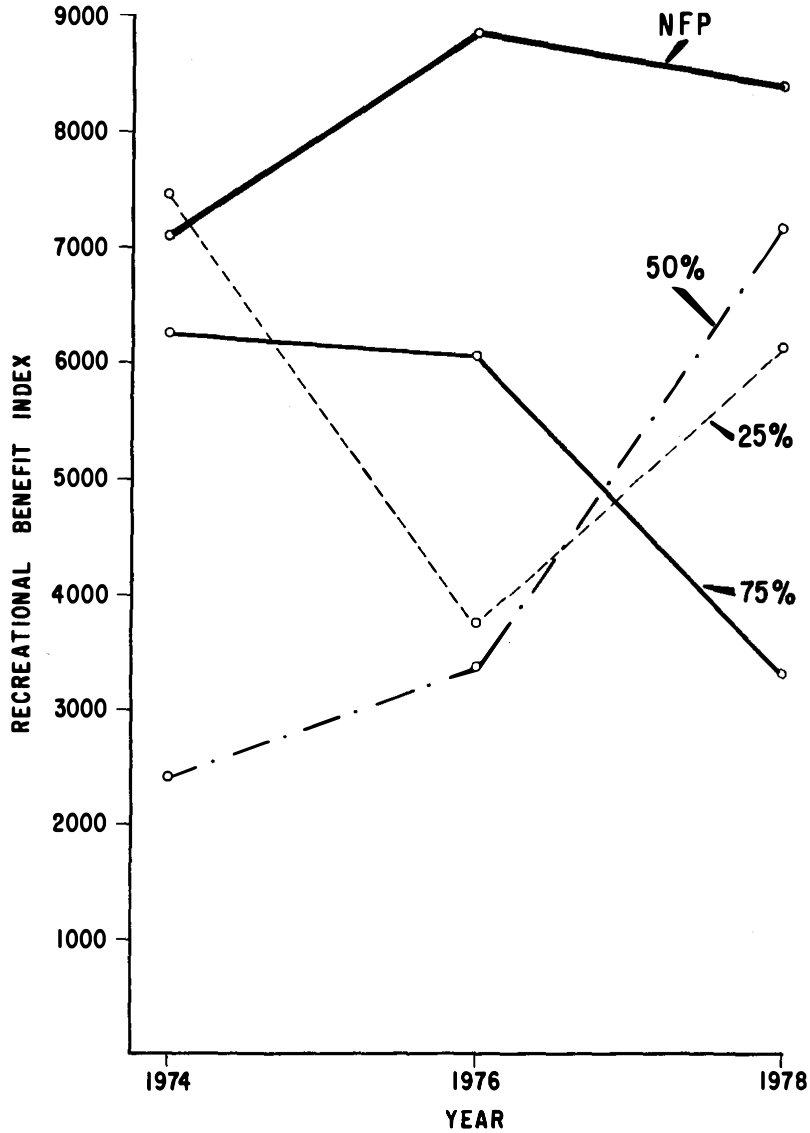

Figure 4. Recreational benefit index by year and level of cutting.

$14.86 an acre (0.4 ha). Manual cutting averaged $8.78 an acre (0.4 ha), and fire was the least expensive at $5.15 an acre (0.4 ha).

As yet, costs have not been computed for treatments on the NFP units.

It is too early to compute cost-benefit ratios since the study is incomplete.

Discussion

As one might expect, our three measures of response in deer populations are imperfect in that the replicate pairs of research units are not true replicates and are different between treatment levels. There are obviously several important extraneous variables peculiar to the units in addition to the four independent variables or treatment levels of experimental design. Consideration of the other factors—soils, drainage, weather, interspersion and juxtaposition of cover types, mast crops, etc.—while critical in many respects, must be dealt with here only superficially. These inherent differences between the eight research units were expected to cause some degree of "noise" in the evaluation analysis.

For all seven units on which we have both pellet group surveys and track count data, there is a direct correlation between the two surveys (r=0.78, P<0.01). In the absence of extensive linear winter to summer movements by deer, we would expect this to be the case. Limited experience with collar-marked deer on the units supports the movement premise. On the other hand, comparison of pellet group and track surveys with hunting season kill has not resulted in consistently high correlations on all units. The association between buck kill and track index is apparent (r=0.84–0.94, P<.01) on all treatment levels except the 50 percent units. Here the relatively low coefficient (r=0.42) indicates some of the difficulties in comparing population parameters both within replicate pairs and between treatment levels. To illustrate, one of the 50 percent units is characterized by an unusually high representation of lowland deer yard (coniferous swamp) coupled with an absence of mature oak. While this unit has produced some of our highest summer track figures, the buck yield has been comparatively low since treatment (Table 2, Figure 3). Deer are probably less vulnerable to hunting under the prevailing interspersion and juxtaposition of the treated–untreated cover complex. In years of heavy acorn production, these deer may move to adjacent stands of oak well ahead of the mid-November hunting season. In fact, late summer track survey activity indicates this is the case, with major shifts and concentrations of deer occurring as early as mid-August in response to acorn drop.

Similarly, the association between winter density and hunting season kill is much less consistent between treatment levels being confounded by movements of deer to adjacent yarding areas and subsequent mortality due to unusual winter severity. As in the case of summer density vs. kill, there is little or no direct correlation between winter density and kill on those units characterized by an absence of mature producing oak and/or unusually high winter mortality.

Thus, final evaluation of the treatment levels must take these variables into consideration. If one ranks the four treatment levels in terms of percent change in the three population parameters (Table 2), the 25 percent level shows the highest composite rating. This pair shows the greatest gain in winter density, and ranks second in both summer activity and buck yield. But percent change in population levels must be tempered with absolute numbers attained. While the 75's show the greatest change in buck yield (125 percent), the mean post-treatment buck kill of 2.7 is still below the level of the other units and the surrounding district. At the other extreme, the very high yield of 6.0 bucks per square mile (2.59 km^2) from the Lake County units represented only a modest 43 percent gain in this parameter.

It would seem, at this point in succession at least, that the 25 percent treatment level shows most promise for habitat management in terms of sustained or stable year-round deer populations and yield.

Several interesting tangents to the population surveys have surfaced that will receive further attention.

One of these involves the possible role played by acorn crops in annual changes in behavior and nutritional plane of deer. This fluctuating food supply seems to be an important factor affecting productivity, vulnerability to hunting and antler development.

The summer roadside track surveys reflect changes in annual productivity and overwinter mortality. In addition, we are attempting to analyze track activity in terms of adjacent vegetation to determine habitat selection across cover and treatment types.

The vegetation data presented in this paper are preliminary. As was pointed out earlier, relationships between visual estimates of herbaceous vegetation and weight, and between twig number and weight are being determined. Once these relationships are known we will be able to make more detailed comparisons of production between cover-treatment type combinations. Estimates of utilization will also be available. Analysis of these additional samples will allow us to compare production in terms of preferred species. Nutrient analyses of preferred species are being made.

The 25, 50, and 75 percent levels were also sampled one growing season after treatment and the NFP units will be sampled in 1980. Analyses of these data will allow comparisons of production over time.

Results of the people studies showed some effects of cutting level on the quality and quantity of forest recreation. Quality differences, for all groups besides firearm deer hunters, were statistically different but not meaningful for policy analysis or program evaluation. Shifts in quality were of minor magnitude but the large number of samples made differences statistically significant. Quality differences for firearm deer hunters were of sufficient magnitude to merit management attention. However, differences in quality, as already mentioned, for this group were due more to variations in deer kill than to level of clearcutting.

The quantity of recreation was influenced more than quality by cutting intensity. In general, cutting produced a shift in the kinds of recreations occurring at each level. Major changes in recreational benefits presented in Figure 4 can then be explained by shifts in recreational use. It is evident, though, that some of these shifts were independent of cutting level. Cutting effects contributed only a minor amount in explaining the variance in recreational quantity.

The NFP units had the highest recreational benefit score as the quantity and quality of recreation on these areas was highest. However, much like the deer populations, these areas also had the highest pre-treatment recreational benefits. Percent increase in recreational benefits was not highest on the NFP areas. Rather, it was highest on the 50 percent research areas. Recreational benefits decreased on the 25 and 75 percent areas.

These changes can be readily explained from our data base. In general, snowmobiling and trailbike riding decreased on the three intensive levels of clearcutting. Snowshoe hare *(Lepus americanus)* hunting, archery deer hunting, and upland game bird hunting increased on the 50 percent level to more than compensate for the loss of snowmobiling and trailbike riding. In contrast, hare hunting did not increase on the 25 percent areas as there was little hare response and did not increase on the 75 percent areas, despite a population response, because the roads and trails were not plowed during winter months. Upland game bird hunting did increase on the 25 and 75 percent areas but not enough to compensate for the loss of snowmobiling and trailbike riding. Archery deer hunting increased on the 25 percent areas and decreased on the 75 percent areas—perhaps because of the lack of cover in large cuttings for concealment and perhaps because of the lack of trees to use for building of tree stands.

An important management implication of the people research relates to the lack of consistency in recreationist's responses. For example, trailbike riders had the most negative attitudes about clearcutting but their enjoyment levels were the highest of all groups except canoeists. Similarly, deer hunters—even on areas with 8 bucks killed per square mile (2.59 km^2), reported the lowest level of enjoyment of any recreational group. Despite this low rating of enjoyment, about 70 percent of the hunters return to the areas the following year. We are then left with the awkward question of what people responses should be used to evaluate programs or to consider in modifying policy. Should one pay attention to complaints even though they will come even in a good hunting year? Should one pay attention to the quality of recreation reported? Should one pay attention if people return to an area or fail to return?

The answer to these questions probably depends on the position of a manager's function and the degree of decentralization in the organization. A staff biologist may have to pay attention to legal action promulgated by key individuals, a district biologist may have to face a stack of letters with complaints, and the field biologist may be most concerned with the return rate of hunters and their ability to harvest animals at an optimal level. However, the public's reaction can be measured by whether or not hunters return, how many days they hunt, and whether they return for other purposes. Their behavior is a better indicator of their reaction to a program than their attitudes, complaints, or enjoyment level. The ideal research and policy analysis solution would be to generate all sets of predicted responses. One could then say that the public will say this and do that. Our research shows, though, that behavior is the most predictable set of public responses while attitudes, complaints, and enjoyments are more variable and less dependent upon manageable factors. In some ways this argument is still well beyond complete resolution as only a very few wildlife programs have been properly evaluated and most evaluations fail to include people. Those that do include people most often consider attitudes rather than behaviors.

Several years hence, when our field data are all in, digested, and analyzed, we must come up with some firm guidelines for management. Looking at the matrix of parameters to date involving deer populations, users, and treatment levels, we glimpse what will undoubtedly emerge as a key use or management option approach. While both percent change (Table 2) and absolute values attained tend to favor the lower treatment levels in terms of deer numbers and hunting pressure, the more intensive levels with fewer deer produced higher deer hunting success and "quality" deer hunting. On the other hand, year-round recreational values—total use, quality, and benefits—were evidently enhanced at higher cutting levels, particularly at the 50 percent range. These contrasting, and sometimes conflicting, relationships between deer numbers, recreational goals, and cutting levels will hopefully give the land manager real cost:benefit trade-offs in planning strategy. In practice, commercial clearcutting operations can then be integrated with the primary use or target user groups on the unit in question.

Other Studies

We recognized, as the study design developed, that even with the multi-Division effort and cooperation obligated to the study by the top administration of Michigan's Department of Natural Resources, we could not possibly handle the many research possibilities offered by the gross habitat treatment. We therefore invited universities and other potentially interested agencies to take advantage of the opportunities.

Our research areas provided sites and conditions for several investigations.

David A. Newhouse worked on all eight research areas in conducting his M.S. thesis investigations entitled "Initial Responses of Ruffed Grouse to Massive Forest Habitat Manipulation" (Newhouse 1975).

Joseph Muszkiewicz in the late 1970s repeated the ruffed grouse *(Bonasa umbellus)* routes initiated by Newhouse in the early 1970s. He also investigated grouse brood use of various treated and untreated cover types on three of our research units; one each of the 25, 50 and 75 percent pairs and on an adjacent area in Gladwin County receiving normal forest treatment. His M.S. thesis, "An Analysis of Ruffed Grouse Brood Habitat in Northern Michigan" presents his findings (Muszkiewicz 1979).

Michael Conroy studied the winter habitat utilization of hares on one of our 50 percent research units. His M.S. thesis "Winter Habitat Structure of the Snowshoe Hare" (Conroy 1976) reports his findings.

Albert Bourgeois studied American woodcock *(Philohela minor)* nest and brood habitat in northern Lower Michigan. Dale Rabe studied seasonal woodcock use of various habitats. Both looked at woodcock use of various treated areas on our research units. Their M.S. theses, (Bourgeois 1976, Rabe 1977) report their findings. Rabe is continuing his work through 1980 for a Ph.D. thesis.

William Fisher of Wayne State University studied bird populations in clearcut, burned, and untreated forest areas on one of our 25 percent research units. His M.S. thesis (Fisher 1974) presents his findings.

Paul Adams and James Boyle of the University of Michigan studied the effects of fire on soil nutrients in clear-cut and whole-tree harvest sites on one of our 75 percent units. Their results are not yet published.

The U.S. Forest Service and our Forest Fire Division investigated the behavior and effects of fire under various situations by studying our prescribed burn sites before, during, and after burns.

Our DNR Forest Fire Division used many of our prescribed burns to train their personnel.

The Wildlife Division's Pathology and Physiology Laboratory collected information on disease and parasites in deer on our research units from samples collected during deer seasons.

Acknowledgements

This study was a multiple Division team effort. Literally dozens of DNR employees from Research and Development, Wildlife, Forestry, Forest Fire, Fish, Statistical Services, and other Divisions assisted in the study. Employees from all three regions of the state helped.

Dr. D. H. Jenkins and M. L. "Pete" Petoskey, chiefs of the Research and Development and Wildlife Divisions respectively at the study's start, gave continuing support and encouragement throughout. Drs. L. A. Ryel and W. L. Palmer actively contributed in the study design. Forest Management Division personnel handled all timber sales and residual contract cuts. Donald Torchia and Robert Slater, Area Foresters for the Houghton Lake and Kalkaska State Forest, and their aides did a commendable job of handling a monumental amount of work and seeing that it was completed on schedule. Donald Grant, District Forest Fire Supervisor for District 7, Darwin Bennett of Forest Fire Staff, and Forest Fire personnel from several districts did a fine job of scheduling, preparing for and executing successfully the many proposed prescribed burns on the units. District Wildlife Biologists Thomas Havard and Robert Huff and their habitat biologists Fred Ignatoski, Jerome Weinrich, Robert Bernard, and Raymond Perez handled people-use surveys on one-half of the eight units. They also scheduled and supervised mechanical and manual forest treatment on the units. Special recognition was earned by Wildlife Research Technicians James Terry, Gary Jakubos and Robert Gray of the Houghton Lake Wildlife Research Station for their dedication in effecting a lion's share of the field work required in the study. Thanks is given the student aids who worked with us for their diligence in the tedious task of summer vegetation surveys and other work. Research personnel from our Rose Lake and Cusino Research stations spent considerable time assisting with deer season surveys as did wildlife field personnel from both the Upper and Lower Peninsulas. Lee Schrader, Departmental Executive at Houghton Lake, efficiently handled the logistics for the study. Karen Douglas, Stenographer at Houghton Lake, has most efficiently typed, handled, catalogued and filed the many reams of forms, documents, notes and reports essential for the study. Support was provided by funds under Pittman-Robertson Aid to Wildlife Restoration, Michigan Project W-117-R.

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Forest and Wildlife Dynamics in the Southeast

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Introduction

By the year 2030 Florida will have been in the United States for exactly the same length of time that it was under Spanish rule. This observation should dramatize the fact that both the conquest of and impact on native southeastern forest resources has occurred over a substantial period of time, and under the influence of several different cultural groups. These impacts have been both direct and indirect. The indirect effects include the introduction of livestock, especially swine *(Sus scrofa)*, which probably affected both the vegetation and wildlife. The consumption, by hogs, of longleaf pine *(Pinus palustris)* seedlings may well have reduced longleaf regeneration significantly (Wahlenberg 1937). Also, the consumption of mast by hogs probably resulted in direct competition with native species such as the passenger pigeon *(Ectopistes migratorius)* (Schorger 1955). The direct exploitation of resources by man was even more dramatic. When the Spanish relinquished Florida to England in 1763, deer hide sales at major sea ports in South Carolina, Georgia, Alabama and Florida brought greater returns than all other exports combined (Wing 1965). Although the products have changed over the centuries, the trend of resource use has been one of continually increasing intensity. Both the forest and the wildlife populations reflect these changes.

The purpose of this paper is threefold: (1) to describe certain characteristic aspects of the forest and fauna of the southeastern coastal plain, (2) to describe the most important recent changes in the forest and, thus, the wildlife habitat; and (3) to suggest some new and different aspects of forest management planning and research.

Some Characteristics of Southeastern Coastal Plain Forests and Wildlife

The southeastern states have historically been covered by a higher proportion of forest vegetation than most other regions of the country (Brown 1909), and remain so today (USDA 1978). The typical forest of the lower coastal plain originally consisted of the longleaf pines *(P. palustrus, P. elliottii* and *P. taeda)* on the deep sandy soils, with hardwoods dominating the richer hammock sites and the lower river bottoms. These pines, especially longleaf *(P. palustrus)* and slash *(P. elliottii)*, produced 80 percent of the world's production of naval stores throughout the early 1900s (National Resources Planning Board 1941). Very sparsely stocked longleaf pine originally dominated 70-80 percent or about 25 million ha of the coastal plain (Harper 1914, 1943, Brown 1909, Croker 1979). The combination of sparse stocking and frequent summer fires created an understory that was dominated by perennial grasses, primarily wire grass *(Aristida stricta)*. Bottomlands were dominated by cypress *(Taxodium* spp.), black gum *(Nyssa sylvatica)*, sweet gum *(Liquidambar styraciflua)*, tupelo *(Nyssa aquatica)*, maple *(Acer rubrum* and

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A. barbatum), and water oak *(Quercus nigra)*. Important species of the rich hammock sites were the live oaks *(Quercus virginiana, Q. laurifolia)*, magnolias and bays *(Magnolia* spp. and *Gordonia* spp.), hollies *(Ilex* spp.), beech *(Fagus grandifolia)*, sweet gum and hickories *(Carya* spp.).

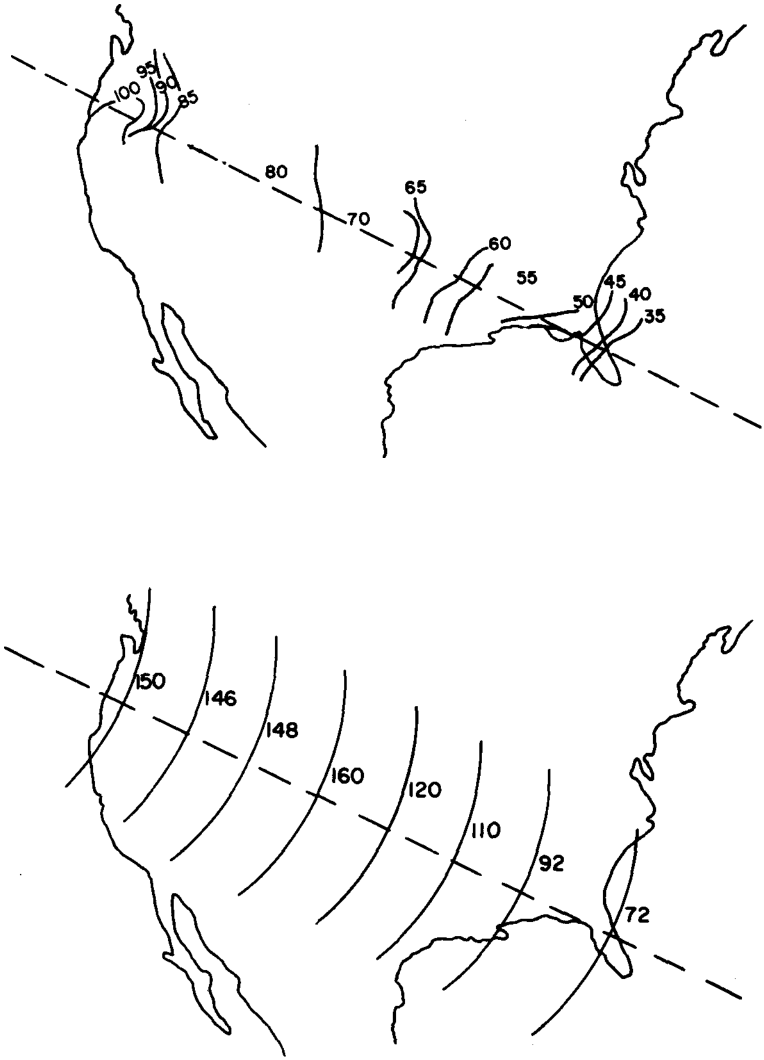
Some characteristics of the region and its forests of special importance to wildlife populations are:

1. A short winter with a relatively high mean temperature that allows water and soil to remain unfrozen and allows endothermic animals to exist on perhaps 30 percent less maintenance energy than their counterparts at 50°north latitude (Kendeigh et al. 1977, Moen 1973).
2. Absence of a winter snow cover and considerably longer winter day lengths than those of the higher latitudes, greatly facilitating winter foraging by diurnal species.
3. With a canopy height of 25-30 m, the forest is about half as tall as that of the midlatitudes and only 40 percent as tall as the coastal forest of the Pacific Northwest. This represents a much reduced forest habitat volume for arboreal species.
4. A high abundance of evergreen, broad-leaved plant species occurring in both the bottomland swamps and upland hammocks. About 45 percent of the tree species and as many as 76 percent of the individual trees commonly occurring in hardwood swamps in north Florida are evergreen (Monk 1966). This foliage is not only important to browsing vertebrates, such as white-tailed deer *(Odocoileus virginianus)*, but also to the phytophagous arthropods that remain active throughout the winter and the foliage-gleaning birds that feed upon them.
5. A continuity in mast production, from those plants that bear their fruit in very late fall, such as the hollies *(Ilex* spp.) and certain greenbriars (e.g. *Smilax walterii*) to those that bear fruit in the very early spring such as Florida maple *(Acer barbatum)*. Still other plant species, such as muscadine *(vitus rotundifolia)* and sumac *(Rhus copallina)*, retain their mast throughout the winter. The naturally diverse coastal plain landscape, therefore, contains abundant mast throughout the year.
6. Perhaps a 10-fold greater decomposition rate of dead organic matter (Olson 1963) that causes non-lightered snags to decompose in a few years rather than decades or centuries. This rapid disappearance most likely increases the competition for cavities in dead trees and greatly increases the ecological importance of the red-cockaded woodpecker *(Picoides borealis)*, only of the southeastern species to excavate cavities in live wood.

Certain aspects of the southeastern wildlife community are also noteworthy. Contrary to popular belief, the number of species of breeding birds and mammals does not increase with the lower latitudes in the southeastern United States. As demonstrated by Simpson (1969), the density of mammal species in the lower coastal plain is less than half that occurring throughout much of western North America. The number occurring in mid-peninsula Florida is only one third the number occurring in the Sierra Nevadas (Figure 1).

The same general trend was shown to exist for breeding bird species by MacArthur and associates (MacArthur 1959, MacArthur and Wilson 1967) with the density of breeding species being only about half as great in the coastal plain as in

Mammal Species / 58275 km^2
(modified from Simpson 1969)



Approximate Breeding Bird Species / 250000 km^2
(modified from MacArthur and Wilson 1967)

Figure 1. Isolines of mammal and bird species densities in the United States showing the general decrease in number of species from northwest to southeast. Mammal data were calculated as the number of species per square grid cell 150 miles (240 km) on a side. Breeding bird densities were calculated as the number of species in grid cells 300 miles (480 km) on a side.

many western areas (Figure 1). Robertson (1955), Rohwer and Woolfenden (1969), and Emlen (1978) have also drawn attention to the low density of breeding birds on the Florida peninsula. Robertson (1955) noted that this number decreased even more dramatically along the Florida peninsula to reach a low of only 29 species of breeding passerines in south Florida.

Contrary to the breeding species trend, the number of overwintering species and individuals in the Southeast is relatively high when compared to North America in general. This point is dramatized by the 400 million blackbirds (e.g. *Agelaius, Quiscalus*), that overwinter in the Southeast (Meanley and Webb 1965). When the number of total recorded species for the various states is divided by the number of breeding bird species, the ratio is highest in Florida and decreases northward. For example, the six southeastern coastal states average 2.4 times as many recorded species as breeding species whereas the ratio for most northern states is well below 2.0. These ratios support the notion that the lower coastal plain forests are much more important for migrating and overwintering North American species than resource managers have acknowledged. Studies in Louisiana suggest that overwintering bird populations in bottomland hardwoods may be twice as great as the breeding bird densities (Noble and Hamilton 1975, Ortego et al. 1976, Dickson and Noble 1978, Kennedy 1977).

Unlike the birds and mammals, herpeto-faunal species are particularly abundant in the Southeast. More than 150 resident taxa (species or recognized subspecies) of reptiles and amphibians occur in Florida alone (Stevenson 1976). These species appear about equally abundant in all ecosystem types (Florida Game and Fresh Water Fish Commission 1976). In total, these statistics show that Florida has more species of reptiles and amphibians than it does breeding birds and mammals combined—a marked contrast to areas such as northern Minnesota, where birds account for 79 percent of the breeding vertebrate species (Siderits et al. 1978).

In addition to the points mentioned, at least one additional characteristic of southeastern wildlife seems noteworthy. Mid-winter reproduction occurs among all four of the terrestrial vertebrate classes in Florida, but it is more pronounced among mammals and amphibians. This point is best dramatized by the January hatching of bald eagles *(Haliaeetus leucocephalus)* and a July-August peak in conception among white-tailed deer on the lower Florida peninsula (A. R. Richter, unpublished data, 1980).

Recent Changes in the Southeastern Forest Habitat

Exploitive timbering, suppression of summer fires, and cultivation have brought about great floristic changes in the southeastern forest. Both the removal of large diameter-class hardwoods, and fire suppression, which has occurred both on former hardwood sites and apparently on many former pineland sites as well, have facilitated the increase of second growth (Quarterman and Keever 1962, Knight and McClure 1971). Unfortunately, the increased density and distribution of many hardwoods of marginal value to wildlife has necessitated expensive brush control practices. The proliferation of water oak *(Quercus nigra)* throughout pinelands seems particularly problematic inasmuch as it is an intermediate host for fusiform rust *(Fomes pini)* (Schmidt 1978); furthermore, its mast appears to be of marginal value to wildlife (Swindell 1949, Beckwith 1957). A more recent trend involves the reforestation of cutover sites with slash and loblolly pine plantations. The original

25 million ha of open, longleaf pine has been reduced to about 10 percent of its original extent (Croker 1979).

About 60 percent of the southeastern land area remains forested today, 90 percent of which is considered commercial (USDA 1978). Of the 80 million ha of forest land in the Southeast (Virginia, North Carolina, Tennessee, Arkansas, Oklahoma, Texas, Louisana, Mississippi, Alabama, Georgia, South Carolina, Florida), slightly more than 70 percent is privately owned. Of this privately owned land, approximately 50 percent is softwood and 50 percent hardwood (USDA 1978). About 280,000 ha of pine are planted annually, bringing the total area of pine plantations to approximately 8 million ha.

The general competition for forest land in the Southeast is intense, despite the high yield of forest products. For example, Florida's forest acreage has been reduced by an average of nearly 50,000 ha per year for the last 25 years (USDA 1978). A recent analysis of land-use dynamics by the Soil Conservation Service identifies a loss of 11.1 million ha, or 12.6 percent, of southeastern forest acreage in the last 8 years (Figure 2). Surprisingly, the losses to urbanization and recreational use account for only a small percentage of the decrease (Diderikson et al. 1977).

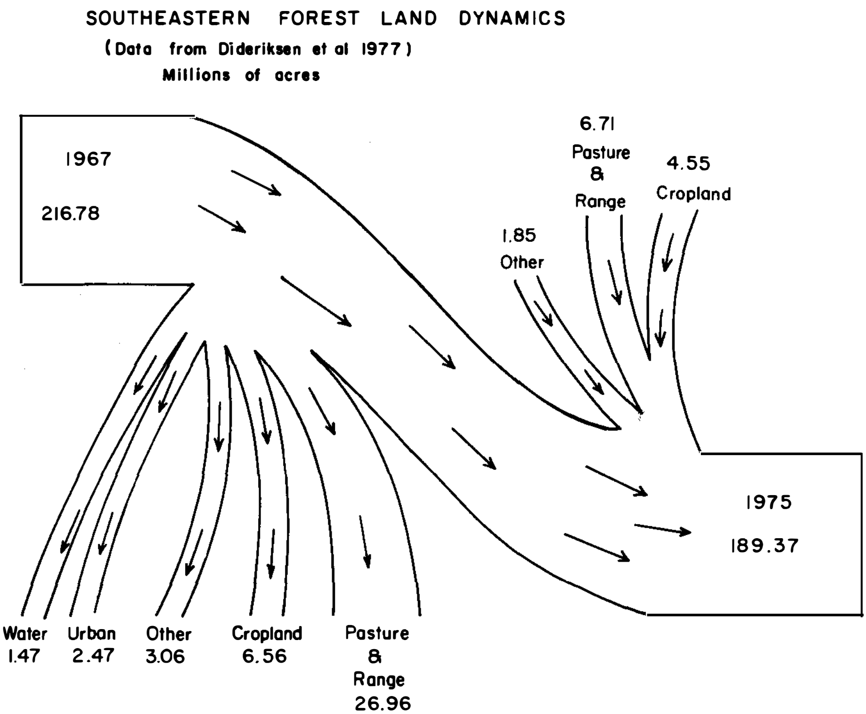


Figure 2. Land use dynamics in 14 southeastern states (Virginia, West Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Alabama, Florida, Arkansas, Oklahoma, Mississippi, Louisiana, Texas) as reported in the 1977 USDA survey of potential cropland in the U.S. (Dideriksen et al. 1977). The total acreage in forest land is reported to have decreased by 13 percent during the eight years preceeding 1975.

Although not happy with all of the trends, southeastern forest managers look to their successes with pride (Wheeler 1970). A 1908 Florida forest survey stated that longleaf pine volume averaged 2000-3000 board-feet/acre and that "twelve thousand feet per acre would be considered a maximum" (Brown 1909). What was thought to be the maximum is now the average and the maximum is double the earlier figure. The same report states that " . . . in 1906 the lumber industry undoubtedly reached the high-water mark of production and is now on the decline" (Brown 1909). Recent statistics suggest that on a statewide basis, current annual yield is perhaps twice as great as in 1909 (Steer 1948, Larson 1952). With proper site amendment and a rotation age of 20-25 years, the best well-managed slash pine plantations are producing 15 times as much fiber as the average stand of 50 years ago (Fisher 1980). This increased production supplies 60 percent of the total U.S. wood fiber (Anon. 1977).

These trends affect wildlife in several ways. (1) The decreasing forest acreage is of prime concern since its conversion to competitive land uses, such as agriculture, improved range and urbanization dramatically changes wildlife community composition and abundance. (2) The higher wood volume and fiber productivity on the managed sites greatly reduces the transfer of solar energy into "competitive" wildlife food plants. (3) Site conversion from either mature hardwoods or mature longleaf pine to slash and loblolly plantations causes a major reduction in wildlife abundance within the planted stands. (4) The smaller size of remaining mature forest stands creates a habitat island effect that discriminates against the larger body-sized and/or higher trophic level species (Miller and Harris 1977, 1979, Diamond 1975, Whitcomb et al. 1976, 1977, Simberloff and Abele 1976). (5) The short (25 years) period between planting and cutting means that as much as 75 percent of the rotation period on any one site consists of dense pines.

Despite their decreasing acreage and greatly increased management intensity, forests still constitute the major wildlife habitat in the Southeast. Forestry is superior to alternative, competitive land uses, such as agriculture, pasture and urbanization for most wildlife groups. Because of their ownership of large, contiguous tracts of land, forest industries play a critical role in the conservation of large, wide-ranging wildlife species. The prescription and implementation of favorable silvicultural practices seems the single best avenue for future wildlife conservation in the Southeast.

Silviculture—Wildlife Relationships

Matthews (1976) has suggested that silviculture involves three distinct aspects: (1) the method of regeneration; (2) the form of trees; and (3) the orderly arrangement of the crops over the whole forest. This is an ideal definition from the wildlife ecology standpoint since two of the three components of the definition imply a concern for structural diversity or heterogeneity. Tree form, density, and related characteristics govern the within-stand heterogeneity. The size, shape and arrangement of the stands in the larger forest management block affect landscape heterogeneity. Both must be considered.

Within-Stand Heterogeneity

The distribution of foliage through the vertical profile is known to be of predictive value in estimating bird abundance (MacArthur and MacArthur 1961, MacArthur et al. 1962). But other important components of structural diversity are not measured by foliage height diversity (FHD). These include the bole, bark and branching structure of the trees, the distribution of cavities and dead wood, the type, abundance and timing of mast, etc. Evidence suggests that natural stands of longleaf pine are intrinsically superior to slash and loblolly for wildlife. If this is so, it probably results from a noticably different trunk, branch and terminal shoot structure as well as a greater expression of dominance between trees and thus a greater FHD than occurs in the other two species. There is some evidence that longleaf pines support higher densities of arthropods than slash pine, and longleaf's greater tolerance to fire allows more advantageous use of prescribed burning. It is also noteworthy that longleaf seeds are more than three times as large as those of the other southern pines. Since longleaf seeds retain their wings they appear more visible and this makes them an ideal food source for game birds and small granivorous mammals. Speaking from a wildlife standpoint, we should encourage the planting and growth of low density longleaf stands.

The structure of understory vegetation is equally important to wildlife. Using an experimental predator-prey approach, Bowman and Harris (in press) demonstrated that structural heterogeneity was more important to ground nest survival than the percent cover immediately above the nest. Other important forms of structural diversity at the ground level derive from topographic and edaphic differences and materials such as stumps and fallen branches and logs (Maser et al. 1979). The forest management practice of windrowing debris is a prime example of enhancing ground-level structure for wildlife. Major differences in stand structural diversity may be achieved by the use of simple techniques such as prescribed burning, and varying planting density and the age of the stands, or perhaps of some trees within the stands (Figure 3). The understory live biomass is considerably less in plantations grown on formerly cultivated sites than on previously uncultivated sites. In general, it is also reduced by certain site preparation practices. In all cases, peak production of understory forage occurs in the first 25 percent of the rotation (ages 2-8 yrs. depending on forage group) and rapidly declines thereafter (Jensen 1962, Skoog 1980).

Because of the unique conditions prevailing in the lower coastal plain forest, emphasis needs to be given to the role of cavities. Whereas approximately 25 percent of the pineland breeding birds are cavity nesters (Rowse 1980), the endangered red cockaded woodpecker is the only species to excavate cavities in live wood (W. Baker, pers. comm.). Given that in the lower coastal plain snag and dead wood decompose in less than 10 years compared to perhaps 100-200 years in the Northwest, competition for cavities must be intense. The eviction (sometimes physically) of red cockaded woodpeckers from their nesting cavities by species such as bluebirds *(Sialia sialis)* is apprarently common (Jackson et al. 1979).

Among-Stand Heterogeneity

When a clearcut is implemented in a forest, a sharp edge or face is created along the remnant stand. As this clearcut is regenerated and the stand regrows, an interface develops between the stands. It is the nature of these faces and interfaces that creates between-stand forest diversity or heterogeneity. The relative value of these different interfaces (edge types) must be known before prescribing

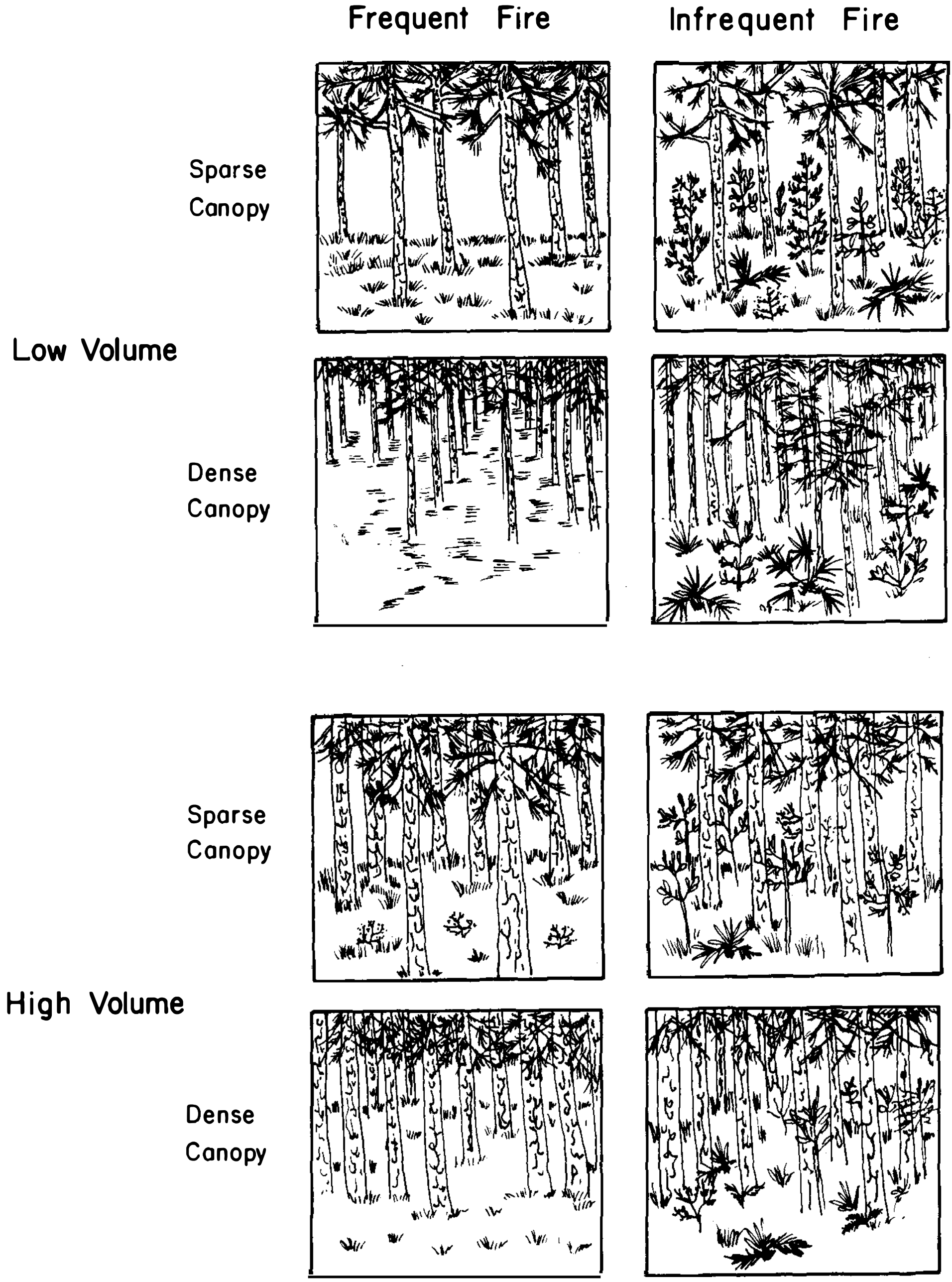


Figure 3. Schematic representations of the forest wildlife habitat resulting from the manipulation of three management variables, volume of wood, planting density and frequency of prescribed burning.

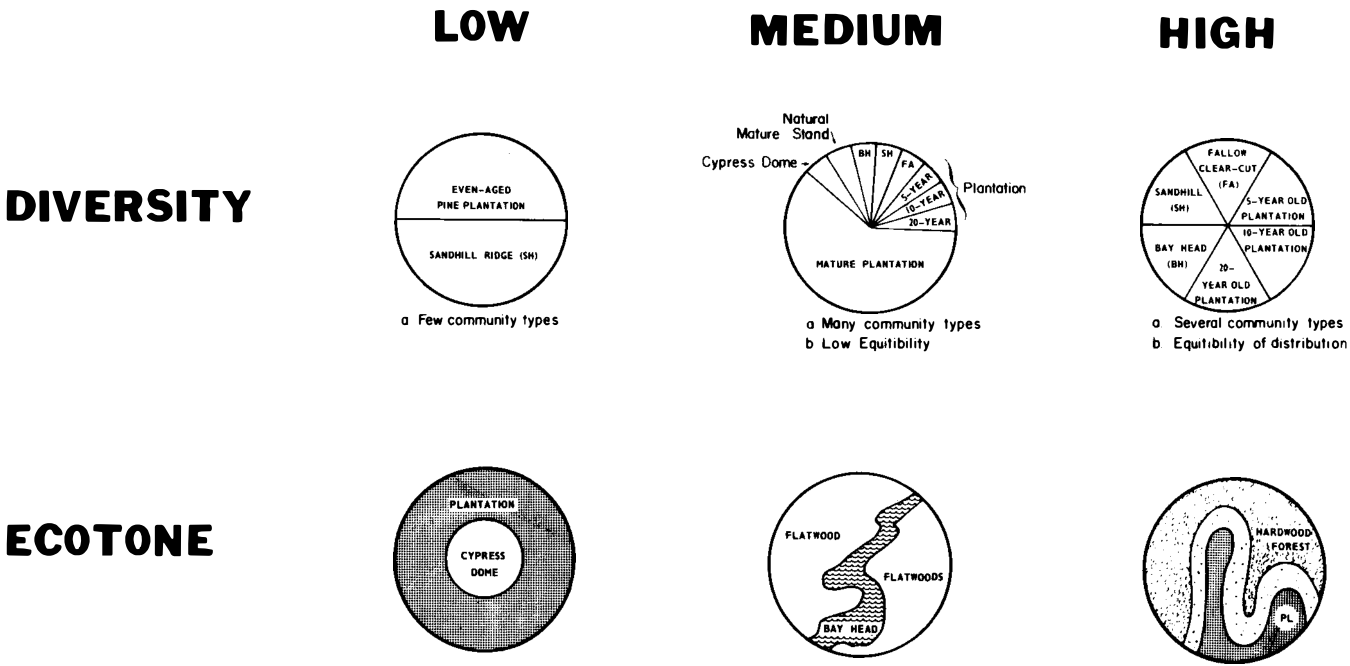
the location and arrangement of cutting operations. An experiment comparing breeding bird densities in two edge types revealed consistently higher densities in the sharp edges created by clearcutting compared to ecotones in similiar but unperturbed habitat (McElveen 1978). When coupled with related computer simulation experiments (King 1978), the results confirm that different types of edge supply different food and habitat requirements for species and therefore have greatly different management utility. It appears that the value of the edge to the full wildlife community may be a direct function of the relative difference in the energy or biomass (or information) concentration of the two adjacent community types. The magnitude of difference is measured as juxtaposition (Figure 4).

It follows that the value of the edge surrounding a plantation will change with the successional development of the plantation as well as the nature of the surrounding community. The relative value of the edge would appear to be directly related to the density and homogeneity of the plantation. This implies that the magnitude of the "edge effect" might be relatively small in very young and very old plantations but greatest in middle to late aged plantations. Edges where three or more community types abut are believed to be superior to those where only two communities abut (Figure 4).

Given that something is known about the value of stand faces and interfaces and thus the value of different positional arrangements, we need to address the issue of stand size. This, in turn, leads to the notion of patchiness or landscape "grain". Available evidence suggests that the number of breeding bird species inhabiting patches of forest habitat is doubled by every 7.3-fold increase in acreage ($Spp = cA^{0.35}$). In other words, if a 3 ha patch of habitat normally supports eight breeding species, a 22 ha patch will be required to support 16 species. Said another way, the number of species inhabiting an area is decreased by 50 percent as 86 percent of the contiguous stand is removed. No matter how numerous, it seems that a montage of small habitat islands will not form large contiguous forests of the desired type. For example, surveys of 12 hardwood hammock islands from 0.4 to 30 ha in size revealed that they supported only 64 percent of the local upland breeding bird species and only 34 percent of the species endemic to mesic hardwood forests (Wallace and Harris in prep).

Habitat type is clearly as important to the density of individuals and species as is the habitat size. It is generally believed that hardwoods support much greater densities of breeding bird species and individuals than do softwoods (c.f. Udvardy 1957, Thomas et al. 1975), a trend that may apply to the other terrestrial vertebrates as well. Differences in bird abundance also exist between southeastern hardwood stand types and pine stand types (e.g. Nobel and Hamilton 1975, Ortego et al. 1976, Kennedy 1977, Harris et al. 1974, Norris 1951, Robertson 1955, Rohwer and Woolfenden 1969). Yet, the same basic species-area relations seem to exist between different community types in spite of their different species densities (i.e. a slope coefficient $\simeq 0.35$). North Florida habitat islands of cypress and hardwood occurring in pineland support twice as many breeding bird species per hectare as do upland hardwood islands. Nonetheless, the rate of increase in species as a function of patch size is the same (Harris et al. 1979).

Bearing these two sets of relations in mind, we can approach the issue of tradeoffs between the size of tract and type of tract. Given that a particular number and kind of species of birds can be specified as a management objective,



LOW
MEDIUM
HIGH
DIVERSITY
EVEN-AGED PINE PLANTATION
SANDHILL RIDGE (SH)
a Few community types
Natural Mature Stand
Cypress Dome
BH
SH
FA
5-YEAR
10-YEAR
20-YEAR
Plantation
MATURE PLANTATION
a Many community types
b Low Equitibility
FALLOW CLEAR-CUT (FA)
SANDHILL (SH)
5-YEAR OLD PLANTATION
10-YEAR OLD PLANTATION
BAY HEAD (BH)
20-YEAR OLD PLANTATION
a Several community types
b Equitibility of distribution
ECOTONE
PLANTATION
CYPRESS DOME
FLATWOOD
FLATWOODS
BAY HEAD
HARDWOOD FOREST
PL

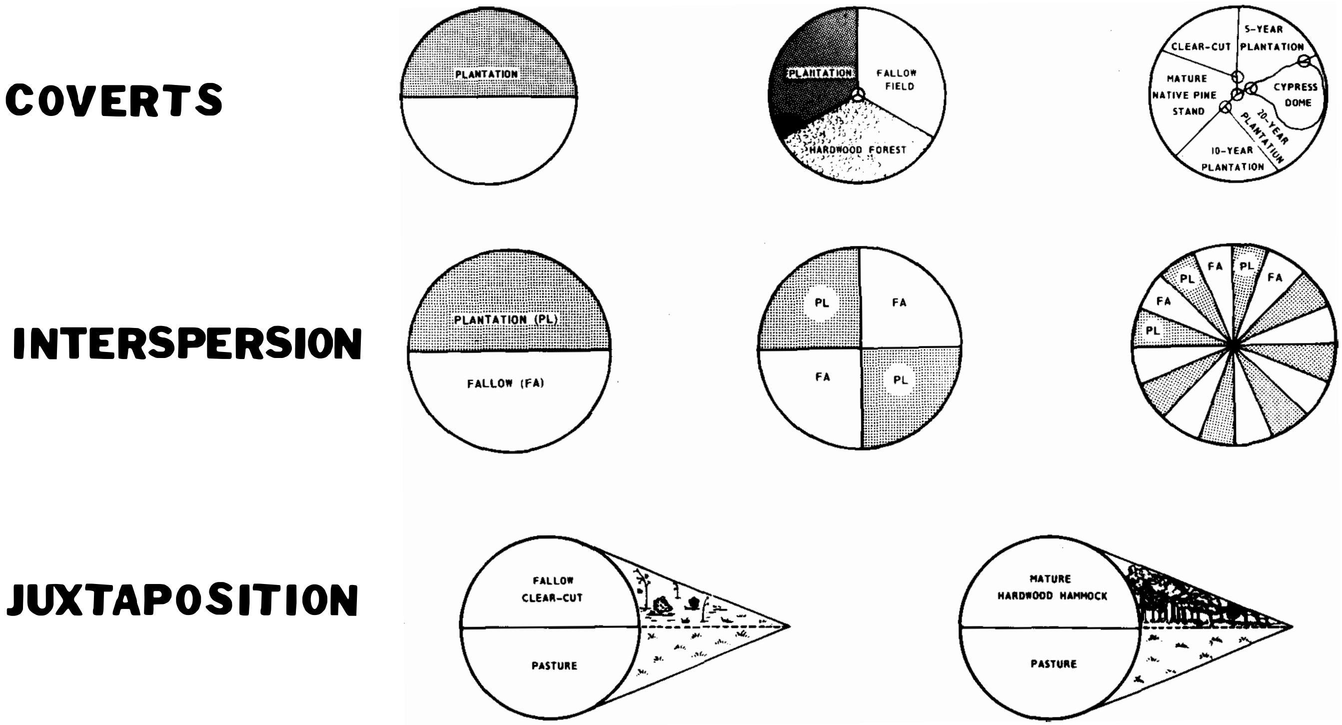


Figure 4. Schematic representation of five forest habitat characteristics of importance to wildlife. Diversity depends upon both the number of habitats and their proportional abundance. Ecotone refers to the gradation of one habitat into another. Covert refers to the point where three or more habitat types join. Juxtaposition refers to the amount of difference between the adjacent habitat types.

the required acreages of different habitat types can also be derived. Said another way, to double the number of breeding bird species inhabiting a given pineland type the size would have to be increased from say 10 ha to 100 ha. The number of species could equally well be doubled by providing a 10 ha patch of hardwood forest.

Time-Space Interactions

Ecology is principally the study of how organisms interact both with and in their natural physical systems. It is also believed that naturally evolved systems are more than simple aggregations of randomly chosen elements. These notions suggest that a maximally functional forest landscape system must be designed around numerous time-space interactions. For example, Umber and Harris (1974) estimated that central Florida white-tailed deer were more abundant in planted pine in the spring but more abundant in nearby natural oak *(Quercus laevis)* habitat in the fall. Landers et al. (1979) observed that the mast utilized by black bear *(Ursus americanus)* in North Carolina derived primarily from the uplands in summer and fall but from the bottomlands in winter and spring. These examples serve to illustrate that even resident species usually require a diversity of stand types during different life stages and seasons. As pine plantations come to dominate a larger proportion of the forest landscape, the losses of within-stand heterogeneity must be compensated for by increased between-stand heterogeneity. A much greater sensitivity to the value of different vegetative community types will be required in order to plan and implement composite landscapes (Harris and Smith 1978, Harris and Kangas 1979).

'Data drawn from studies of the herpetofaunal community in north Florida will illustrate the level of sensitivity required. Cultural practices that change the water quantity and quality in the cypress ponds interspersed throughout the flatwoods are increasingly common. The construction of drainage ditches, for example, causes a shift in the distribution of individuals from the more aquatic species to the more terrestrial species (Vickers 1980). A large change in water quality, however, seems to greatly impact the density, distribution and reproductive success of the entire local amphibian population.

Cypress ponds serve as breeding refugia for the flatwoods amphibians. Thus, adult frogs would move to the ponds seasonally to reproduce and subsequently both the adults and their offspring would emigrate to the surrounding flatwoods. However, a major increase in eutrophication causes a bloom of floating duckweed *(Lemna* spp., *Spirodella* spp.) and a shift to anaerobic water conditions. Populations of shore flies (Ephydridae) and filter flies (Psychodidae) build to high numbers and detain the adult frogs in the ponds. Because the water is anaerobic, reproductive success is very low and few young are produced. The net result is that neither adults nor offspring emigrate to the surrounding flatwoods (Jetter and Harris 1976). An elaborate season by space by life-stage interaction under unperturbed conditions is disrupted and not only the amphibian population but the entire food chain is impacted.

In addition to the interaction effects described for resident species, I believe it is critical that we place increased attention on the role of the southern forest in the context of the North American migratory fauna. Virtually all bird work has focused on the breeding bird community. Current impact analyses dismiss overwintering habitats as though the winter residents are simply nondiscriminating visitors. Yet the evidence suggests that, whereas pineland communities support their highest bird populations during spring and summer (Rowse 1980, Reese and Hair 1976), the bottomland hardwoods support their highest bird densities in the winter (Ortego et al. 1976, Kennedy 1977). The migrant granivores obviously prefer rangeland, fallow fields and clearcuts. Data from the work of Dickson and Nobel (1978) suggest that year-round resident birds utilize the midstory consistently through all seasons. Winter and spring migrants use primarily the ground and midstory, whereas the summer and fall migrants utilize the upper canopy. The implication is clear: evaluation and design of southeastern forest environments for wildlife must not only include a heightened awareness of the resident taxa involved, but the importance of these environments to the entire North American migratory fauna.

Summary

The high regional human population growth rate and recently increased agricultural and rangeland incentives are exerting severe competition for southeastern forest lands. The reduction in forest acreage appears to be about 1.5 percent per year. When coupled with the ever-increasing demand for fiber this means that a decreasing number of forest hectares are being managed more intensively. This trend suggests that the loss of former within-stand habitat diversity must be compensated for by between-stand heterogeneity. The stand arrangement and nature of the early 21st century forest is totally dictated by the planting schedules of today. Planning for wildlife should be an integral part of current reforestation decisions if the future forest is to be of maximum value to wildlife. The landscape is suggested as the appropriate level of consideration.

This paper stresses certain unique characteristics of the southeastern forest and wildlife community. Because of a paucity of resident mammal and breeding bird species, the relative importance of migrant birds and amphibians and reptiles is accentuated. Increased attention must now be focused on the role of forest habitats during the warm winter months when residents remain active and migrants become abundant. Attention must also be focused on the time-space interactions in order to ensure habitat quality throughout the seasons.

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Management Needs on Private, Nonindustrial Forests

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Management Needs on Private Nonindustrial Forest Lands: A Summary of Four Regional Conferences

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Introduction

William Towell has reviewed the structure and rationale for the four regional conferences that preceded the national conference on the needs of nonindustrial private landowners.

The lands in question are currently providing 38 percent of the softwood and 76 percent of the hardwood timber harvest in this country. In some local areas the statistics have even more impact. In Mississippi, for example, 80 percent of the timber harvest comes from private nonindustrial ownerships. Likewise 80 percent of our deer habitat is in private ownerships.

Any assessment of these ownerships must recognize their diversity. The 283 million acres (114.5 million ha) or private, nonindustrial forest lands are controlled by some 4 million landowners. When the diversity of the land is coupled with the diversity of ownership goals and objectives, the result is a complex matrix which does not lend itself to simple analysis at the local, regional, or national levels.

Nor is the present situation static. There is currently a shifting of new capital investment in the forest products industry from the Northwest to the South. This shift will have significant impacts on the private land base in the South. A corollary to this shift is the interest in improving productivity on private lands as a means of relieving demand for stumpage from public lands in the Northwest.

There has been a tendency in this country to plan the landowners' futures and to make assumptions about their receptivity to various public incentives. The assumption that they share publicly desirable goals was certainly challenged by the attendees at the conferences. Two categories of interest groups emerged: (1) the landowners, and (2) the interests of the public and the agencies and professionals involved in management activities on its behalf.

The landowners were primarily concerned with those aspects of policy and programs that affected the profitability of investments in forestry. One state forester reminded us that "citizens in our society are expected to act in their own self-interest." Another observed that "the best national policy is that policy which best satisfies the needs of the woodlots and the landowners who manage them."

The representatives of the public leaned toward support for policies and programs designed to persuade the landowner to manage his lands for public benefit. Adequate recognition of these perspectives is critical when developing policies designed to increase the productivity of private ownerships. The potential of the future lies in a mutually beneficial relationship between public and private interests. Intrusions on ownership rights are not the answer, nor is it reasonable to commit public funds without an expectation of public benefit. While some of the regional conferences tended to favor one interest over the other, on balance they project a course of action that will enhance both public and private interests.

Taxes

Tax relief was viewed as the principal incentive for improved productivity by the four conferences. Nowhere was this more evident than in Atlanta, where 100 landowners ranked priorities on their own, without representation from the "public" interests. Tax codes at the federal, state, and local levels were viewed as disincentives to the retention and management of forest lands.

Most recommendations were based on direct relief in the following areas:

a. tax reductions (all categories)
b. tax incentives (investment tax credits, accelerated depreciation schedules, treating reforestation and stand improvement costs as ordinary expenses)
c. repeal of the carryover basis rule for inheritance taxes (this has since been accomplished)
d. simplify the tax code so landowner is assured of full benefits

The objective of this concern was tax equity and the recognition of forest and related resource management as a *management activity* rather than the *depletion* of a non-renewable resource.

This strategy is of equal importance to wildlife, recreation, and other resource values that are dependent on the maintenance of forests. Tax disincentives promote the displacement of forests by other land uses. Bill Towell recognized this need in saying "the important thing is to manage these forests for whatever purposes their owners desire and in the process do everything we can to keep these forests in production."

Education and Technical Assistance

Lack of adequate information emerged as a top priority in the northeastern region, which consisted of agency and industry representatives, as well as private landowners. All regions perceived a strong need for more knowledge to guide decision making by the landowner. The mechanisms recommended ranged from the traditional service role to the need for research to develop improved management techniques for these ownerships.

Responsibility for the development, transfer, and application of the necessary knowledge involves many organizations and mechanisms. It involves those federal agencies whose missions include research, extension, and technical assistance in the many aspects of resource management. It also involves trade associations and conservation groups.

It includes expanded programs in research and technology transfer at the state and local levels in recognition of the diversity of conditions and needs that exist at local levels. There was a clear signal that technology transfer is not as effective as it should be in order to achieve the desired results. In the West, there was concern about the identity of the state forestry organization as the lead agency in service on private lands.

The recommendations provide a strong role in technical assistance for the private sector, the consulting forester, and it is considered the inherent responsibility of all professionals to help bridge the technology gap.

All of the conferences pointed out the need for improved coordination among those agencies and organizations involved in education and technical assistance. There is confusion about who does what, which sometimes leads to frustration by agency representatives, as well as landowners. There is a need for public agencies and private industry to assure coordination of their programs and a better delineation of their respective roles. There is also a need to coordinate management for the various resource benefits that are possible from a given unit of land. Two conferences recommended the establishment of a clearinghouse for information, perhaps at the county level, that would serve landowner needs.

There was widespread awareness of the need for better public understanding of the importance of private, nonindustrial forest lands and of good forest management for timber production, wildlife, recreation, water, and other forest values. For example, the notion still persists in some quarters that wildlife values are maximized in the absence of forest management.

Improved public understanding of forestry was also deemed important in developing and maintaining favorable public attitudes on regulation, taxation, and incentive programs. Lastly, landowners who are doing a good job appreciated the public recognition of their roles. The American Tree Farm System was cited as an example of a means of promoting landowner pride.

There were also specific recommendations on the need for educational programs developed specifically for realtors, bankers, accountants, and other interests that relate specifically to the private landowner. These groups need a better understanding of the problems and potentials that are peculiar to forest investments.

Markets and Marketing

Reliable information on markets and prices was identified in all the regions as being essential to sound landowner decisions. There is concern that the advice typically offered by prospective buyers may not be in the best interest of the seller. Market reporting systems patterned after the U.S. Department of Agriculture crop reporting systems were recommended. Improved access to information on future supply/demand projections was considered desirable to promote confidence in making present investments for future returns.

There was also an expressed need to develop markets for minor species and low quality stems. Better utilization of the current crop was considered financially desirable and an asset to forest renewal.

Financial Assistance

There was considerable diversity about the types of financial assistance that would stimulate forest management. In the Northeast, markets were considered the best financial incentive in the long run. In the West, there is a need for more awareness of public incentive programs, and more latitude is needed in approving practices that met state and local needs. The western conference also concluded that allocations for wildlife, watershed and range resource improvements will be important in the future. In the north central region, owners are generally satisfied with current incentive programs, but are wary of subsidies that would result in restrictions on property rights. There was also concern about property rights in the South, and a conviction that industry could provide more assistance for timber production.

Overall, there was conditional support for increases in direct cost-sharing assistance. There was also significant support for indirect assistance through crop insurance and/or forestry loan programs, particularly in the South.

Resource Inventories

The western region reported that lack of adequate, timely information on the resource and the people who control it is a major problem in developing programs and policies to improve forest management on private lands. The number of acres of privately owned land is declining and the number of owners is increasing, which points out the dynamic nature of the problem.

All of the conferences recommended improved inventories at more frequent intervals to guide the landowner, the investor, policy makers, and the creation of new markets. There was also a consensus for learning more about the attitudes and goals of the private nonindustrial landowner.

Property Rights vs. Public Expectations

Regulation was considered to be a deterrent to landowners in every region. Responsible but voluntary management action is the preferred response to legitimate public concern for environmental protection. There was a perceived need for adequate technical assistance to make landowners fully aware of the impacts of their activities.

Increased public use of private lands to collect firewood, operate off-road vehicles, as well as traditional uses has resulted in increased concern about litigation, theft, and vandalism. The landowner is also becoming more wary of the implications of regulatory and incentive legislation on his rights. These developments are perceived as deterrents to public use of private lands.

Constraints on public use deny the landowner of income from wildlife or recreation that could partially offset the costs of forest management. This denial of access leads to frustration by the public sector, and pressures for forced access through governmental action. Model legislation that could provide protection from unreasonable liability was recommended to encourage landowners to provide public use opportunities.

Benefits of Forest Management

The tremendous diversity in profit potentials must be recognized in public programs designed for these landowners.

All regions recommended more analyses of the economic potential of forest investments for private nonindustrial forest owners. There was also concern that this information be adequately disseminated to landowners, as well as other individuals and organizations involved in the financing of forest investments.

The trade-offs among the multiple benefits from forestry are not clearly understood in any region. The impacts of various levels of timber management on wildlife, recreation, range, and water resource values need to be researched and made available to landowners and to the public that supports financial incentives for private, nonindustrial forest lands.

Summary and Observations

These unique conferences have brought the full potential of the private nonindustrial lands and their owners to the attention of policy makers across the country.

The accommodation of these recommendations, with appropriate adjustments to reflect regional and local conditions, offers tremendous potential for the improvement of this nation's private forest lands. The diversity of these lands, owner attitudes, and the forestry infrastructure mandate an array of programs and approaches to stimulate production. There are no simple solutions and there is no single program that assures success.

It is not sufficient for public or industrial programs to provide management plans for the land and capital for technical and financial assistance to implement forest practices. The landowner must be convinced that good forestry is in his self-interest, and this must be done every time the land changes ownership.

The consumer will bear the ultimate costs of forest improvements. This is the American way. But how will the massive cost be financed? In the southern region alone the need is estimated at $227 million per year for the next ten years. The magnitude and complexity of the opportunity suggests that government, industry, and the landowners will need to share the task. The allocation of scarce resources should favor those investments that are likely to yield the most favorable returns.

These conferences were specifically dedicated to programs and policies affecting timber production on private lands. But numerous studies have demonstrated that both the landowner and the general public are concerned about other resource values. Timber production can be improved on most private lands while maintaining or even enhancing recreation and wildlife values. Improvements in the productivity and the value of private lands can help sustain the forest base. This strategy will promote the conservation of all natural resources.

The proposed recommendations deserve the support of all who have an interest in the publicly or privately controlled natural resources of this country. If appropriate policies and programs are developed to support the private, nonindustrial forest lands, the natural resource base in this country can be renewed and strengthened. The 283 million acres (114.5 million ha) of private lands can contribute additional public and private benefits. With commitment, they will.

A Report on the National Private Nonindustrial Forestry Conference held in Washington, D.C. November 26 and 27, 1979

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I want to take just a minute or two in order to set the stage for my remarks which follow concerning the National Conference on Nonindustrial Private Forestry held in Washington during the last week in November last year. I believe the few statistics which I'll give may offer a better understanding of the overall problem and opportunities involved.

We have a very large timber resource—about one-third of our land area or 740 million acres (299.5 million ha) are in forest. Fifty-eight percent or 283 million acres (114.5 million ha) are owned by farmers and other private owners (doctors, housewives, businessmen, etc.). It is estimated that there are some 4 million such owners in the country.

We know quite a bit about our forests because of periodic forest surveys made by the U.S. Forest Service. It will be of particular interest to those attending this meeting that new forest surveys are beginning to include more detailed vegetational biomass inventories which can be used to rank habitat quality for wildlife species and the individual resource elements such as wildlife will be separated out.

The nonindustrial private forest owners have also been studied considerably. There are dozens of reports on these owners, on topics that include their objectives and ownership; how they do or don't manage their forests; their opportunities and characteristics, etc. It may or may not surprise you to learn that in the Northeast the average owner does not consider harvesting timber as an important reason for owning forest land because he generally does not think of his holding in terms of timber production. In the Northeast only 4 percent of the owners hold land primarily for timber production. The most frequently expressed reason for owning forest land is simply because it is part of the owner's farm or residence. Many other owners hold forest land for real estate speculation, recreational use, or to enjoy the greenery (Kingsley 1979).

In short, although we have much generalized information about nonindustrial forest owners, we really do not know these owners because each is a separate and distinct individual with his or her own objectives of ownership. They do not fit neatly into little boxes or squares. Therefore, we are forced to generalize.

As natural resource professionals and nonprofessionals, alike, we recognize the importance of these 283 million acres (114.5 million ha) and the contributions these forest lands make. Foresters and the forest industry increasingly look to this forest land to provide the many goods and services needed. Those of you in the wildlife field are fully aware of the vital contributions which forests provide by way of habitat, food and cover for wildlife. Incidentally, in any realistic perception involving hypothetical owner objectives on a scale of 0 to 100, recreation-wildlife always ranks high at about 40 to 50, second only to satisfaction of ownership, which ranks 95 to 100. Probably less appreciated is the fact that although these 4 million forest landowners pay the taxes and other costs associated with ownership, we all benefit from the many amenities which forests provide. In short, 283 million acres (114.5 million ha) of forest land is too large a figure to ignore and vital to professional interests such as those represented at this meeting and the resources we are attempting to manage.

In general, it is admitted that programs and policies have failed to address the individual owner's goals and welfare. All too often, foresters, for example, employed in organizations involved with private nonindustrial forest owners have approached these owners with a bias towards serving the goals and welfare of their employer rather than those of the owner. Foresters usually will mention wood products in connection with the production capacity of nonindustrial private forest land, but there are many alternative uses to be considered. To the classical multiple-use list with which we are familiar—wood, water, wildlife, grazing and recreation—we should add other possible landowner objectives such as open space; second home sites; mining for minerals, gas and oil; real estate investment and speculation; satisfaction of ownership; and wood for energy, all of which may not be directly marketed but which have an intrinsic value. In short we must recognize the great diversity of landowner goals and we should select and adapt programs to meet our goals and objectives and present him with alternative solutions to his problems. In order to achieve this there must be better interdisciplinary coordination.

It is becoming increasingly apparent that the nonindustrial woodlands will have to provide a considerable portion of our future needs for forest products and other goods and services which flow from the forest. Public forests are increasingly being withdrawn from timber production and limited to preservation and nonconsumptive uses. Forests owned by industry are not likely to increase much in acreage. Traditionally, privately owned forest lands are supplying about one-half of the wood used in our country.

Clearly, if private nonindustrial forests are to realize their potential in meeting future needs, it is vital that policy and adequately funded program be developed. At the present there is no clear indication of Administration support in this direction. As has been said, there is an urgent need for concise, comprehensive national policy for private, nonindustrial forest lands.

In brief, the purpose of the Private Nonindustrial Forestry Conference was to pull together the results of the regional meetings and, through a national forum, attempt to seek consensus toward the formulation of clearer policy and objectives for private forestry. It is recognized that policy direction must be determined largely by landowner and public needs. Programs in the past have not met many landowner interests and problems. What must be done to induce better management on these private lands and how can we best motivate landowners? The national meeting attempted to address these issues and for the first time brought before the nation's leaders and policy makers the "grass roots" thinking of landowners and professionals most actively involved in private forestry today.

Speakers at the national conference included Project Coordinator Bill Towell, Secretary of Agriculture Bob Bergland, Assistant Secretary of Agriculture Rupert Cutler, Forest Service Chief Max Peterson, American Forestry Association's Executive Vice-President Rex Resler and many others.

In the time remaining I will attempt to "capsule" some of the remarks and thoughts expressed by some of the speakers at the national meeting.

Rex Resler mentioned that there were two broad and distinct groups of interest:

1. The interests of the landowners themselves
2. The interests of the public and their constituency—the agencies and the professionals involved in land management activities.

According to Resler, the landowner clearly is concerned with those aspects of public policy and programs that influence the profitability of investing in forestry activities and in holding forest property.

The latter interest leans toward the identification of actions and programs that will provide encouragement to landowners to produce an array of goods and services that are more conducive to public benefits.

I believe Resler's next statements are particularly pertinent. "Any solution that infringes upon the rights of ownership of property is no solution whatever." It should be remembered that in practically all cases we, as renewable resource professionals, are working or practicing our profession on land belonging to someone other than ourselves. In the case of the private forest landowner, it is the landowner who purchased the land who is paying taxes and any other ownership costs. Resler suggests we are remiss if we do not properly identify with these landowners and their objectives of ownership. He goes on to say "by the same reasoning, the use of public funds to provide services or incentives, or financial aid to any individual carries with it an obligation and an expectation of some public benefit, either directly or indirectly."

A number of priorities were identified and were thought necessary to include in the development of a national program for private forestry.

1. *Taxes*

There was universal agreement that the principal incentive to improved forest land management was tax relief. The proposed changes included tax reductions (property, capital gains and inheritance); tax incentives for management (investment tax credits, expensing of reforestation, T.S.I. costs, accelerated write off); repeal the carryover basis rule; simplify the tax code and provide competent tax advice to forest landowners. It was stated that there was a need to bring equity to the tax structure so that the management of forest land for timber and all other related forest values is treated as a management activity and not as a depletable, exhaustible resource. A better public understanding of this one issue alone will be of tremendous value.

2. *Technical Assistance*

Greater technical assistance for the forest owner was said to be needed. But the form of assistance requested was highly variable, ranging from the conventional form of one-on-one technical advice to the landowner to exhaustive research into genetic improvement of planting stock that eventually would be made readily available to him. Incidentally, one of the fields specifically mentioned was wildlife habitat improvement. The Federal Government, the states, forest industry, and consultants were to all share in this responsibility of technical assistance.

3. *Market Information*

What, where and how to sell were deemed important market information to have. Many landowners expressed concern over the fact that they were subject to the advice of the log buyer and that such advice is not always in the best interest of the landowner. Access to independent market advice, the need for development of markets for minor species and products, including wood for energy, and advice on better utilization could be patterned after the existing crop reporting system in the U.S. Department of Agriculture.

4. *Financial Assistance*

It was thought that financial assistance programs should be continued and expanded. Those felt most valuable were (a) direct cost sharing, such as Agricultural stabilization and Conservation Service programs, and (b) indirect assistance such as crop insurance coverage for timber and forest load programs.

5. *Improved Protection*

Due to increasing timber values and the risk of loss of capital investments for management activities, it was felt that increased protection from fire, insects and disease is definitely called for. Recent curtailments or cutbacks in federal support for protection activities are not being offset by increased state funding.

6. *Resource Inventories*

The lack of timely and detailed inventory information was seen as a deterrent to sound resource judgments—judgments that must be made by people at all levels: the landowner, the investment counselor, local and federal policy makers, and others. There was a broad consensus that inventory cycles need to be shortened and classes of information broadened to better depict not only the status of growth, inventory and losses, but to reflect changes in land status and ownership.

7. *Landowner Rights vs. Public Rights*

Growth in public use with attendant risk to loss of property, vandalism, and liability of the landowner was perceived as a deterrent to public use of private lands and, therefore, delimits opportunities for public use and for income to the landowner. Model legislation designed to provide protection from unreasonable liability for the landowner was felt important and deemed necessary.

8. *Regulation*

The risk of excessive regulation was held up as a depressing influence and a deterrent to the landowner. Regulation was deemed unnecessary or undesirable and it was felt that voluntary forms of inducement to good management coupled with adequate levels of technical assistance is a much better alternative.

9. *Analysis of Costs, Returns, and Benefits*

There seemed to be a general recognition that we have not done an adequate job of displaying the costs and profits of forestry activities, nor have we adequately conveyed these benefits to landowners, the investors, and/or the public. More is known about the costs and returns of timber production than is known about the other values (including nonconsumptive uses) of well-managed forest lands. These multiple values must be thoroughly analyzed and the information conveyed, if we expect both the landowner and the public to support investments in private, nonindustrial forest (PNIF) lands.

Resler's summary and identification of national PNIF priorities were well received at the national meeting. It remained, however, for Agriculture Secretary Bergland and Assistant Secretary Rupert Cutler to make the real commitments.

Bergland reaffirmed the Administration's position of priority and support for private forestry programs, but made it clear that the Federal Government's role in check writing or subsidy for private forestry is limited. He also promised to take another look at various programs of special interest to the forest community, such as matching programs (some of which are to be phased out) and the reduction of federal support to such traditional programs as fire control and reforestation.

Assistant Secretary of Agriculture Rupert Cutler made some positive and forthright comments to the conference. I will not attempt to repeat verbatim his remarks which can be read in the Conference proceedings. However, I have excerpted and paraphrased some of his comments and I will pass these on:

Given the diversity of ownership Cutler was surprised at the unanimity of agreement reached on the problems and opportunities. He promised to assist with tax problems through the Cooperative Forestry Assistance Act. He was supportive of forestry ASCS programs. He asked the U.S. Forest Service to take the lead in initiating a national price reporting service. Working with national associations and with state foresters and Extension personnel, he wanted to look further into local landowner associations and cooperatives. He said that the pilot fuelwood projects started in six New England states are to be expanded. He wanted to step up the amount of planning assistance to private forest landowners. This calls for a massive cooperative effort and sets a goal of 400,000 formal management plans each year. (This is about 10 percent of the total number of forest landowners). He pledged support for forest research, including tree improvement programs, about which he set a goal that within 10 years every tree seedling planted will be from genetically improved seed. Cutler went on and pledged support for several of the other needs expressed at the conference including protection against theft and vandalism. He said he has urged the FBI to help on such cases.

In his closing remarks Cutler commented that all reports that were presented had addressed timber supplies without reservation and that this was certainly appropriate. He went on to say that the owners of these forest lands have a great variety of uses for them and whatever we do must be in harmony with the multiplicity of goals of the owners of these lands.

In closing, I feel the regional meeting which I attended and the national meeting were well conceived and carried out. Many of the problems, opportunities and possible solutions were discussed. The national conference helped define specific needs and priorities on a wide front and, hopefully, has established a momentum for private forestry which will continue. As our Project Coordinator, Bill Towell, has said "This is a beginning and not an end . . . . We have a blueprint. It may not be perfect, but it's better than we ever had before."

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Bottomland Hardwoods: Status, Values and Maintenance Needs

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Status of Bottomland Hardwoods Along the Lower Mississippi River

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Introduction

This paper is designed to define bottomland hardwoods in a general sense; outline what has happened to them and why (specifically in the lower Mississippi Valley); explain some of the efforts to preserve them; and suggest future action. Other papers will elaborate upon specific aspects of bottomland hardwoods and factors affecting their existence.

Bottomland Hardwoods: Description and Definition

Bottomland hardwoods is a term generally used to describe forest species occurring in floodplains. More precisely, bottomland hardwoods are those dominant forest tree species that occur on soils that are moisture-saturated or inundated during a portion of the year. Because of their proximity to streams, bottomland hardwoods fit within the general definition of riparian vegetation.

The Fish and Wildlife Service (FWS) has long considered bottomland hardwoods to be wetlands. For descriptive purposes the FWS has defined three types of wetlands which make up bottomland hardwoods. Two of these are classified as wooded and shrub swamps in Circular 39 (Shaw and Fredine 1956) and as "Palustrine, forested, needle-leaved or broad-leaved deciduous, seasonally to semi-permanently flooded" and "Palustrine, scrub/shrub, broad-leaved deciduous, seasonally to semi-permanently flooded", respectively, by the National Wetland Inventory (NWI) (Cowardin et al. 1977). Wooded swamps are dominated by bald cypress *(Taxodium distichum)* or tupelo *(Nyssa* spp.*)* and often by a combination of both species. Shrub swamps are typified by buttonbush *(Cephalanthus occidentalis)*, water elm *(Planera aquatica)*, swamp privet *(Foresteria acuminata)*, and willow *(Salix* spp.*)*. Although shrub swamps do not usually exhibit vegetative growth typical of a forest, they are interspersed within other bottomland hardwood wetlands and function as part of the total system. The third type of wetland is referred to in Circular 39 as seasonally flooded basins and flats. The NWI classification of this wetland type is "Palustrine, forested, broad-leaved deciduous, temporarily flooded." This wetland is comprised of tree species such as sweetgum *(Liquidambar styraciflua)*, sugarberry *(Celtis laevigata)*, bitter pecan *(Carya aquatica)*, elm *(Ulmus* spp.), ash *(Fraxinus* spp.), and several species of oaks *(Quercus* spp.). The degree of flooding of these wetlands varies in frequency and duration but they are usually dry in the summer and fall.

The U.S. Forest Service classifies forest land according to its suitability for growing certain species groups. The bottomland hardwood forest group consists of the oak-gum-cypress and elm-ash-cottonwood forest types (Murphy 1975). This classification encompasses many of the same species of trees as the FWS classifications, but groups the species in a different manner. Also, the U.S. Forest Service bottomland hardwood group excludes the shrub swamp species previously mentioned.

Bottomland hardwoods in the southeastern United States constitute some of the most productive wildlife and fishery habitats in the United States. These forested areas provide food and cover to numerous species of wild animals. Game animals, such as white-tailed deer, squirrel, and turkey, utilize the high quality food (mast) provided by the hardwood trees, and deer and rabbits use the understory vegetation for browse and cover. Furbearers, such as raccoon and mink, abound in bottomlands particularly where cypress and tupelo swamps are present. Many birds, specifically waterfowl, depend on bottomlands for survival. Wood ducks nest in the basins and flats and raise their young in the wooded and shrub swamps. Migratory waterfowl, primarily the mallard in the Mississippi Flyway, winter in bottomlands, and numerous species of songbirds nest in the trees and understory vegetation. Other groups of animals, including reptiles and amphibians, are found within the bottomland hardwoods. In addition, the bayous and streams interspersed within the wooded flats and swamps have historically provided habitats for many species of fish and aquatic life that are important commercially and for recreational purposes. This aquatic habitat is expanded both quantitively and qualitatively by the seasonal flooding of the wetlands. In addition, the presence of forest vegetation greatly reduces erosion and sediment build-up, thus maintaining high water quality.

Status

The lower Mississippi River Valley, commonly referred to as the Delta, consists of the alluvial plain of Arkansas, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee (Figure 1). The valley is cut by ridges and streams into several drainage basins and is defined by steep bluffs along most of its length. The Mississippi River bisects the 25-million-acre (10.1 million ha) valley from Cairo, Illinois, about 600 miles (966 km) south to the Gulf of Mexico. The FWS funded a recent study (MacDonald et. al., 1979) which looked at the land use changes in the lower Mississippi Valley since 1937, discussed the causes of the changes, and predicted land use changes through 1995. Previous studies by Sternitzke and Putnam (1956), Korte and Fredrickson (1976), Holder (1970), Yancey (1970), and Frey and Dill (1970) documented land use changes for different areas of the lower Mississippi

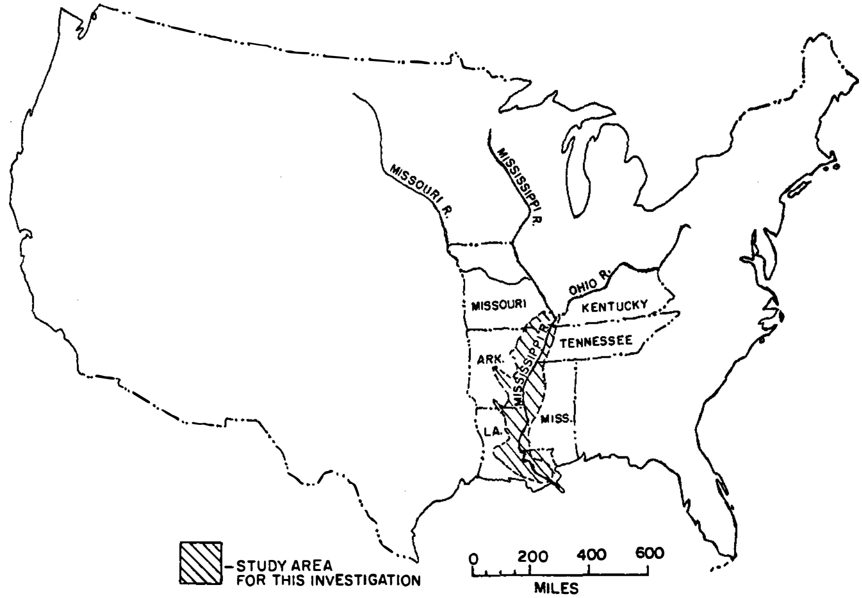

Figure 1. Lower Mississippi Valley.

Valley. Those studies and other data collected by MacDonald et. al. (1979) documented a bottomland hardwood acreage decrease in the lower Mississippi Valley of approximately 6.6 million acres (2.7 million ha) since 1937, leaving about 5.18 million acres (2.1 million ha) remaining in 1978. Sixty percent of the 5.18 million acres (2.1 million ha) [3.12 million acres (1.3 million ha)] were seasonally flooded basins or flats and the other 40 percent [2.06 million acres (0.83 million ha)] were wooded and shrub swamps. Of the 1978 total acreages of bottomland hardwoods for the whole lower Mississippi Valley, more than half (57 percent) was in Louisiana. About 20 percent of the 1978 total was in Arkansas and approximately 18 percent was in Mississippi. The other 5 percent comprised bottomland hardwood forest acreages in the Missouri, Tennessee, and Kentucky portions of the valley. It is also important to note that, in 1978, 80 percent of the wooded and shrub swamps were in the Louisiana portion.

The study by MacDonald et. al. (1979) revealed that remnant acreages of bottomland hardwoods were scattered throughout the lower Mississippi in areas of various size. The Atchafalaya Basin of Louisiana contained one-half of the bottomland hardwood acreages of the state study area and nearly one-fourth of the total 1978 bottomland hardwood acreages for the entire lower Mississippi Valley. Although other remaining areas are not as large as the Atchafalaya Basin hardwood area, many of them are equally as important. The bottomland hardwoods of the Cache River Basin of Arkansas are an example of such an important area, primarily due to their location, utilization by migratory waterfowl, and possible destruction by a Corps project.

Factors Influencing Land Use Change

The basis for the massive land use change in the lower Mississippi Valley is economic gain. The nutrient rich alluvial soils are extremely productive for a variety of crops, particularly soybeans, which bring a greater economic return to the landowner than either natural stands of bottomland hardwoods or hardwood plantations. In fact, according to MacDonald et. al. (1979), the highest annual returns from managed hardwood plantations are often less than half the returns that can be realized from crops such as corn which are less profitable than soybeans. In addition to being more profitable, soybeans are quite adaptable to the various characteristics of the alluvial soils. Furthermore, the seasonal flooding of bottomland hardwoods normally occurs from November through May, therefore providing the soybean sufficient time to grow and mature from June to October. Despite this adaptability of the soybean to such "natural" conditions, the yield is increased with flood protection. This protection provides stimulus for land clearing which requires more flood protection which encourages more land clearing. That cycle is still ongoing in the lower Mississippi Valley even though MacDonald et. al. (1979) found that, since 1937, agricultural lands increased by about 5 million acres (2.0 million ha).

Flooding in the lower Mississippi Valley consists both of headwater and backwater flooding. Headwater flooding normally results from rainstorms over the drainage basins of the tributary streams to the Mississippi River. This condition, augmented by snow melt in the upper tributary areas, has traditionally produced the spring floods of the Mississippi River. Backwater flooding is a phenomenon produced by high water stages on the Mississippi River main stem which create flooding along the tributary streams by the damming effect of the main stem waters. This damming effect holds or slows runoff in the tributaries and, at times, actually causes a reverse flow of the tributary stream some distance upstream from its mouth. The result is generally long-duration inundation of the adjacent floodplains.

To control these floods, the Corps of Engineers (Corps) has developed one of the world's most comprehensive flood control systems. This flood control program, in force since 1928, and being expanded continually, comprises four major elements: (1) devices for containing flood flows; (2) floodways for the passage of excess flows past critical reaches of the Mississippi; (3) channel improvements and stabilization; and (4) tributary basin improvements such as dams and reservoirs, pumping plants, auxiliary channels, and levees.

The Corps projects have been complemented by the Soil Conservation Service (SCS) small watershed program authorized by Congress in 1954 with the passage of PL-566, the Watershed Protection and Flood Prevention Act. The program addresses problems of watershed protection in headwater areas, and flooding and related water management problems of small streams. Project measures include a variety of land treatments, dams, channel clearings, or realignments, floodways, and other similar measures to manage the flow of water. Design of PL-566 projects is coordinated with Corps flood control projects for maximum effectiveness.

Acquisition

Unmet Mitigation

Within the lower Mississippi Valley and adjacent areas, the FWS has made significant mitigation recommendations on Corps water resources projects under the provision of the Fish and Wildlife Coordination Act (Gard 1979).

The FWS gained a significant role in the protection of fish and wildlife resources through the 1958 Fish and Wildlife Coordination Act amendments. The Fish and Wildlife Coordination Act provides for the recognition of the importance of fish and wildlife resources to the nation and provides that fish and wildlife conservation measures shall receive equal consideration and coordination in planning and implementing water resources development programs. Under this law, federal agencies are required to consult with the FWS and appropriate state wildlife resource agencies whenever any stream or body of water is proposed or authorized to be impounded, diverted, deepened or modified for any purpose. Through this consultation, the FWS is authorized to prepare reports and recommendations for the purpose of determining the possible damages to fish and wildlife resources and to determine means and measures to prevent (mitigate) loss or adverse impact to the resources. The law also provides authorization for the construction agency to modify its plans in order to provide structural and non-structural measures as an integral part of the plan at project cost. The structural and non-structural features requested by the FWS were the mitigation features considered by Gard (1979).

For the purpose of this discussion, the term "mitigation" shall mean those significant structural features or land acquisition requests made by the FWS to offset identified fish and wildlife resource losses or identified adverse impacts. The term "unmet mitigation" shall mean those structural or land acquisition requests made by the FWS, but not in place at this time.

Since the majority of the conversion of bottomland hardwoods to farmland has been made possible by massive federal flood control projects, the FWS, under the authority of the Fish and Wildlife Coordination Act, reviewed and made recommendations for offsetting some of the resource loss.

Within and adjacent to the lower Mississippi Valley, 58 Corps of Engineers' projects were found to have significant recommendations. Of the 58 projects, 50 were either authorized for or under construction, 4 were authorized for construction but pending inactive at this time and 4 were in planning. Of the 50 authorized or under construction, a total of 39 requests, amounting to 610,740 acres (247,163 ha) of mitigation land, have been recommended by the FWS under the Fish and Wildlife Coordination Act. Of this 610,740 acres (247,163 ha), 182,765 acres (73,964 ha) or 18 percent of the recommended lands have been authorized, but only 36,683 acres (14,865 ha) or 6 percent of the recommended land is actually acquired and under management for fish and wildlife purposes at this time. This leaves a total unmet mitigation of 574,057 acres (232,318 ha) and 35 structural requests. When these 50 projects are completed, the FWS estimates there will be a direct and induced loss of 2,058,977 acres (833,257 ha) of bottomland hardwood habitat and channelization or modification of 6,657 miles (10,718 km) of stream habitat.

Had consideration been given to those Corps of Engineers' projects where no mitigation was requested, such as the massive Mississippi River levee system, or if it were possible to quantify the cumulative impact of past flood control projects as influenced by the speculative anticipation of future flood control features and resultant forest clearing activities, the habitat loss would be many times greater than the previously identified figure. In addition, tremendous acreages have been cleared as a result of flood control activities of the SCS, state, and private interests (Gard 1979).

Federal Acquisition Programs

Federal acquisition programs have resulted in a significant amount of bottomland hardwood habitat being protected, but when compared to the original amount and the amount lost, their significance is greatly reduced. Federal acquisition programs are sporadically implemented with varying results. Most recently the FWS initiated the Bottomland Hardwood Preservation Program in the lower Mississippi Valley while the Unique Wildlife Ecosystem Program was started in several locations.

The long range objective of the Bottomland Hardwood Acquisition Program is to preserve as many areas as possible that are important to the waterfowl resources. While the entire lower Mississippi Valley is important to waterfowl, a total of 74 acres encompassing some 731,000 acres (295,832 ha) of bottomland hardwood habitat have been identified as vital for maintaining mallard and wood duck populations.

Since initiation of the Bottomland Hardwood Preservation Program in 1978, the FWS has acquired three new national wildlife refuges. These three refuges, Panther Swamp, Morgan Brake, and Upper Ouachita, presently total approximately 40,000 acres (16,188 ha) and will eventually total 61,613 acres (24,934 ha). Unfortunately, due to the amount of funds and land available, the FWS Bottomland Hardwood Preservation initiative presently seems to be diminishing.

The Unique Wildlife Ecosystem Acquisition Program also initially offered a tremendous opportunity for preservation of hardwoods. It was thought that amounts of up to $100 million would be available when the program began, but again, funds and land availability have diminished along with additional legislation, making it more difficult to use available funds. To date, almost three years into the programs, no hardwood areas have been purchased in the lower Mississippi Valley using this program.

The present total federal ownership of bottomland forest in the lower Mississippi Valley is divided as follows: U.S. Forest Service—61,162 acres (24,752 ha); U.S. Fish and Wildlife Service—276,781 acres (112,012 ha); total federal ownership—337,943 acres (136,764 ha).

State Acquisition Programs

State acquisition programs have historically been more active than the federal or private sector. However, most states have experienced tight budget restrictions in recent years which have almost completely stopped new acquisitions. Missouri has implemented a special tax which is providing significant amounts of money for acquisition. Total state ownership of forested lands within the lower Mississippi Valley is divided as follows: Kentucky—1,524 acres (617 ha); Tennessee—29,574 acres (11,968 ha); Missouri—5,802 acres (2,348 ha); Arkansas—145,176 acres (58,752 ha); Louisiana—158,301 acres (64,064 ha); Mississippi—10,408 acres (4,212 ha); total state ownership—350,785 acres (141,961 ha).

Private Acquisition Programs

No private organization has an acquisition program within the lower Mississippi

Valley. However, National Audubon Society, National Wildlife Federation, The Nature Conservancy, and the Sierra Club have all been active in local conservation efforts which may result in federal or state acquisition of several significant bottomland hardwood areas.

Conclusion

The massive loss of forest resources that has been documented along the lower Mississippi River gives a good indication of what will happen to the remaining bottomland hardwoods in the southeastern United States. The rich soil characteristics and the ever increasing flood control projects, coupled with strong economic incentives, will provide motivation for the eventual conversion of most of the remaining bottomland hardwoods to agriculture and other uses, except where public ownership is involved.

The challenge of the future is finding how to reverse the past and present trend. This trend of bottomland hardwood loss must be changed to ensure the preservation of a portion of the remaining acreages. Such a change will require a comprehensive program which is probably not within the reach of any single agency or group. Presently, lack of funding or local support have severely restricted success of those preservation programs which do exist. For example, within the lower Mississippi River valley alone there are at least six state acquisition programs, three federal programs, and numerous impending mitigation activities which could all result in preservation of hardwoods. The Atchafalaya River and Cache River projects offer the opportunity to save over 600,000 acres (242,817 ha) of hardwoods which is nearly as much as presently exist in public ownership in the entire lower Mississippi Valley. The six state programs, along with adequate support, could easily double this acreage. Also, numerous federal and state agencies are involved in regulatory programs which also offer a significant opportunity to reduce the rate of loss.

Obviously none of those programs have had sufficient scope, funding, or support necessary to affect the total resource significantly. What is needed is an immediate, unified and coordinated effort from both a program and a public support basis. The most important and critical factor for the future will be total, dedicated support to the preservation of a significant portion of the bottomland hardwoods of the United States.

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Values and Functions of Bottomland Hardwoods

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Introduction

In paleohistory the river swamps may be very old. Many bottomland hardwoods had ancestors in early Tertiary times; hackberry, sycamore and persimmon are traceable to late Mesozoic (Voight and Mohlenbrock 1964). Swamps with tupelo were worldwide in the temperate zone Miocene (R. H. Eyde, pers. comm.). River swamps possess a relict fauna of bygone ages. Their alligators, turtles, gars and bowfins date back at least to the age of dinosaurs. The latter two fish are lung equipped—the gar reaches a length of 9.8 feet (3.3m) and a weight of 302 pounds (132 k) (Drott 1970). One of the two, huge, eel-like salamanders living there, the siren, is the only living relative of the giant aistopod amphibians of the late Paleozoic. In these refugia of antiquity, bottomland hardwoods (Figure 1) are

Figure 1. Mature bottomland hardwoods (Bear Island, Effingham Co., Ga.) on the Savannah River floodplain. Sweetgums are consistently the largest trees with average circumference (CBH) of 12 feet (3.7m); some measure 15½ feet (4.7m) CBH; water oaks attain a CBH of 17 feet (5.2m). Because of good acorn mast and higher elevations this forest serves as refuge and feeding grounds for bear and other game from the remainder of the island which is wetter. Canebrakes of the large river cane *(Arundinaria gigantea),* the haunts of Swainson's warbler (Meanley 1972), may dominate the understory. This is the type forest that sustained the ivory-billed woodpecker.

a large and important environment. They are essential to the river's orderly management of the nation's water and to other life support functions that are comparatively cost-free to society.

Defining the Bottomland Hardwood Community

Bottomland hardwoods generally cover all the floodplain surface. Gum-cypress in sloughs, ponds and oxbows are sometimes considered a separate community. The floodplain is the riverine "bottomland" that is used by an unregulated (by man) river in times of high ("flood") water, either annually or during higher but less often flows. The word "swamp" is a term that includes bottomland hardwoods although some authors restrict its use to gum-cypress. Determining what are "wetlands" is a current chore among regulatory agencies. Wetlands may be on uplands (as a gum pond or shrub bog) or in bottomlands. Bottomland hardwoods on the "first bottom" (Figure 2) I consider to be unquestionably wetlands. Many hardwood forests on higher terraces ("second bottoms," Figure 2) are also wetlands. Just as elevation alone does not necessarily indicate wetlands, neither does flooding. Coastal Plain blackwater streams may inundate adjoining pine lands (as do some Piedmont streams), yet soils are not sufficiently saturated during the growing season to sustain a biotic community of wetland life.

Since the river and its floodplain form one functional ecosystem unit, bottomland hardwoods and wetland forests in general are best defined in terms of geomorphology, soils, hydrology, plants and animals. Cultural phenomena such as logging and grazing on the floodplain and alterations of upland forests in the watershed must also be considered.

Regulatory agencies find plant lists (usually trees) confusing. Shrubs and herbs may be as good or better indicators (Figure 3). Plant lists not only reflect regional differences (Nuttall's oak occurs only in the lower Mississippi basin), but there are pronounced changes with latitude. Northern floodplains, for example, have sugar maple, black walnut and black cherry (Lindsey et al. 1961, Richardson et al. 1978, Morris et al. 1979, Merrit and Lawson 1979) which in the south are upland species of rich, moist mountain coves and slopes. In Georgia, persimmon is a scrawny tree around old fields—it is startling to see huge, tall persimmons on the Mississippi River floodplain. It appears that upland species, under conditions of soil and

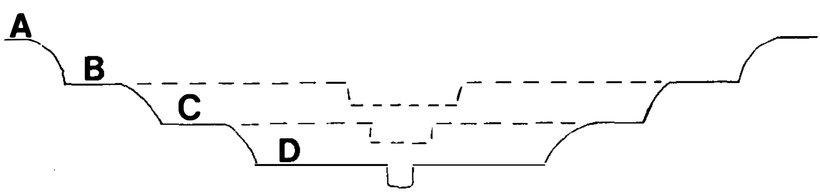

Figure 2. Modern and relict floodplain surfaces (hypothetical) showing three surfaces of degradation, perhaps coinciding with fluvial periods. Note diminished river and floodplain size with each regime. (A) upland; (B) high terrace perhaps formed from high flows of Wisconsin glacial meltwater, not inundated; (C) second bottom, inundated by higher inundations than (D) (1½, 2, 5, 10, etc. year intervals) soils may be developing profile (zonation); (D) first bottom, annually inundated, soils generally azonal. Note: terraces are notoriously difficult to trace and equate with one another; sometimes they occur on one side of the floodplain and not on the other, thus the drawing is an over-simplification.

Figure 3. The swamp chestnut oak-cherrybark oak-spruce pine association here on the Ocmulgee floodplain (Glass Tract, Telfair Co., Ga.) occupies higher parts of the annually-flooding bottoms of southeastern floodplains. Overcup oak dominates low depressions. Fronds of the swamp palm *(Sabal minor),* an indicator species of wetlands, can be seen in the photograph. Because of differences in elevation and food availability, the environmental mosaic of these bottomland hardwood associations make prime wildlife habitats.

higher latitudes, can occupy the bottomland hardwood niche. Conversely, under certain conditions, some bottomland species are able to grow on upland sites.

The Leaf River floodplain near Hattiesburg, Mississippi provides an example of how soils and drainage affect bottomland hardwood tree species. Here grow "cove" hardwoods—tulip poplar, bigleaf magnolia *(Magnolia heterophylla)* and black cherry. The soil auger helps explain why. There is a thick, fast-draining, sandy soil with deep, incised drainways nearby, which means a low water table in the growing season. Nor are there surface clays to "pond" rainwater.

Two recent instances point out how narrow definitions could mislead. Almost all of the 20,000 acre (809 ha) Lake Ophelia (Avoyelles Parish, La.) tract are wetlands, the bulk being bottomland hardwoods (Figure 4). The mostly "meander

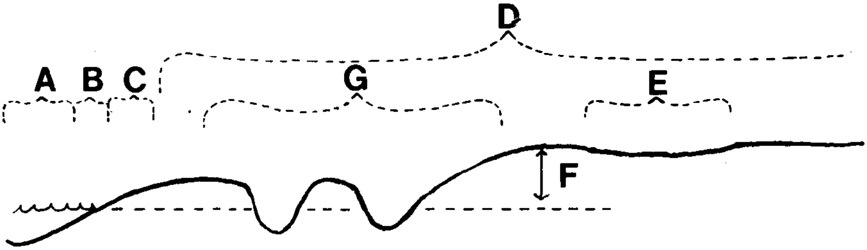

Figure 4. Idealized cross section of terrain in the Lake Ophelia area (Avoyelles Parish, La.) with typical plant associations. Soils are Red River Overwash, underlain by deposits such as Sharkey or Tensas. Stiff clay subsoils enable growing season rain to assist backwater inundation in maintaining these wetland communities. (A) buttonbush in shallow swales; (B) swamp privet-water elm *(Planera)* zone; (C) water hickory *(Carya aquatica)*-over-cup oak (this zone may include water locust); (D) sugarberry *(Celtis laevigata)* dominant, codominants: American elm, cedar elm, honey locust, green ash, persimmon, Nuttall oak, willow oak. Shrubs: *Ilex decidua, Sabal minor, Crataegus viridis.* Heavy logging and grazing has modified the original forest composition; (E) slight depression causes grouping or "stands" of certain species. Even cypress occasionally occurs; (F) approximate elevation difference is 10 feet (3m); (G) "meander scar" terrain.

scar" terrain, alluvial soils, depth to mottling, presence of crayfish and swamp rabbits *(Sylvilagus aquaticus)* all served to identify this as a wetland area. The effect of overgrazing, and the forests' seral response to heavy logging were also of importance. The Tallahala floodplain first bottoms (Jasper Co., Miss.) bears such anomalies as white oak *(Quercus alba)* in places, "upland" species such as blackgum on alluvial flats, and incipient beech-magnolia hammock (Figure 5), all best explained by fast drainage over impermeable soils and rapid on-off inunda-

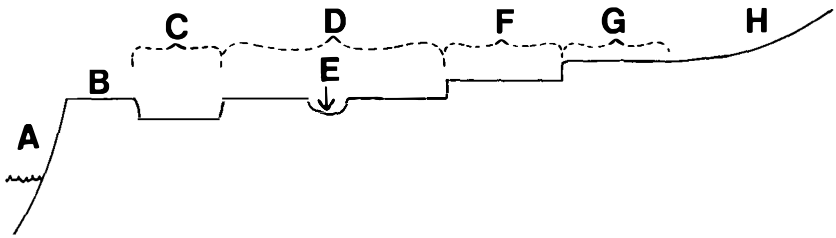

Figure 5. Cross section of one-half of Tallahala floodplain (Jasper Co., Miss.), dominated by remarkably flat terrain underlain principally with stiff clays. Small differences in elevation lead to entirely different tree associations or, sometimes, "stands." Natural levees are not discernable to eye. (A) Tallahala Creek in deep channel; (B) streamside zone with high species diversity, often incipient beech-magnolia forest owing to more sandy soil and/or nearby deep channel; (C) laurel oak zone; (D) widespread water oak zone-codominants: American elm, black gum, winged elm, shagbark hickory, sweetgum, green ash; (E) shallow depression with overcup oak or deep depression with water elm *(Planera)*; (F) swamp chestnut oak-cherrybark oak *(Quercus pagoda)*-spruce pine *(Pinus glabra)* association; (G) beech-magnolia hammock (transitional to upland environments); (H) uplands (mostly loblolly pine). An ecotone (most often between D and H) with maximum organic matter, may occur: laurel oak-Virginia willow-arrowwood-stiff cornel *(Cornus stricta)*. "Steps" in sketch are diagrammatic.

tions. What has emerged from the studies of Shelford (1954), Lindsey et al. (1961), Richardson et al. (1978), Fredrickson (1979), Huffman (1979) and others is that bottomland hardwoods grow on a continuum of moisture, interacting with other variables such as drainage, inundation, elevation and aeration. In reality the community is a mosaic of plant (and animal) associations changing over distances of as little as a few meters. On the Alcovy floodplain, it is possible to tell within three meters which traps will catch spotted salamanders and which will not. With experience, single variables such as elevation can be used to separate tree associations (Hodges and Switzer 1979). Even a six-inch (25cm) difference in elevation can change the species mix on some bottomlands. The Tallahala floodplain (Figure 5), afforded an unusual opportunity to relate tree associes with elevation, especially following heavy rains which revealed lower areas not discernable to the eye (Wharton and Brinson 1979).

Zonation is often telescoped on narrow Coastal Plain blackwater river floodplains. Many blackwater streams tend to fluctuate less, have more organic-rich floodplain soils and carry far less silt and clay than do alluvial rivers draining the Piedmont (Figure 6). Figure 7 is a cross section of a blackwater stream floodplain where one may traverse numerous "zones" or distinctive biotic associations in 100 to 200 meters.

Life Support Functions—Water Quantity

Bottomland hardwoods are part of the floodplain "fluctuating water level ecosystem," dependent on dynamic, yearly pulses of water arising from

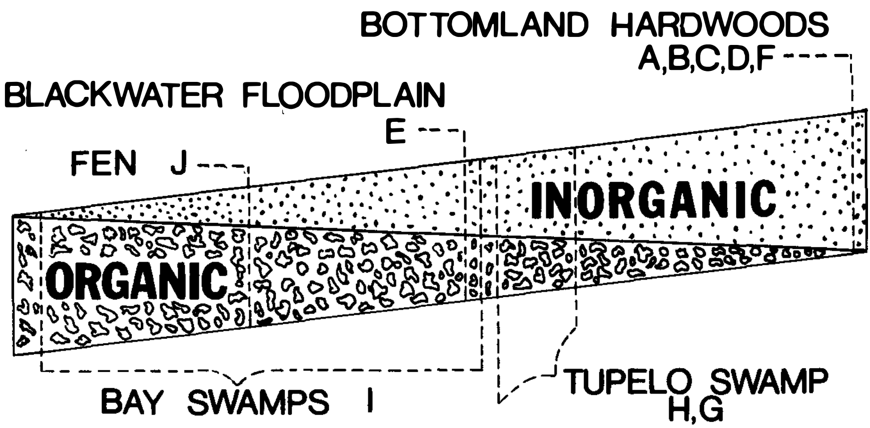

Figure 6. Relative proportion of organic matter (in percent) on alluvial floodplains (bottomland hardwoods, gum-cypress excluded), blackwater floodplains (largely gum-cypress) and pure tupelo stands, compared with some upland wetlands (bay swamps, fens). (A) Blountstown, range 0.20–4.58 percent (av. 1.41), (B) Wewahitchka, range 0.22–3.79 percent (av. 1.35) alluvial river (Fla.) Leitman (1978); (C) Tippecanoe, range 0.0–2.7 percent (av. 1.16), (D) Wabash, range 0.3–3.7 percent (av. 1.5) alluvial rivers (Ind.) Lindsey et al. (1961); (E) Six blackwater rivers (Fla.) average 45 percent, (F) two alluvial rivers (Fla.) range 2.8–5.2 percent (av. 4.0) Wharton et al. (1977); (G) tupelo swamp 40 percent; (H) river bottom tupelo 26 percent (S.C.) Klawitter (1962); (I) Bay swamps 41–98 percent (Fla.) Wharton et al. (1977); Shrub-herb bog (fen) 71.4 percent (Mich.) Richardson et al. (1978).

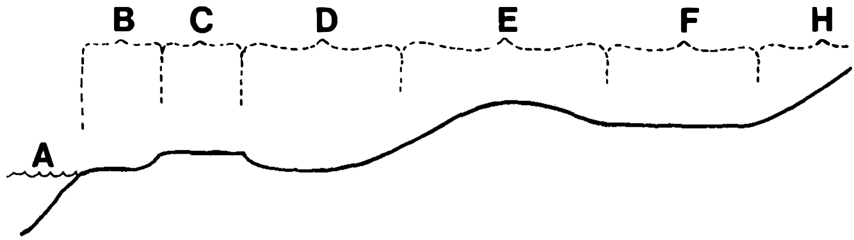

Figure 7. A diagrammatic cross section of one-half of an organic-rich blackwater stream floodplain (Upper Three Runs Creek, S.C.) (A) creek; (B) sweetgum-blackgum *(Nyssa sylvatica)*-river cane-hobblebush *(Leucothoe)* zone; (C) raised peat bog–a modified shrub bog vegetation with pond pine *(Pinus serotina)* canopy; (D) sweetgum-laurel oak-arrowwood *(Viburnum dentatum);* (E) incipient beech-magnolia hammock (beech-American hollyhorse sugar *(Symplocus)* association on "island"); (F) water oak-loblolly pine-swamp chestnut oak-hickory association; (H) uplands. Strong vertical exaggeration.

meteorologic events in the watershed. One of their principal life support functions is the management of the high-water pulse.

Bottomland hardwoods are wetland systems. They grow on the bottom of the river's high water channel. They manage the catastrophism of high water and minimize downstream disorder. High flows are catastrophic. Doubling river velocity may quadruple erosive power. Most of the catastrophic annual flow is handled by the "first bottom" (Figure 2d). Higher flows ("floods") come at unreliable statistical intervals of 5, 10, 25, 50, 100 and 1000 years as well as hurricane stormfall. On the Chattahoochee floodplain (Fulton Co., Ga.) the 50-year flood was exceeded four times in one 10-year period. At such a time the river's strategy is to employ the "second bottoms" (Figure 2c) as its channel. If the second bottom has been cleared for agriculture, disorder may ensue. Levees only make bigger problems downstream.

Cropland, much of which is on the once-forested floodplain, contributes an average of 38.4 tons of topsoil/acre/year (95 tons/ha/yr) to the Obion-Forked Deer River (Tenn.) (U.S. Soil Conservation Service 1977).

Flood peaks do not get as high nor do they rise and fall as rapidly with intact forests (Wharton 1970). Figure 8 indicates the possible effect of the great Oconee Coastal Plain swamps on flood volume. In spite of an increase of 2000 square miles (3220 km^2) of watershed, flood levels cease to rise and sometimes even fall after water enters the up to 4 mile (10km) wide floodplain below Milledgeville. River height slowed markedly in relation to discharge as soon as a blackwater river utilized its swamps (Benke et al. 1979). Preventing a river from using either its first or second bottoms or denuding either of trees means the taxpayer must pay for downstream damage or further engineering. In Georgia, the four inundations of the Piedmont Alcovy are "smoothed out" by the Altamaha, whose hardwoods are more or less under water from January to June (Wharton 1977). The out-of-water period unfortunately coincides with the soybean season (June-November).

The river pays a price for the forest's services. We have calculated that a Mississippi floodplain forest lost twice as much water by evapotranspiration than was evaporated by a proposed reservoir. While the reservoir "used" less water, neither did it perform the services of the forest. In fact, reservoirs "lock up"

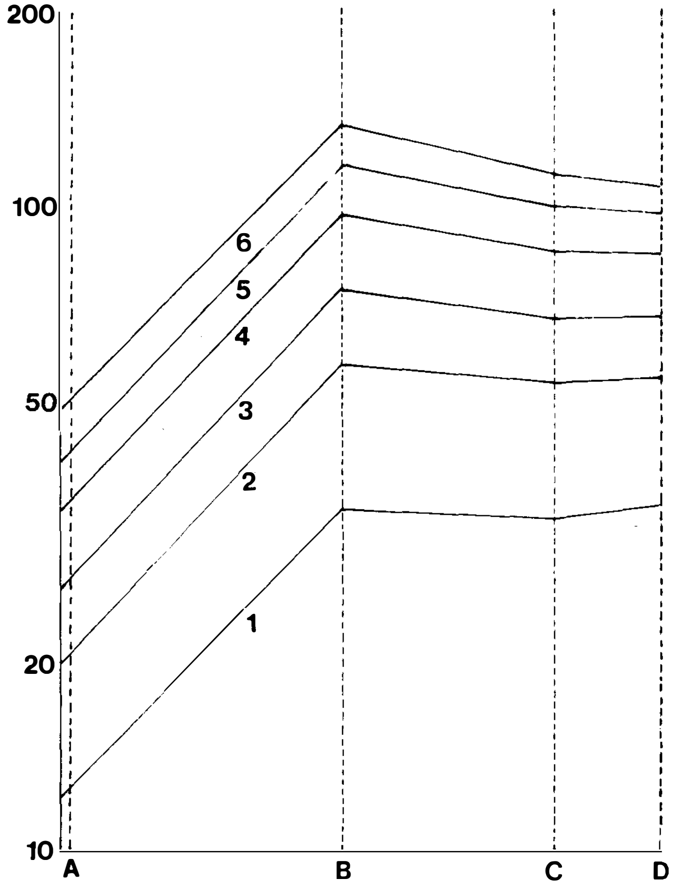

Figure 8. Relation of flood discharge (ordinate, cu. ft./sec., in thousands) of Oconee River (Ga.) to distance down stream (abcissa). (A) Piedmont station (Greensboro); (B) fall line station (Milledgeville, drainage area 3000 square miles, 4830 km^2) just above the first great Oconee swamps; (C) downstream station at Dublin; (D) junction with the Ocmulgee (Mt. Vernon, drainage area 5150 square miles, 8292 km^2). (1) 2-year flood; (2) 5-year flood; (3) 10-year flood; (4) 20-year flood; (5) 50-year flood; (6) 100-year flood. Although evapotranspiration could reduce flood crests, most floods occur before leaf-out. Ground water or aquifer recharge may be a factor in actual water loss. Data from U.S. Geological Survey (1979).

nutrients. Seasonal evapotranspiration may assist in regulating the river's high-water pulse (Livingston 1979, Livingston and Loucks 1979).

While rivers "charge" their floodplains at high water, on alluvial floodplains, such as along the Apalachicola (Florida), residual water is perched in backswamps 3 to 7 feet (0.9-2.1m) higher than the river level. Floodplain pools, sloughs and depressions were shown to rise by local rainfall independently of river stage (Leitman 1978). The same is true on the Alcovy. Considering this and evidence from Lake Ophelia and the Tallahala, it becomes clear that local rainfall, coupled with certain alluvial soils, is highly important to bottomland hardwood systems. Insufficient water diminishes growth and can cause dieback, while excess water increases radial growth (Broadfoot 1960, 1967, Klawitter 1962). Since bottomland hardwoods clothe the high water channel of the river, their survival is intimately related to variations in the hydrologic regime. Huffman (1979) showed that the survival of ironwood, cherrybark oak, water oak, sweetgum and blackgum seedlings depends upon whether inundation occurs during March 25–April 25, between April 25–May 25 or between May 25–June 25.

Life Support Functions—Water Quality

Bottomland hardwoods, with their wide, shallow root mats, anchor the soil and prevent loss by scour. Their trunks, logs and debris lower water velocity and sediments drop out, thus "cleaning" the water. Even a single limb has dramatic results (Lindsey et al. 1961). The most dramatic large-scale erosive changes in natural systems such as cuts and fills, changes in river course and movement of enormous quantities of sand, take place not annually but during higher flows. Shortening rivers increases velocity and bank undercutting; snagging can be disastrous, breaking precious root bind. The filtration of river water, acid rain or agricultural runoff is accomplished by slow passage over floodplain soil and litter surfaces. Either clays absorb chemicals and are deposited, or chemicals are extracted by ion-exchange on soil surfaces. Pesticides cling to clay and organic particles at levels 10,000 to 100,000 times higher than their concentration in water (Keith 1966). Alluvial floodplains are sinks for radioactive cesium, oil (see Wharton 1977); nitrogen and especially phosphorus (Kitchens et al. 1974, Holmes 1977, Wharton and Hopkins [in prep.], Kibby 1979); sewage (Wharton 1970); and fly ash (Guthrie et al. 1974). The switch from aerobic (oxidizing) to anaerobic (reducing) conditions on floodplain floors favors bacterial metabolic pathways such as methanogenesis, sulfate reduction and denitrification (Wharton and Brinson 1979). While this "work" occurs in gum-cypress sloughs, much is accomplished in temporary pools following flooding or rain. On the slowly permeable Tallahala floodplain, we observed thousands of rain-activated "mini-basins". Similar "swirl bowls" were discussed by Lindsey et al. (1961).

Life Support Functions—Productivity

Floodplain Productivity

In addition to excess water, alluvial floodplains receive two subsidies from upstream: minerals (silt or clay) and energy (organic matter in the form of detritus, primarily leaves). Floodplain forests are thus among the highest producers of southeastern ecosystems (Brown et al. 1979). Blackwater floodplains generally lack the mineral subsidy, their acidity inhibits bacteria and they are less fertile. Boyd (1976) found laurel oaks larger and cotton mice denser on the Oconee's alluvial floodplain than on the blackwater Canoochee floodplain. Details of litter processing are summarized by Brown et al. (1979), Wharton and Brinson (1979), and Merritt and Lawson (1979). The latter found that a Michigan floodplain supported an assemblage of litter processing species "unique to this ecosystem," as did Grey (1973) for the upper Santee (S.C.) floodplain. Energy and minerals from subsidies and from local biomass production enter productive food chains of both floodplain and river.

Winter pools on the Alcovy floodplain (Georgia) swarm with life. There follows a winter-spring cyclic abundance of one organism following another: stoneflies, mayflies, amphipod and isopod crustaceans and oligochaete worms (Parsons and Wharton 1978).

Most unpolluted river floodplains whether alluvial or blackwater, support a host of invertebrates feeding on the particles derived from leaves and twigs of bottomland hardwoods. Some of these organisms are flushed off the floodplain directly, and others are eaten by fish on the floodplain at high water (crayfish are especially important). Insect families widespread on the floodplain are ground beetles (Carabidae), rove beetles (Staphylinidae) and wrinkled bark beetles (Rhysodidae). These and earthworms support often high densities of marbled, mole, southern dusky, two-lined and dwarf salamanders. Frogs are abundant, reptiles less so. Crayfish are unusually abundant and feed everything from warmouth bream to otters, barred owls and ibis. Shrews (Southeastern, shorttailed) and mice (cotton, golden and jumping) are remarkably abundant on Alcovy and Chattahoochee (Ga.) floodplains.

As Tanner (1975) has pointed out, southern swamps and bottomland forests were the last refuge for the cougar, red wolf and ivory-billed woodpecker, the latter specialized to feed on dead and dying old growth hardwoods. Louisiana's Singer Tract of 120 square miles (166 km^2) supported about (Figure 1) seven pairs of ivorybills. Some rare birds feeding and/or nesting on floodplains include the Mississippi and swallowtail kites, limpkin, bald eagle, and two warblers, Swainson's and Bachman's. Hollow trees provide countless dens for raccoon, owls, squirrels, wood ducks, bats and woodpeckers. The floodplain is a home to the large swamp rabbit who swims readily, and refuge for bear and dog-driven deer. Bottomland forests feed migrant swarms of cedar waxwings, robins and blackbirds. When floodplains are inundated, ducks outcompete squirrels, bears, turkeys, bluejays, woodpeckers and raccoon for the massive acorn crop. Some animals are quite food specific. Meanley (1972) reports that bears climbed to get overcup oak acorns, ignoring Nuttall oak acorns lying on the ground. Some 500,000 ducks (90 percent mallards) winter in the White River bottoms of Arkansas—they prefer water and willow oak acorns.

Aquatic Productivity

Aquatic consumer animals sponsor a whole series of food webs in sloughs, oxbows and river. Detritus (litter) is either flushed into the waterways as dissolved humic substances (predominantly in blackwater rivers) or as particulate matter (leaf particles) in both river types.

While humic substances may flocculate and feed bacteria and some insect larvae, especially in blackwater systems, and vascular plant fragments and diatoms are important (Wallace et al. 1977), it is the particulate organic matter that is most vital to river life. Estimating loss through net pores (760m) of 80 percent, an average of 3,860 K/day of fine particulate matter moved down the Altamaha (Ga.) on 16 sample days between 4 February–21 July, 1976; and at higher flows 11,000 K/day (James Gardner, pers. comm.).

Much of this organic matter from the floodplain is used by innumerable larvae of blackflies, caddisflies, stoneflies, mayflies, midge flies, and by snails and clams. Arthur Benke (pers. comm.) has recorded densities of 20,000 per m^2 of insect larvae on underwater snags and 40,000 per m^2 midge fly larvae in sandy bottoms of the Satilla River (Ga.). There is a constant downstream drift of organisms. In the Altamaha, Gardner and Woodall (1975) documented as many as 115 taxa washing downstream constantly by night (6.5 per m^3 of water) or day (2.2 per m^3). About three organisms per m^3 were recorded for the blackwater Satilla (Benke et al. 1979). This provides a never ending food supply for fish. It is not remarkable that the world's record largemouth bass came from an oxbow slough on the Ocmulgee floodplain (Telfair Co., Ga.).

Many fishes tie their life cycles to annual high water pulses, either leaving the channel to feed among the roots of oaks and hickories (catfish and centrarchids) (Woodall et al. 1975) or to spawn there (blueback herring, centrarchids). Marine fish enter estuaries at this time. Day et al. (1975) found that a Louisiana river swamp fed an estuary (Barataria Bay, producing 45 percent of the state's commercial fish catch) with pulses of carbon, nitrogen and phosphorus at the precise time when migrant species were entering the estuary for feeding and spawning. The degree that estuaries can be dependent upon the normal flow of rivers and their intact bottomland forests is shown by recent research on the Apalachicola River (Fla.). The Apalachicola is one of the few large southern rivers whose bottomland forests were not removed for rice culture. It's detrital load to Apalachicola Bay is thus quasi-natural. This bay supports 80 percent of Florida's oyster industry and is the west coast's crab-spawning center. Livingston et al. (1974, 1975) have shown that the bay's cyclic productivity depends not only upon annual pulses of organic detritus and silt from the bottomland hardwoods, but on their import during a major 5 to 7 year pulse originating in the mountains of north Georgia. These longer pulses in productivity are linked with peaks in commercial fisheries catches (Meeter et al. 1979, Livingston et al. 1976). There is even data that each kind of tree leaf may have its own special food web (Sheridan and Livingston 1979, White et al. 1979). The important conclusion is that water higher than the annual inundation has tremendous downstream effects—these higher "floods" specifically involve the highest bottomland hardwood associations!

This is additional evidence that the entire length of a river must be considered in evaluating the function of its parts. From the oligotrophic montane streams to its discharge in a coastal estuary, a river has physical, chemical, hydrologic and biotic gradients, which, if disturbed in one place, may change the whole system downstream (Wharton and Brinson 1979).

Along the lower Altamaha the width and length of the floodplain seems partitioned off into a mosaic of habitats vital to one species or another. The sloughs, ox-bows, tributaries and floodplain itself serve as spawning grounds and nurseries not only for fresh water fish but for many anadromous marine fish as well. Among three species of shad, two sturgeons, striped bass, hogchoker and needle fish, each species may use different habitats and different sections of the river for breeding and nursery functions. Striped mullet and southern flounder may travel upriver as far as river mile 120 (166 km) just to feed.

Life Support Values—Other Tangible and Intangible Values

Bottomland hardwoods have other obvious dollar values. Some are less tangible, but nonetheless important.

Bottomland hardwoods contain the major hardwood timber resource in much of the deep South. Unfortunately, the "best" species are often heavily overcut, reducing the seed supply and leaving a forest dominated by hackberry, elm and honey locust. Too often clearcutting, rather than selective cutting, is the logging method of choice. After clearcutting, some sites are prepared (bedded) for the planting of pines, less often sycamores and cottonwoods. The community has been hardest hit, however, by the conversion of forest to row-crop agriculture, particularly where man-made structures have made flow regulation possible.

Whole parishes in Louisiana once in bottomland hardwoods are now in soybeans. Tax dollars built levees, canals and reservoirs that allowed this. Even first bottoms are being converted—hundreds of acres are being sheared off the Savannah floodplain below Augusta. Taxpayers have subsidized this short-term gain and we may permanently lose the long-term, life-support functions of this ecologically complex system.

Jahn (1979) listed some cultural resource values: open space, recreation, archeological and historical sites, scientific study, outdoor education and natural beauty. In the South at least, most of the uplands are in pine tree farms or agriculture, hence the green belts of floodplains represent for most of us the last wildernesses. Adapted to natural catastrophism, they can handle almost anything except solid wastes. Trampling does not damage their azonal soils. Wharton et al. (1977) discuss management and use of river swamps.

Wharton (1970) calculated a dollar value of 2,300 (931 ha) acres of Georgia Piedmont bottomlands at \$3125/acre/year (\$7718/ha/year). I expect that if potential values were recalculated, adding things like flood control, heavy metal immobilization, wildlife, and controlled movement of bed load, values might approach the \$4000/acre/year (\$9800/ha/year) estimated for the salt marsh (Gosselink et al. 1973). Another approach is to value all life support functions (timber, water quality, flood control, fauna and fisheries, microclimate, CO_2 elimination, recreation, etc.) based on the natural energy flows (sun, water, rain, wind) equivocated with coal energy values (Odum et al. 1977). For every calorie of natural energy the system uses, 2.5 calories of outside energies (fuel, goods, services) are "attracted", much as a pulp mill might be "attracted" to locate on a large river swamp (see Wharton et al. 1977). King et al. (1979) criticized both approaches and proposed using Federal Principles and Standards which evaluate four areas: economic, ecologic, social and political.

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Factors Controlling the Fate of Pesticides in Rural Watersheds of the Lower Mississippi River Alluvial Valley

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Introduction

The use, misuse, and abuse of pesticides have caused significant fishery resource losses in many areas of the United States. Pesticide-related losses have occurred from fish kills, habitat deterioration, and declining productivity. Pesticide residues in fish, at levels considered dangerous for human consumption, have resulted in closure of sport and commercial fisheries. Although many fishery losses have been linked directly to point-source pollution discharges, chemical spills, and direct application of chemicals to water, resource losses resulting from contaminated runoff have also been documented in a wide variety of habitats. Well-publicized losses resulting from agricultural non-point source pollution have occurred in the southeastern and south-central United States, where both sport and commercial fisheries have been closed because of elevated toxaphene and DDT residues in fish tissues (Willis et al. 1976, Cotton and Herring 1970), and game species have been eliminated from some lakes by these and other compounds (Bingham and Parker 1969, Ferguson 1967).

The environmental fate of chemicals used in agriculture or silviculture can be expressed in terms of four basic processes: application, attenuation, transport, and accumulation. Land-use practices affect the rates of these basic processes and ultimately determine the fate of the pesticides. The fate of pesticides is discussed as it is affected by climatological factors, land use, and agricultural practices common to the lower Mississippi alluvial plain.

General Principles

A materials flow diagram for a generalized watershed (Figure 1) has been synthesized from a number of sources (e.g., Bailey et al. 1974, Donigan and Crawford 1976). This conceptual model illustrates functional ties between terrestrial and aquatic components of a watershed in determining the fate of chemicals applied to the land. Rectangular units represent environmental compartments in which pesticides can accumulate and be degraded, and arrows represent the flow or flux of material into and out of the compartments through the process of application, transport, and attenuation (Figure 1). Fluxes are additive; therefore, if total input rates equal total output rates for a compartment, the compartment is at equilibrium; if inputs exceed outputs, material is accumulating; and if outputs are greater than inputs, there is a net loss of material. Environmental compartments are soils

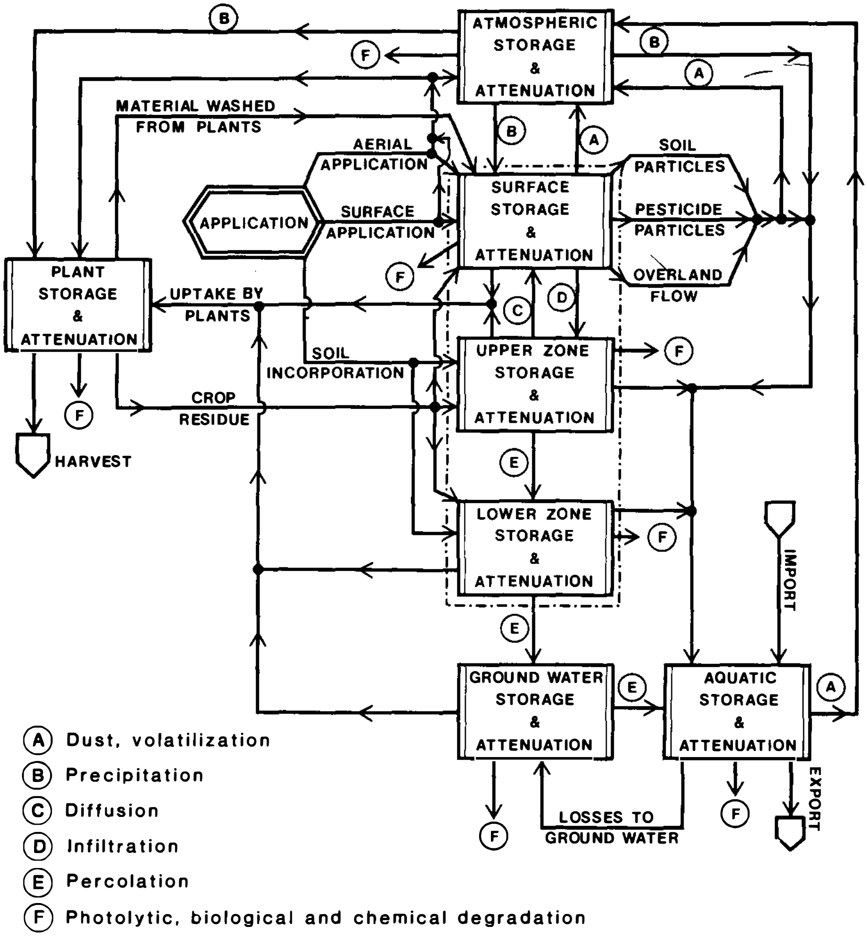


Figure 1. Materials flow diagram for a generalized watershed. Rectangular units represent environmental compartments in which pesticides can accumulate and be degraded, and arrows represent potential pesticide fluxes through the processes of application, transport and attenuation.

(surface, upper zone, and lower zone), groundwater, atmosphere, living plants in the watershed, and aquatic ecosystems. Besides application rates, fluxes include transport processes (volatilization, overland flow, infiltration, percolation, and precipitation) and attenuation processes (photolytic, biological, and chemical degradation of the compound).

Pesticides may be applied from the air (aircraft or overtop spray), in solution or suspension to soil surfaces, in an emulsion to plant surfaces, or as a liquid or solid to be incorporated into the soil either before or during planting (Figure 1). Aerial application supplies material directly to soil surfaces, plants, and the atmosphere. Soil surfaces and plants may then contribute material to the atmosphere through volatilization and dust. The atmosphere in turn may be a source of material to soil surfaces, plants, and aquatic ecosystems through precipitation. Aerial application of pesticides may also supply material directly to aquatic ecosystems by way of spray drift and precipitation. The primary attenuation processes in the atmosphere are chemical degradation and photolysis.

Soil surfaces contribute most of the pesticides that eventually reach aquatic ecosystems (Bailey et al. 1974, Woolhiser 1976). Depending on the compound and its formulation and method of application, losses from soil surfaces may occur (1) in liquid form, either dissolved or complexed in water entering aquatic systems as overland flow or as subsurface flow after first infiltrating to lower soil zones; or (2) in solid form, either adsorbed to soil, dust, and plant material, or as suspended pesticide particles (Figure 1). Some pesticides applied to soil surfaces may be accumulated by plants, and the surface may subsequently receive this material incorporated in crop residues. Attenuation processes at the soil surface include photolytic, chemical, and microbial degradation.

The upper and lower soil zones receive pesticides through infiltration from the soil surface and from direct application before or during planting (Figure 1). Losses from these zones occur as a result of uptake by plants and percolation to lower soil zones and groundwater. Water and pesticides may also diffuse upward to the surface layer, replacing material lost through evaporation (Caro 1976). Microbial and chemical degradation are the major attenuation processes in the soil.

Aquatic ecosystems may receive pesticides via aerial application (including spray drift), import from upstream aquatic systems, overland flow (soil particles, pesticide particles, or water), subsurface flow, contaminated groundwater, or contaminated precipitation (dry or wet fall) (Figure 1). Losses from surface waters may occur through downstream export, volatilization, and where groundwater resources have been depleted or in seepage lakes, losses to groundwater. Attenuation in aquatic ecosystems is primarily due to microbial activity and chemical degradation, although photolysis and degradation by higher plants and animals may also occur.

The remaining storage component consists of the cultivated plants, which may accumulate pesticides directly from any of the soil zones or from groundwater if plant roots reach the water table (Figure 1). Trace amounts of pesticides may become adsorbed on plant surfaces from dry and wet precipitation, or material may be applied directly. Pesticides may then reach soil surfaces either after being washed from plant surfaces by rain or as crop residue incorporated into the soil or left on its surface after harvest. Some pesticides may be harvested with the crop. Photolysis and metabolization of the compounds by the plants and chemical degradation are the major attenuation processes.

Even though Figure 1 is designed to represent an agricultural watershed, this conceptual model can be used to describe the functional relationships among storage compartments in any aquatic-terrestrial system by altering the flux rates. A managed forest ecosystem would be identical to the cropped agricultural system except that flux rates would be different. An unmanaged forest ecosystem would receive only atmospheric inputs. A golf course or suburban lawn might never be harvested; the crop residues (grass clippings) could all be returned to the soil surface.

With the exception of pesticides entering directly via spray drift, precipitation, or import from upstream, all inputs to aquatic ecosystems are associated with liquid and particulate material transported from the watershed. Therefore, understanding the fate of chemicals requires an understanding of the processes that control water and sediment movement from terrestrial to aquatic components. All flux rates—application, attenuation, and transport—are interrelated and are influenced by climatological, geographic, and chemical (compound-related) properties. Chemicals used, application rates and methods of application are based on land-use management decisions, and these decisions may be influenced by watershed characteristics and environmental factors. Similarly, even though pesticide solubility and persistence are largely properties of the compounds, these properties are also influenced by climatological factors and properties of the watershed related to soil type. It is therefore difficult to single out 'land-use' as a driving variable because it affects ecosystems in many ways and is, in turn, influenced by other factors. Nevertheless, factors determined largely by land-use practices that control transport of pesticides from the land to aquatic ecosystems can be identified and described.

Availability of Agricultural Compounds for Transport to Aquatic Systems

Among the most important properties of a compound in determining its availability for transport is longevity. In terms of soil persistence, this may range from a period of days or weeks for some organophosphate and carbamate insecticides (e.g., parathion, phorate, fonofos, carbaryl, carbofuran) and some phenoxy herbicides (2,4-D salts), to months for triazine herbicides (cynazine, simazine, atrazine) and some other fairly long-lived organic herbicides (e.g. paraquat, picloram, profluralin, diuron). Some organochlorine insecticides (e.g., DDT, dieldrin, lindane), arsenical herbicides (MSMA, monosodium methanearsenate; DSMA, disodium methanearsenate), and desiccants (arsenic acid) may remain active in the soil for over a year (Wauchope 1978). Although basically a property of the compound, longevity may be influenced by environmental factors such as temperature, soil moisture, and pH. Furthermore, degradation products of some agricultural compounds may be ecologically significant; the metabolites may be as toxic (or more so) than the parent compound, as is true for one photochemically degraded isomer of dieldrin (Rosen et al. 1966, cited in Pionke and Chesters 1973).

The water solubility of a compound is important in determining its distribution in runoff. Solubilities of agricultural chemicals range from a low of <.001 mg/L (ppm) for DDT to >10 percent by weight for many herbicides, and may also be influenced by environmental factors. The relationship between solubility and the proportion of a pesticide lost in liquid and solid phases of runoff (Figure 2) was illustrated by Wauchope (1978). In general, compounds with solubilities of 10 mg/L or greater are transported primarily in the liquid phase; less soluble compounds are transported in the solid phase, adsorbed to soil particles. Paraquat and MSMA are exceptions (Figure 2); these water-soluble ionic compounds become chemically adsorbed to the surface of soil particles (Bailey and White 1964) and are transported in the solid phase (Wauchope 1978).

Physical adsorption of a compound to soil particles is also important in determining its mode of transport. Soil moisture and organic content are important factors determining the ability of soils to adsorb non-ionic pesticides and herbicides (Bailey and White 1964), although other factors related to soil conditions

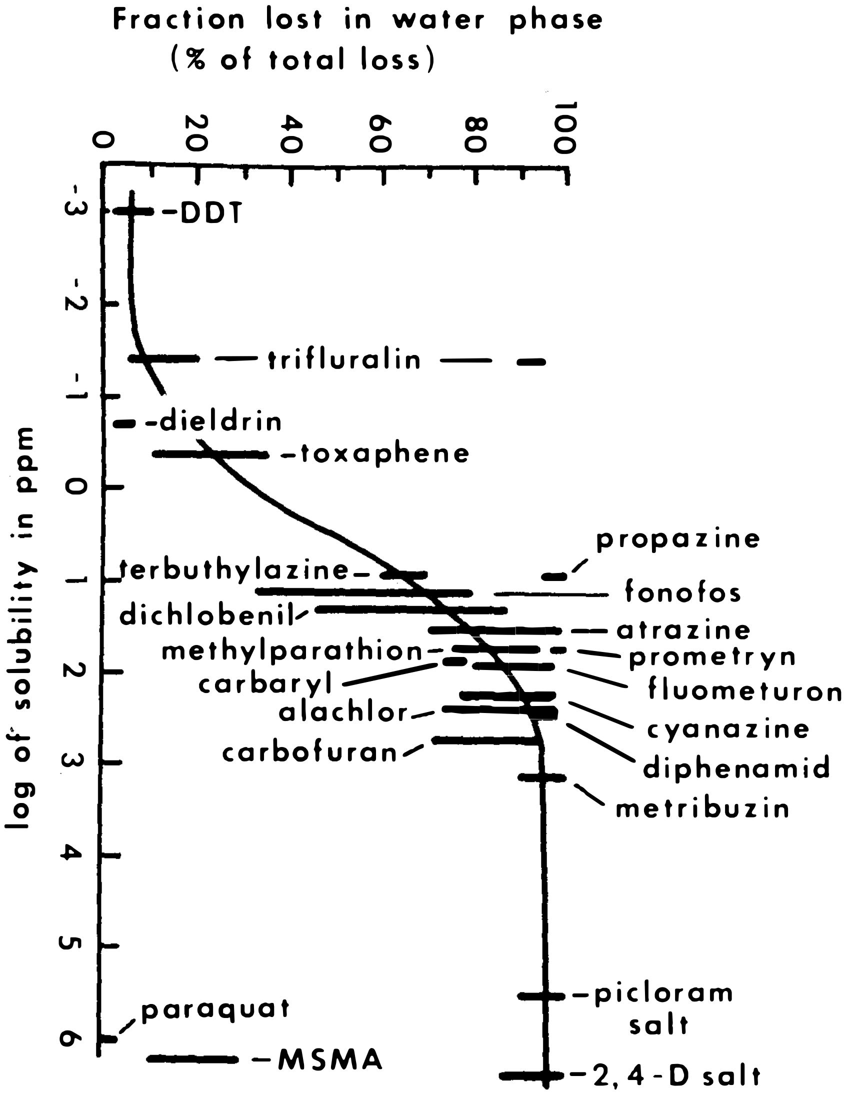


Figure 2. Partitioning of pesticides between water and sediment in runoff samples (from Wauchope 1978).

may also be involved. Figure 3 illustrates the effects of some soil characteristics and temperature on adsorption of lindane (γ-benzene hexachloride), a low-solubility organochlorine insecticide, from water (Mills and Biggar 1969). More material is adsorbed by the highly organic peaty muck than by the clay soil, and both soils adsorb more lindane than either bentonite or silica gel. Furthermore, lindane adsorption by both soils is reduced as temperature increases from 10° C to 40° C.

The mobility of a compound is also determined to a great extent by its formulation and method of application. Although all pesticides behave differently,

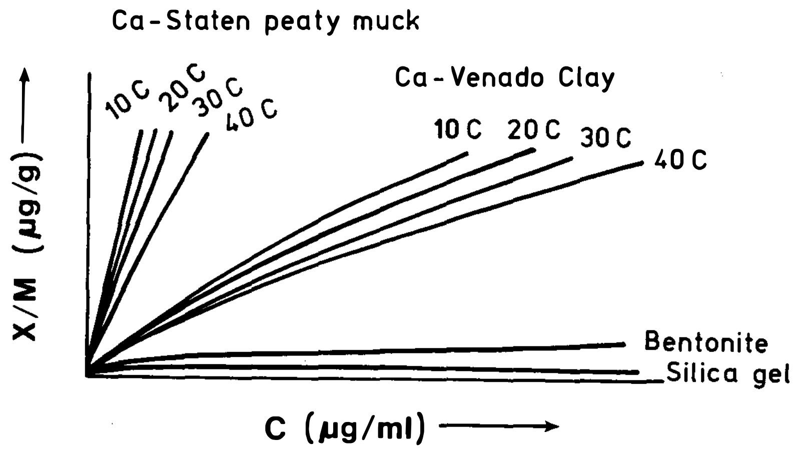


Figure 3. Adsorption of lindane (γ-benzene hexachloride) from aqueous solution by two soils at four temperatures and on bentonite and silica gel at 20°C (from Mills and Biggar 1969).

Wauchope (1978) grouped pesticides into three categories based on the proportion of the material applied that eventually ends up in runoff: (1) wettable powders, most of which are herbicides applied to the soil surface, with typical long-term losses of up to 2–5 percent depending largely on land slope; (2) water-insoluble emulsions (usually foliar-applied insecticides), with normal runoff losses of up to 1 percent (except for DDT, which remains available for an unusually long period after application and for which runoff losses of 2–3 percent are typical); and (3) water-soluble pesticides applied either in aqueous solution to the soil surface or in soil-incorporated formulations, for which losses of less than 0.5 percent are typical. Although a lower percentage of the water-soluble compounds applied tends to be lost, a higher percentage is lost in solution (Figure 2). It is therefore available to the biota upon reaching the aquatic ecosystem, whereas pesticides adsorbed to soil particles may be essentially unavailable.

Soil and Water Transport to the Aquatic Environment

Transport of pesticides depends on the movement of water and soil from the watershed and the timing of runoff events in terms of application and the compound's longevity. It is common knowledge that some land uses are associated with higher sediment production than others. In terms of erosion rates on a unit area basis, forests and grasslands rank lowest among major non-urban land uses in the United States and active surface mines and construction sites have the highest erosion rates (Table 1). There is a 500-fold difference between undisturbed forest, at 8.5 metric tons/km^2/year, and harvested forest at 4,250 metric tons/km^2/year. Weighting the rates by acreage in each land use shows that surface mining and construction, despite their high unit area erosion rates, contribute relatively little to total annual sediment production (Table 1). Harvested forests, grassland, and cropland together contribute 19 times more sediment each year than do undisturbed commercial forests, surface mines, and construction sites (Table 1). The major sediment-producing land uses are also the ones involving the heaviest use of pesticides.

Table 1. Representative erosion rates for land in various uses (adapted from McElroy et al. 1975).

Land use	Annual rate (metric tons/km²)	Unit area annual rate relative to forest (x forest rate)	Relative rate weighted by acreage
Forest	8.5	1	1
Grassland	85	10	11
Abandoned surface mines	850	100	<1
Cropland	1,700	200	168
Harvested forest	4,250	500	11
Active surface mines	17,000	2,000	2
Construction	17,000	2,000	6

Factors Controlling Erosion and Runoff

Although erosion from a given field may vary greatly from year to year, long-term average soil losses from agricultural lands can be described by the Universal Soil Loss Equation:

$$A = RKLSCP,$$

where A (soil loss in units of mass/area/time) is expressed in terms of R, a rainfall factor; K, a soil erodibility factor; L, a slope-length factor; S, a slope-steepness factor; C, a cropping and management factor; and P, an erosion control practice factor (Wischmeier and Smith 1965). These factors, most of which are dimensionless, adjust erosion of a particular watershed to that of a standard field in continuous fallow. Farming practices determine C, the cropping and management factor, and P, the erosion control factor. Land-use practices influence K, the soil erodibility factor, less directly; it is largely a 'given' property of the soil which can be altered through farming practices. Conversely, rainfall, slope, and slope length are characteristics of the watershed that tend to influence or limit land uses.

In general, topsoils with a high percentage of silt and fine sand (particle diameter 0.004–0.1 mm) and low clay and organic matter content tend to be the most erodible. Clay and organic matter tend to bind soil particles together, decreasing erodibility, but this effect is complex and related to a host of other soil variables including pH, moisture content, bulk density, structure, and prior land use and tillage practices (Wischmeier and Mannering 1969). Organic material also helps to maintain soil structure and porosity and therefore reduces its runoff potential (Woolhiser 1976). Many of these erosion-determining properties also influence the ability of soil to adsorb and retain many pesticides; for example, adsorption, resistance to erosion, and infiltration are all positively correlated with percent organic matter and tend to reduce overall pesticide losses. Likewise, organic content can be influenced by tillage and crop residue management practices (cf. Wischmeier 1976). The erodibility of both surface soils and subsoils exposed at construction and surface mining sites is also positively correlated with percent silt and fine sand, and negatively correlated with percent organic matter (Wischmeier et al. 1971). In heavy clay subsoils, erodibility also decreases with increasing levels of amorphous hydrous iron and aluminum oxides, which can serve as soil binding agents (Roth et al. 1974). Soil loss rates can vary widely due to differences in soil particle size and particle detachment, which can then cause similar variability in the transport of soil-bound pesticides.

The erosion control practice factor, *P*, accounts for conservation practices such as contouring and strip-cropping, the effectiveness of which are related to slope, slope length, and soil infiltration capacity (Wischmeier and Smith 1965). Practices related to tillage system, cropping history, and residue management are usually accounted for in the cropping and management factor.

Tillage method is extremely important in determining soil loss; the ability of a soil to retain water and resist particle detachment and transport is directly proportional to the roughness and porosity of its surface (Wischmeier 1976). Crusting or puddling, which cause surface sealing, increase runoff and soil erosion. Soil compaction from the use of heavy equipment increases runoff but may decrease erosion by strengthening the soil. Tillage methods may be categorized as (1) conventional tillage, which includes a primary tillage of moldboard plowing followed by several secondary disking and smoothing operations; (2) minimum tillage, in which secondary disking operations are reduced or omitted; (3) conservation tillage, involving primary and/or secondary tillage operations that leave crop residues on the soil surface and depend on herbicides to control weeds; and (4) no-till, in which a crop is planted directly into an untilled seedbed and herbicides are used to kill both weeds and existing vegetation (Wischmeier 1976).

The cropping and management factor *(C)* in the Universal Soil Loss Equation is directly related to tillage methods and other farming practices. Figure 4 illustrates how *C* varies with farming practices, crop, and crop stage for several important crops of the southeastern and south-central United States (data from Wischmeier and Smith 1965). Crop stages are defined as Period F, rough fallow (rough soil surface, no cover); Period 1, seedling (smooth soil surface, no cover); Period 2, establishment (smooth soil surface, small plants provide minimal cover); Period 3, growing and maturing crop (smooth soil surface, plants provide cover); and Period 4, residue or stubble (smooth soil surface, residue mulch cover). Changes in *C* through the crop stages are due primarily to development of the crop canopy (which protects the soil from raindrop impact) and the soil reinforcement provided by roots.

Figure 4-A shows how *C* for corn or soybeans, grown under several management practices, changes during the first year following the turning under of mixed grass-legume hay. Important features illustrated by this graph are that soil loss in the initial rough fallow period is low relative to continuous fallow; losses for minimum till practices are lower than for conventional till; soil losses during the residue-stubble stage are lower when the residue is left than when it is removed; and winter soil losses are greatly reduced when a cover crop is planted. Figure 4-B, illustrating *C* for corn and soybeans several years after turning the hay crop under, shows that soil loss is higher than in the first year at almost all stages, even for minimum till, due to breakdown of the previously incorporated sod. Also, the protective action of the previous year's crop residue extends through the seedling period (Period 1, Figure 4-B). The factor *C* for two hay crops (Figure 4-B) illustrates the magnitude of row-crop sediment yields relative to those of grassland.

Figures 4-C and 4-D show the same type of information for cotton. Soil losses tend to increase each year after the initial turning under of sod, and the beneficial

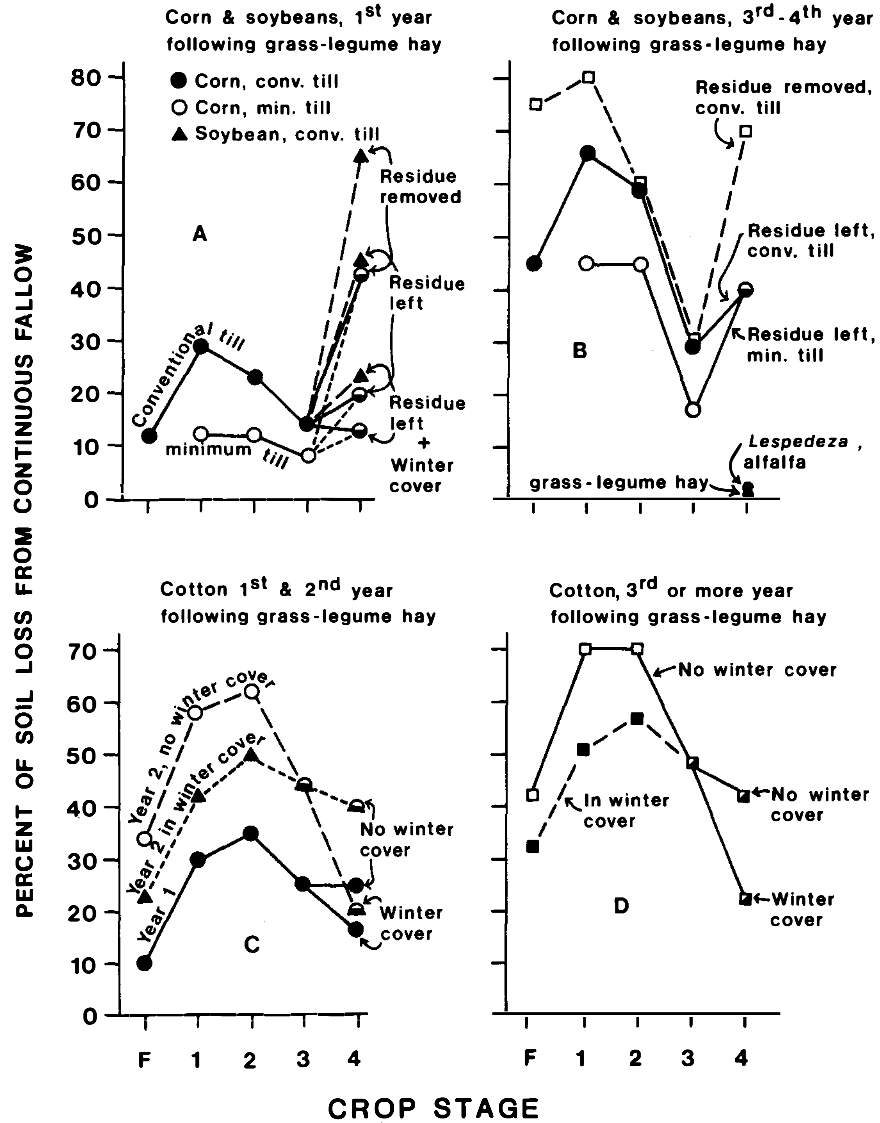


Figure 4. Erosion of several crops as a percentage of erosion from continuous fallow during four crop stages: Period F, fallow; Period 1, seeding; Period 2, establishment; Period 3, growing and maturing crop; Period 4, residue or stubble (data from Wischmeier and Smith 1965).

effect of a winter cover crop persists throughout the following growing season.

Actual sediment yield to receiving water bodies, and therefore yields of sediment-associated pesticides, may be overestimated if the Universal Soil Loss Equation is used to estimate losses from small areas, and these delivery rates are then applied to an entire watershed (Karr and Schlosser 1977). Sediment yield on a unit area basis tends to decline with increasing watershed size, due to increasing sediment storage capacity and decreasing transport energy (Dendy and Bolton 1976, Ongley 1976).

The amount and energy of rainfall ultimately determine both soil and water yield from a watershed. Rainfall energy, in terms of its ability to detach and transport soil particles, is related to both intensity and quantity. The total kinetic energy of a storm times its maximum 30 minute intensity is a measure of its ability to erode soils. Summing these values for individual storms over an entire year yields an Erosion Index (EI) that relates erosion to climate. The rainfall factor, *R*, in the Universal Soil Loss Equation is a long-term (22 year) average of these annual total EI values (Wischmeier and Mannering 1969). The distribution of *R* for areas of the United States east of the Rocky Mountains (Figure 5) shows that the erosive ability of rainfall is greatest in the Central Gulf Coast region and tends to decrease to the north, northeast, and west (Wischmeier and Smith 1965). Because the growing season is long and annual rainfall is high, average runoff is also greatest in the Central Gulf Coast region (Figure 6) and, like *R*, tends to decrease to the north, northeast, and west (Stewart et al. 1976a).

The timing of significant rainfall events relative to agricultural operations is also important in determining water, soil, and pesticide yields. Seasonal differences exist in the cumulative distribution of rainfall in contiguous areas of the southeastern and south-central United States (Figure 7, from Wischmeier and Smith 1965),

Figure 5. Average annual values of the rainfall factor, R, for areas of the United States east of the Rocky Mountains (from Wischmeier and Smith 1965). See text for explanation.

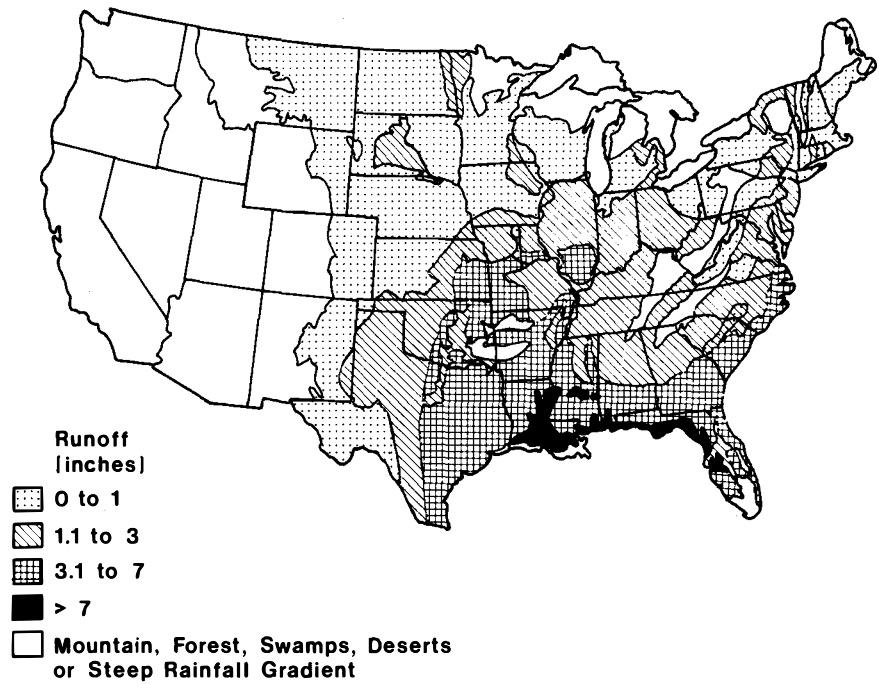
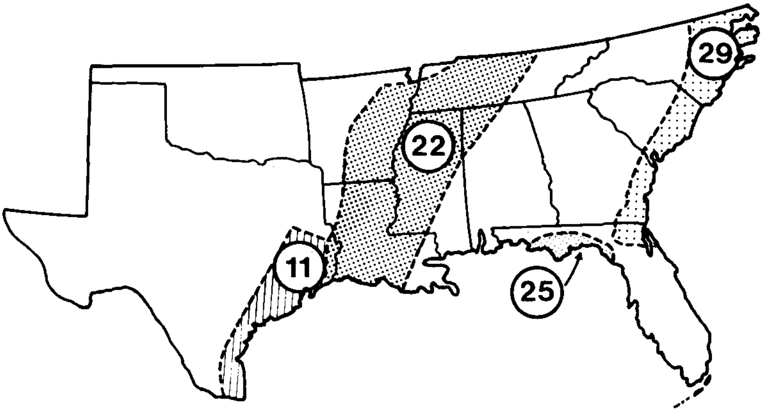


Figure 6. Geographic distribution of average growing-season runoff volume (from Stewart et al. 1976a).

even though the rainfall factor may be identical in many locations. For example, in Area 22, which includes the lower Mississippi Valley, an *R* value of 400 is likely to be distributed more evenly over the year than would be the same value in Area 29, along the southeastern Atlantic Coast.

Runoff occurrence relative to pesticide application becomes increasingly important in determining losses as the longevity of the compound decreases. Many studies have shown that runoff from the first few storm events following application of short-lived pesticides contains most of the material that will eventually be transported from the fields (cf. Smith et al. 1978, White et al. 1976, Willis et al. 1975, Caro et al. 1974, Bovey et al. 1974). Similar results have been demonstrated for longer-lived insecticides (e.g., Willis and Hamilton 1973, Caro and Taylor 1971, Caro et al. 1972), but significant losses of these compounds may also occur months after application. This was shown particularly well for toxaphene applied to cotton on an experimental farm in the Mississippi Delta, where runoff concentrations were highest following summer application, but sediment and pesticide yields were greatest during the spring tillage period (Willis et al. 1976).

Three types of runoff events are important relative to pesticide transport and effects (Wauchope 1978): (1) storms that occur within two weeks of pesticide application, yield at least one centimeter of rain, and produce a runoff volume that is 50 percent or more of total precipitation. (Unless the pesticide is incorporated or is very persistent, these events produce most of the runoff losses likely to occur during a season); (2) events producing runoff losses of 2 percent or more of the



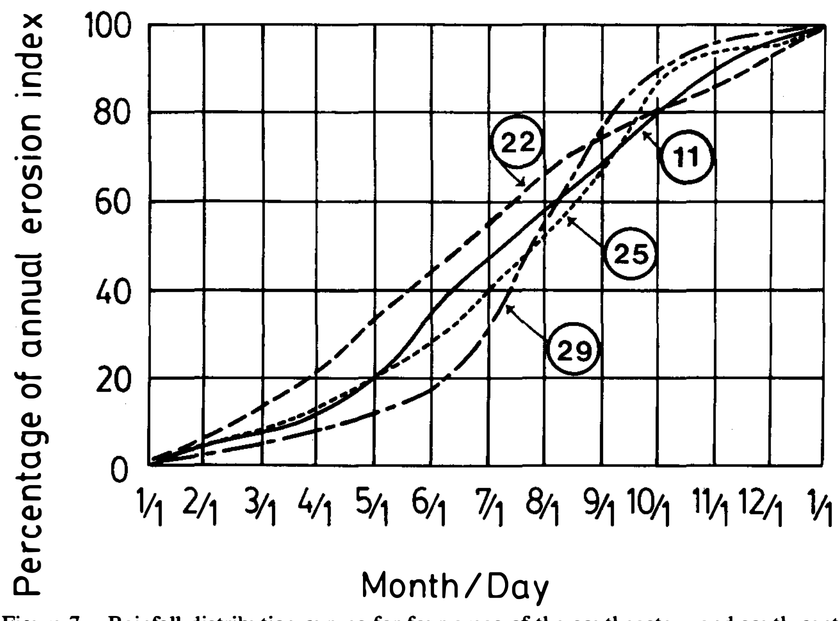


Figure 7. Rainfall distribution curves for four areas of the southeastern and south-central United States (from Wischmeier and Smith 1965).

amount of pesticide applied. (This is an arbitrary categorization identifying storms that move large quantities of chemicals); and (3) events producing small runoff volumes occurring while pesticide residues in the field are high—and therefore producing high concentrations in the runoff. (Although total pesticide losses might be small, the effects of these short-term, high concentrations can be severe).

Many land-use practices that determine the loss of soils and soil-associated pesticides also influence runoff and the loss of soluble pesticides. In general, practices that reduce erosion also reduce runoff, but to a lesser extent (Woolhiser 1976). A series of rainfall versus runoff curves (Figure 8) illustrates these relationships. For curve 100, for example, rainfall equals runoff; there is no infiltration. As the curve numbers decline, so does runoff percentage. Table 2 lists the curve numbers that describe runoff patterns for certain land uses and practices on various types of soil in several hydrologic conditions. Soil types grade from A, with high infiltration capacity, to D, heavy clay soils with little infiltration capacity. Hydrologic conditions grade from "good" to "poor" depending on infiltration ability and recent land use. Curve numbers generally decrease from highest (>90) in the upper right corner (fallow and straight-row crops on heavy soil) to lowest in the lower left (pasture, meadow, or woods on well-drained soils). This gradation corresponds to a change from most of the rainfall associated with a storm event ending up as runoff at curve 90 to almost none at curve 20 (Figure 8). However, for a given crop and soil condition, such as straight row versus contoured row crops on Type D soils, farming practices have relatively little effect on runoff quantity. Soil moisture content, relative to its water storage capacity, also influences runoff; runoff tends to increase as total rainfall during the 5 days preceding a storm event increases (Stewart et al. 1976b).

Land use affects the timing of runoff as well as the quantity. A comparison of runoff curves for adjacent farmed and forested watersheds (Figure 9) illustrates how a forested watershed's surface litter greatly retards water movement, allowing water to infiltrate the soil and enter streams over a longer period. Despite similar runoff volumes and peak flow timing, runoff is more episodic in the farmed watershed. In fact, overland flow may be completely lacking in some undisturbed watersheds (Hewlett and Nutter 1970).

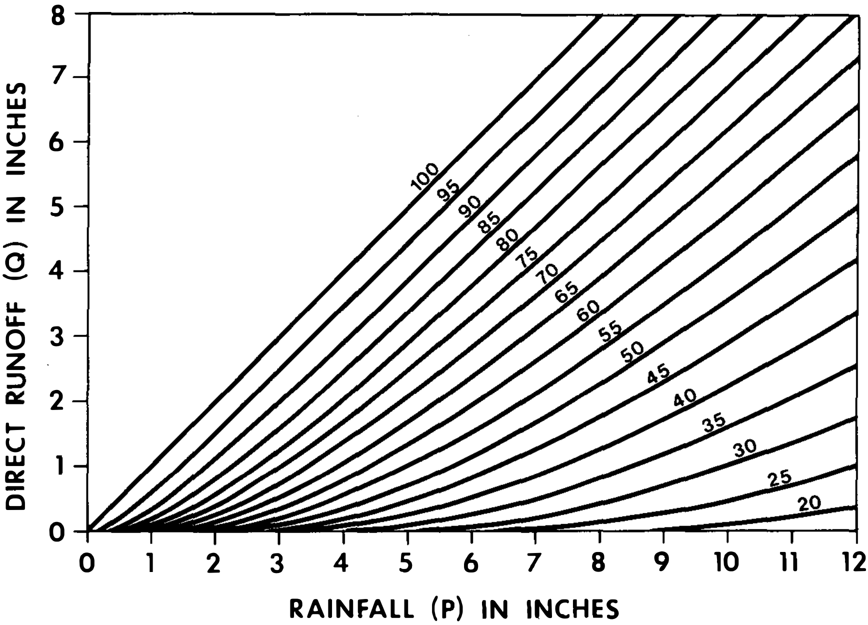


Figure 8. Runoff vs. rainfall curves (from Maukus 1969, Stewart et al. 1976b).

Table 2. Representative runoff curve numbers for hydrologic soil-cover complexes (adapted from Maukus et al. 1969 and Stewart et al. 1976b).

Land use, cover, and treatment or practice[a]	Hydrologic condition[b]	Hydrolic soil group[c]			
		A	B	C	D
Fallow					
SR	—	77	86	91	94
Row crops					
SR	P	72	81	88	91
SR	G	67	78	85	89
C	P	70	79	84	88
C	G	65	75	82	86
CT	P	66	74	80	82
CT	G	62	71	78	81
Small grain					
SR	P	65	76	84	88
SR	G	63	75	83	87
C	P	63	74	82	85
C	G	61	73	81	84
CT	P	61	72	79	82
CT	G	59	70	78	81
Close-seeded legumes or rotation meadow[d]					
SR	P	66	77	85	89
SR	G	58	72	81	85
C	P	64	75	83	85
C	G	55	69	78	83
CT	P	63	73	80	83
CT	G	51	67	76	80
Pasture or range	P	68	79	86	89
	F	49	69	79	84
	G	39	61	74	80
C	P	47	67	81	88
	F	25	59	75	83
	G	6	35	70	79
Meadow	G	30	58	71	78
	P	45	66	77	83
	F	36	60	73	79
	G	25	55	70	77
Farmsteads	—	59	74	82	86
Roads[e]					
Dirt	—	72	82	87	89
Hard surface	—	74	84	90	92

[a]SR = straight row; C = contoured; CT = contoured and terraced.
[b]Relative infiltration capacity based on previous land-use practices: P = poor; F = fair; G = good.
[c]Relative infiltration capacity based on soil characteristics: A > B > C > D.
[d]Close-drilled or broadcast.
[e]Including right-of-way.

The Lower Mississippi Alluvial Plain

In light of the previously discussed principles, potential pesticide transport in the lower Mississippi alluvial plain can be evaluated. The erosive force of rainfall in this region is the highest east of the Rocky Mountains (Figure 5), and it is distributed rather evenly over the year (Figure 7). Runoff volume is also great (Figure 6). Because of the wet climate and the high clay content, and resulting poor drainage of many Delta soils, winter and early spring moisture levels are frequently too high to permit seedbed preparation. Consequently, fields are prepared as early as possible after harvest in the fall or early winter, leaving the soil unprotected through the wet winter and the early stages of crop development the

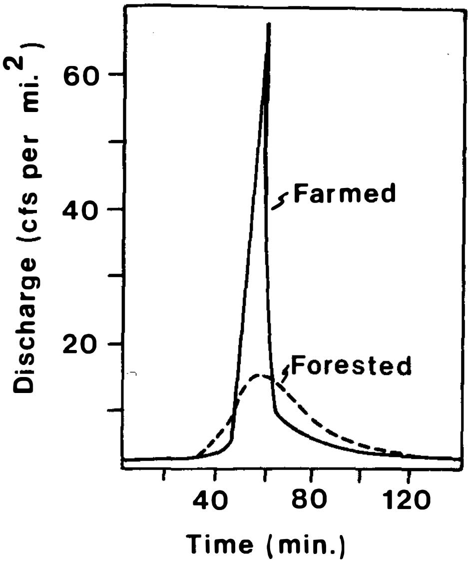


Figure 9. Discharge from adjacent farmed and forested watersheds (from Karr and Schlosser 1977).

following spring (Murphree et al. 1976, Willis et al. 1976). Furthermore, the high silt content of the soils makes them highly erodible. The results of this combination of agricultural practices, climatic factors, and soil conditions is high erosion and water yields despite the flatness of the floodplain. For example, Murphree et al. (1976) estimated that nearly 3,000 metric tons/km^2 of sediment—nearly twice the U.S. cropland average (Table 1)—were exported in one year from an experimental watershed in the Mississippi Delta planted to cotton.

Compared with farming practices in some other areas of the United States, agriculture in the Delta depends heavily on chemicals to control insects, fungi, nematodes, and weeds, and to defoliate cotton. To illustrate the relative intensity of chemical use, Table 3 summarizes some statistics compiled by the U.S. Department of Agriculture on the use of pesticides by farmers during 1976. Acreage and pesticide uses are compared for the major crops of the "Corn Belt" states (Missouri, Iowa, Illinois, Indiana, and Ohio) and the "Delta States" (Louisiana, Arkansas, and Mississippi). Table 4 lists the quantities of the major pesticides used by farmers in these two regions.

The major crops in the Delta States (corn, cotton, and soybeans) accounted for a total of 73 percent of the area's 13.5 million cropland acres (5.5 million ha); 53 percent were planted in soybeans, 18 percent in cotton, and 2 percent in corn (Table 3). The fourth most important crop was rice. Corn and soybeans together accounted for 75 percent of the 64.4 million cropland acres (26.1 million ha) in the Corn Belt—46 percent in corn and 29 percent in soybeans. Wheat was the next most important crop. Croplands accounted for nearly identical proportions of total farmland in both areas, indicating similar farming intensities.

Herbicide use patterns for the major crops differed substantially between the two regions (Table 3). Of the acreage planted in corn, only 57 percent was treated in the Delta States, but 96 percent in the Corn Belt, was treated. As a result, Delta

Table 3. Acreage and pesticide use in row crop production during 1976 for two regions of the United States (data from Eichers et al. 1978).

Crop and region	Area planted		Herbicide use			Insecticide use		
	Thousands of acres	Percent of total farmland	Amount used (thousands of lbs)	Percent of acreage treated	Application rate (lb/acre)[a]	Amount used (thousands of lbs)	Percent of acreage treated	Application rate (lb/acre)[a]
Corn								
Delta States	405 (163.9 ha)	2	387 (175.7 kg)	57	1.7	22 (10.0 kg)	60	0.1
Corn Belt	39,702 (16,079.3 ha)	46	108,037 (49,005.6 kg)	96	2.8	14,091 (6,391.7 kg)	91	0.4
Cotton[b]								
Delta States	3,342 (1,353.5 ha)	18	11,562 (5,244.5 kg)	100	3.5	32,653 (14,811.4 kg)	100	9.8
Soybeans								
Delta States	9,845 (3,987.2 ha)	53	15,241 (6,913.3 kg)	88	1.8	173 (78.5 kg)	89	0.020
Corn Belt	24,700 (10,003.5 ha)	29	41,505 (18,826.7 kg)	92	1.8	115 (52.2 kg)	92	0.005
Total								
Delta States	13,592 (5,504.8 ha)	73	27,190 (12,333.4 kg)	90	2.2	32,848 (14,899.8 kg)	91	2.7
Corn Belt	64,441 (26,098.6 ha)	75	149,542 (67,832.2 kg)	95	2.4	14,206 (6.443.8 kg)	91	0.2

[a]Total pounds used/total acres treated
[b]No cotton planted in Corn Belt

Table 4. Herbicides and insecticides most heavily used by farmers in two regions of the United States during 1976 (data from Eichers et al. 1978).

Pesticide	Delta States		Corn Belt	
	Thousands of pounds used	Percent of total	Thousands of pounds used	Percent of total
Herbicides				
Trifluralin	10,349 (4,694.3 kg)	31	6,764 (3,068.2 kg)	4
Propanil	5,022 (2,278.0 kg)	15	0	
Fluometuron	4,652 (2,110.1 kg)	14	0	
Arsenicals[b]	3,054 (1,385.3 kg)	9	0	
Bentazone	2,367 (1,073.7 kg)	7	741 (336.1 kg)	<1
Alachlor	1,472 (667.7 kg)	4	56,690 (25,714.6 kg)	37
Atrazine	554 (251.3 kg)	2	42,131 (19,100.6 kg)	31
Butylate	28 (12.7 kg)	<1	11,303 (5,127.0 kg)	7
2,4-D[c]	360 (163.3 kg)	1	7,552 (3,425.6 kg)	5
Total used	33,921 (15,386.6 kg)	82	155,277 (70,433.6)	80
Insecticides				
Methyl parathion	12,450 (5,647.3 kg)	37	315 (142.8 kg)	2
Toxaphene	10,109 (4,585.4 kg)	30	594 (269.4 kg)	4
EPN[d]	6,032 (2,736.1 kg)	18	0	
Chlordimeform	2,727 (1,237.0 kg)	8	0	
Phorate	0		3,560 (1,614.8 kg)	23
Dyfonate	0		2,323 (1,053.7 kg)	15
Carbofuran	39 (17.7 kg)	<1	2,194 (995.2 kg)	14
Terbufos	0		2,001 (907.6 kg)	13
Heptachlor	0		1,569	10
Total used	33,710 (15,290.8)	93	15,738 (7,138.8 kg)	80

[a]Active ingredient (from Eichers et al. 1978)
[b]Monosodium methanearsenate (MSMA)+ disodium methanearsenate (DSMA)
[c]2,4-dichlorphenoxyacetic acid
[d]ethyl *p*-nitrophenyl thiono-benzenephosphonate

State farmers used only 387,000 pounds (175,543 kg) of herbicides on corn in 1976 as opposed to 108 million pounds (49 million kg) in the Corn Belt. The average application rate for corn (total pounds used/total acres treated) was also higher—2.8 for the Corn Belt, 1.7 in the Delta States. Regional herbicide use patterns for soybeans were more similar; most of the acreage was treated (88 percent in the Delta States, 92 percent in the Corn Belt), and the average application rate was 1.8 lb./acre in both regions (Table 3). Differences in the totals for soybeans reflected the greater treated acreage in the Corn Belt (Table 3).

Cotton production accounted for 42.5 percent of the 27.2 million pounds (12.3 million kg) of herbicides used in the Delta States; virtually all the acreage in cotton during 1976 was treated at an average rate of 3.5 lb/acre, the highest of any major crop in either area (Table 3). However, the average application rate for all cropland was about the same for both areas (Table 3).

Major regional differences in the herbicides used during 1976 were apparent. Six chemicals accounted for 80 percent of the herbicides used in the Delta States (Table 4): trifluralin, used in both cotton and soybeans; the arsenicals and fluometuron, used in cotton; the rice herbicide propanil; and the soybean herbicides bentazone and alachlor. In the Corn Belt, the corn and soybean herbicides alachlor, atrazine, and butylate, along with 7 million pounds (3.2 million kg) of 2,4-D (used primarily in growing wheat) accounted for 76 percent of the herbicides used. Of the herbicides used on corn, cotton, and soybeans only the methylated arsenicals (MSMA, DSMA) can be considered persistent and likely to be associated with high runoff losses. However, trifluralin is relatively toxic to fish (Stewart et al. 1976a), and atrazine is toxic to immature stages of frogs (Mauck and Olson 1976, unpublished).

Insecticide use patterns also differed substantially for the two regions. In the Delta States, 32.6 million pounds (14.8 million kg) of insecticides, largely methyl parathion (12 million pounds [5.4 million kg], toxaphene (10 million pounds [4.5 million kg]), EPN (6 million pounds [2.7 million kg]) and chlordimeform (3 million pounds [1.4 million kg]) were applied to cotton, and 100 percent of the cotton acreage was treated (Tables 3 and 4). Toxaphene, a persistent organochlorine compound, is highly toxic to fish (Johnson and Finley, in press). The compound has been used as a fish eradicant (e.g., Hooper and Grzenda 1957), and residues from agricultural runoff entering lakes and ponds in Mississippi have caused fish kills (Cotton 1977, Bradley et al. 1972). In 1976, over 2 million pounds (900,000 kg) of toxaphene were applied to soybeans in the United States. However, most of this was in the Southeast; virtually all the toxaphene used in the Delta States was applied to cotton (T. Eichers, U.S. Dep. Agriculture, pers. comm., 1980). The average insecticide application rate for cotton in the Delta States was about 10 lb./acre.

Corn farming accounted for most insecticide use in the Corn Belt, where 14 million pounds (6.3 million kg) of mostly organophosphorus and carbamate compounds were applied to 91 percent of the corn acreage (Tables 3 and 4). Of the corn insecticides listed in Table 4, heptachlor, carbofuran, and terbufos have caused fisheries or wildlife problems. Of these, only heptachlor, an organochlorine compound, can be considered persistent and it is no longer in use (although significant residues will remain for some time). Except for terbufos, the shorter-lived organophosphorus and carbamate insecticides in Table 4 are more toxic to invertebrates than to fish. Like herbicides, their effects on aquatic communities are therefore more subtle, occurring at lower trophic levels, and are harder to detect because there is usually no fish kill. Also, these classes of compounds are not generally bio-concentrated or accumulated to any great degree; hence, unlike organochlorine insecticides, there is usually little or no residue.

The average insecticide application rate for soybeans was much higher in the Delta States than in the Corn Belt (Table 3). As a result, 173,000 pounds (78,473 kg) of mostly carbaryl, azinphosmethyl (Guthion), and methyl parathion (Newson et al. 1975) were applied to 8.2 million acres (3.3 million ha) in the Corn Belt (Tables 3 and 4). Because of this use, as well as heavy use on cotton, total insecticide application averaged 2.7 lb/acre in the Delta States as opposed to 0.2 in the Corn Belt (Table 3).

Agriculture in the Delta States also required substantial use of other chemicals in 1976. For example, in addition to insecticides and herbicides, 2 million pounds (900,000 kg) of the defoliants sodium chlorate and DEF (S,S,S-tributylphosphorotrithioate) and 3.4 million pounds (1.5 million kg) of the soil fumigant PCNB (pentachloronitrobenzene) were used in cotton production (Eichers et al. 1978). Soybean production in the Delta States required 1.8 million pounds of the soil fumigant DBCP (dibromochloropropane—none was used in the Corn Belt), and Delta States agriculture in general required substantial quantities of the fungicides captan and benomyl (Eichers et al. 1978), which are both highly toxic to fish (Johnson and Finley, in press).

Conclusions

The combination of current agricultural practices, climatic factors, and prevailing soil conditions suggests that there is more risk of toxic materials reaching and accumulating in aquatic systems in the lower Mississippi region than in some other geographic areas farmed with equal intensity. It is not surprising, then, that fish from the Yazoo River, which drains the Mississippi Delta, contain higher toxaphene, DDT, and endrin residues than fish from any other station in the National Pesticide Monitoring Program (U.S. Fish and Wildlife Service, Columbia National Fisheries Research Laboratory, unpublished data) along with substantial residues of other organochlorine insecticides and arsenic. Although the toxicological effects of such chemical combinations are difficult to define, the fishery resource losses that have resulted have been well publicized.

Agricultural practices are changing. The current trend toward reduced tillage, brought about largely by rising energy costs, should generally increase soil conservation. The limited data presently available (e.g., Baker et al. 1978, Willis et al. 1976, Triplett et al. 1978) suggest that the reduced transport of sediment-associated pesticides achieved through incorporation of these farm practices may negate some of the potential environmental consequences of increased herbicide use required in reduced tillage farming. More definitive research in this area is needed, especially to determine the effects of long-term exposure of aquatic communities to low levels of water soluble compounds. Other farming techniques, including optimization of planting time and pesticide placement, planting of resistant crop varieties, crop rotations, trap plots, and biological controls (e.g., Newson et al. 1975, Stewart et al. 1976a, Gilman et al. 1978, Crawford et al. 1972, Woolf and Brugman 1973) substantially reduce the quantity of pesticides necessary for profitable crop production. As a result, recommended application rates are declining (e.g., Newsom et al. 1975), and fewer persistent compounds are being used. Cotton acreage, with its heavy pesticide requirements, is also decreasing. Nevertheless, agriculture in the Delta States will probably still require high rates of pesticide application relative to other areas, and recent evidence (Coleman 1979) suggests that even short-lived compounds draining from farmland may threaten aquatic resources.

Bottomlands in the Lower Mississippi Valley are rapidly being cleared and brought into crop production (Frey and Dill 1971, Sternitzke 1976, Yancey 1969). Increasing the amount of land farmed for row crops will obviously increase the quantities of pesticides to which aquatic ecosystems in this region will be exposed. Compared with other areas, climatological and soil conditions are conducive to the transport of materials from the land's surface to receiving water bodies. Consequently, agricultural chemicals are likely to find their way into and possibly threaten aquatic resources as a result of these land-use changes.

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Management of Lowland Hardwood Wetlands for Wildlife: Problems and Potential

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The Mississippi River Delta has changed dramatically since Europeans arrived on this continent. The loss of over 20 million acres (8 million ha) of the original 25 million acres (10 million ha) of lowland hardwood habitat and its conversion to row crops is one of the most obvious changes (MacDonald et al. 1979). Structural attempts to control natural water flow are in evidence everywhere in the form of levees, ditches, dug channels, dams, diversions, by-passes, and pumping stations. Numbers of once-common wildlife have decreased dramatically and other wildlife species have become extinct or extirpated. The passenger pigeon *(Ectopistes migratorius),* Carolina parakeet *(Conuropsis carolinensis),* ivory-billed woodpecker *(Campephilus principalis),* and Bachman's warbler *(Vermivora bachmanii)* are reminders of a lost heritage. Swamp rabbit *(Sylvilagus aquaticus)* numbers are reduced and usually require forested areas of 600 acres (250 ha) or more for survival (Korte and Fredrickson 1978). Black bear *(Ursus americanus),* mountain lion *(Felis concolor),* and river otter *(Lutra canadensis)* are reduced greatly in numbers and distribution.

The combined effects of water resource developments, government subsidies, the introduction of soybeans as a cash crop, a developing agricultural technology, and other factors result in the continuing demise of southern swamps (Korte and Fredrickson 1977). In this process, the natural phenomena that controlled and maintained the vitality of this productive system were overlooked. As forested areas disappeared in the lower Mississippi drainage, there was an increasing concern for maintaining adequate wildlife habitat and areas for future generations to enjoy. The designation of lowland hardwoods as priority 7 for acquisition by the U.S. Fish and Wildlife Service is a recent positive step that assures some hardwood habitats will be saved. Nevertheless, inadequate funds and current public opposition to large acquisition programs preclude adding more than a few key areas as public lands.

Lowland hardwood forests are complex systems. Functionally, these southern forests probably have many similarities to tropical rain forests and fewer similarities to North American forests where our understanding is more complete. Our lack of understanding of energy flow and other natural processes in wetland forested systems reduces our effectiveness in making good decisions for acquisition, protection, and management (Mooney et al. 1980). Biologists are just beginning to recognize the delicate balance between physical condition, breeding potential, and wintering habitat of waterfowl. Previously, our main research thrust to enhance duck production was geared toward breeding ground studies, but wintering needs were largely overlooked (Fredrickson and Drobney 1979). The maintenance of highly productive populations of migrant birds, including the highly prized mallard *(Anas platyrhynchos),* necessitates protection and management of lowland hardwood wetlands. An understanding of the allocation of time and energy by wintering birds is essential in the development of optimum management strategies. As we understand how, when, and where energy becomes available to wildlife, our appreciation of the lowland hardwood system is enhanced and we can improve our efforts at protection, management, and acquisition. For example, Section 404 of the 1977 Clean Water Act provides a legal base for wetland protection. When regulatory agencies only recognize a part of the lowland hardwood wetland, the cypress zone, under Section 404, the regulation only provides protection for wetter portions of the wetland rather than the larger functional unit.

The purpose of this paper is to emphasize the importance and the difficulty of whole system management. An understanding of wood duck *(Aix sponsa)* behavior and this species' allocation of time and energy is used in this paper to gain an insight into how obvious and subtle habitat manipulations, man-made or natural, affect wildlife and their survival.

Lowland Hardwood Wetlands

Undisturbed lowland hardwood wetlands are dynamic systems where short- and long-term water fluctuations are dominant forces that control plant and animal communities. Short-term water cycles are dependent on local rainfall or headwater flooding from midwinter until early summer. Mean annual rainfall within the Mississippi Delta is 45 inches (114 cm) in southeastern Missouri and increases at more southerly locations (Fredrickson 1979*a*). Mean monthly rainfall generally increases in November and is highest during March, April, and May when amounts regularly exceed 4 inches (11 cm) monthly and cause annual spring flooding (Knauer 1977). Nevertheless, usually heavy rainfall of 6 inches (14 cm) or more may occur during any month in this region. These annual variations in rainfall determine the extent of flooding; extensive flooding is usually concurrent with heavy rainfall. Because lowland hardwood wetlands within the Mississippi Delta are usually associated with riverine systems, backwater flooding is also important. The combination of local rainfall and backwaters results in unusually deep flooding at infrequent intervals.

Drainage is poor throughout the Mississippi Delta because of the generally flat landscape. The low relief from meander scars and other landforms characteristic of riverine systems further impedes water flow. The rate of drainage is slowed further by naturally occurring log jams as well as by beaver *(Castor canadensis)* impoundments. Poor drainage and variable rainfall coupled with occasional backwater flooding results in a great diversity of flooding on any given wetland tract. The lowest elevations may hold permanent water except during the driest years, whereas some higher sites may have surface water no more than 1 year in 10. In contrast to flood conditions, high temperatures and reduced rainfall in late summer and early fall result in drought conditions that have another important impact on this dynamic wetland system.

Woody and herbaceous vegetation within lowland hardwood wetlands has a zonation or diverse horizontal distribution pattern that reflects differing elevations or water depths (Bedinger 1979a, 1979b, Fredrickson 1979c). The pattern occurs in response to flooding regimes where differences in the timing, depth, and duration of flooding have important impacts on the germination, establishment, and growth of plants. The lowest sites that are flooded the longest have the most water-tolerant trees such as baldcypress *(Taxodium distichum)* and water tupelo *(Nyssa aquatica)*. Moving upward in elevation, overcup oak *(Quercus lyrata),* pin oak *(Q.*

palustris), willow oak *(Q. phellos),* and shagbark hickory *(Carya ovata)* occur at locations where water depths are less during flooding and the duration of flooding is gradually reduced. Submergents such as watermilfoil *(Myriophyllum* sp.*)* or watershield *(Brasenia schreberi)* occur in permanent water in the lowest sites. Then moist soil plants such as smartweeds *(Polygonum* sp.*)*, barnyardgrass *(Echinochloa* sp. *)*, and beggarticks *(Bidens* sp. *)* occur on intermediate elevations after waters recede. Terrestrial vegetation occurs at the highest elevations and may be more widespread during dry years.

Severe deep flooding also has important impacts on the wetland plant community. For example, 7 percent of the oaks on a Missouri site suffered mortality after a summer flood in 1973. Large mature pin oak and cherrybark oak *(Q. farcata* var. *pagodaefolia)* were the most obvious victims of summer flooding where water was 40 inches (100 cm) deep for a month or more during the growing season. This type of mortality results in single tree openings within the forest canopy that are particularly valuable for wildlife. After several years, downed limbs and trunks from these large trees provide cover for swamp rabbits and other animals. Herbaceous plants, such as *Carex* species, develop within these openings and serve as a readily available forage. The species composition of the woody and herbaceous growth within these new openings reflects current flooding conditions and results in a patchy environment. Both structure and plant composition may be very different from the surrounding forest. Waterfowl congregate in great numbers in these openings where moist soil seeds are produced.

Although water cycles in southern hardwoods are erratic, these cyclic phenomena resemble the dynamic situation that occurs within glacial prairie marshes in the northcentral United States where wet-dry cycles normally result in the development of submergents and the elimination of many emergents every 3 to 7 years (Weller 1978). Drying of basins or fluctuating waters are required in both systems for the establishment of wetland plants. Undoubtedly, productivity varies within lowland hardwood wetlands in relation to the water cycles, but these changes are not well documented (Conner and Day 1976). Prairie nesting waterfowl respond to favorable habitat and abundant food resources when prairie wetlands are reflooded, and have higher recruitment during the wet phase of the prairie wetland cycle. The complexity of hardwood communities and the secretive habits of wood ducks and hooded mergansers *(Mergus culcullatus)* make correlations between habitat conditions and the productivity of these two species very difficult.

The Wood Duck

Wood ducks frequent forested habitats from southern Canada southward throughout the United States east of the Rocky Mountains and in the West from California into Washington. The primary distribution includes the Mississippi Delta where lowland hardwood wetlands are in abundance (Bellrose 1976). Wood ducks have evolved in response to adaptive pressures within these southern wetlands (Drobney 1977, Scherpelz 1979). Their specific habitat requirements restrict their distribution to wooded wetlands (Weller 1964:54). Because of their fitness for life within lowland hardwood wetlands, habitat requirements and the allocation of time and energy by wood ducks provide an insight into how natural and man-made impacts influence the survival and reproductive potential of wildlife.

Although male wood ducks are often described as the most gaudy of all North American waterfowl, the white and irridescent feathers are cryptic when the disruptive color pattern is viewed in flooded timber with intermittent light (Scherpelz 1979). Males are obvious at short distances, but at a distance they remain well camouflaged in the vegetation normally occurring in wooded wetlands. The diverse vocalizations of wood ducks are another adaptation to forested habitats. In these wooded wetlands where visual signals are of limited value, vocalizations concentrate, orient, and synchronize birds for courtship, and enable hens to synchronize the exodus of their broods from nesting cavities (Gottlieb 1963, Scherpelz 1979).

The lack of site attachment allows wood ducks to exploit food resources in a dynamic environment where waters are constantly fluctuating. The constant water fluctuations within southern forested wetlands in spring and the restricted feeding mode of wood ducks require that food resources must be exploited opportunistically. Pairing begins in September and paired males provide the protection to allow females to feed unmolested before and during egg laying (Korschgen and Fredrickson 1976, Drobney and Fredrickson 1979). Although wood ducks feed in fields on occasion (H. George, California; R. Palermo, Louisiana; C. Endicott, Missouri; pers. comm.), this species consistently uses natural wetlands more than many other anatids (Knauer 1977, Taylor 1977). The digestive tracts of all 166 wood ducks that were examined for foods consumed in Missouri during spring and early fall contained naturally occurring foods. Only 4 birds consumed a cultivated food (soybeans) even though all birds were collected within 0.3 miles (0.5 km) of crop fields (Drobney and Fredrickson 1979).

An examination of energetics and foods consumed in relation to breeding status further verifies the importance of natural lowland hardwood wetlands. Wood duck breeding strategy requires that enough high energy foods are consumed before egg laying to accumulate the endogenous lipid reserves equivalent to a clutch of eggs (Drobney 1977). These lipids are acquired from readily available environmental sources such as ash *(Fraxinus* sp.), elm *(Ulmus* sp.), and maple seeds *(Acer* sp.) as well as from acorns, seeds of buttonbush *(Cephalanthus occidentalis),* watershield, and other aquatic and semi-aquatic plants. Laying cycles are initiated once nesting hens weigh about 1.7 pounds (760 g). At this weight, hens appear to have enough lipid reserves to lay about 12 eggs. The most critical food resource, however, is protein because it must be acquired from exogenous sources over an 18 day period immediately before and during egg laying (Drobney 1977). Protein resources are readily available in lowland hardwood wetlands as the macroinvertebrates that are normally associated with leaf litter (Hubert and Krull 1973). Amphipods, isopods, gastropods, insects and arachnids are usually present. During January, macroinvertebrate biomass from leaf litter within the flooded pin oak zone is 0.14 gram per square foot (1.5 g/m^2, dry weight) in Missouri (D. White, pers. comm.). On a dry weight basis, this is equivalent to about 14 percent of the standing crop of acorns (McQuilken and Musbach 1977). The diverse protein sources in these natural wooded wetlands have a diversity of amino acids that are common to wood duck eggs. These specific energy and protein requirements exploited by wood ducks clearly delineate the importance of natural wetlands where dynamic water fluctuations are the rule.

A restrictive requirement for breeding wood ducks is an abundance of tree holes used for nesting sites (Weller 1964). The cavity dimensions suitable for use dictate that trees at least 16 inches (40 cm) dbh provide the majority of cavities sufficiently large for use by wood ducks (Weier 1966). Competition for these scarce cavities among wood ducks and other wildlife such as squirrels *(Sciurus* sp. *)* may limit recruitment (Weier 1966, Bellrose 1976). The excellent homing tendencies of wood ducks assure that successful hens are likely to return to the same cavities in subsequent years. Some hens have returned to specific sites in Missouri for as many as nine consecutive years. Hens with precise homing tendencies not only account for the majority of the annual recruitment, but produce female offspring with similar homing and recruitment tendencies. In Missouri, about 80 percent of the breeding females return to nest in the same general area (within 0.25 mile) and 26 percent regularly return to the same nest site (Hartman 1972, Clawson 1975). Attempts to attract wood ducks to new nest boxes only 0.5 mile from dense populations have been largely unsuccessful in Missouri.

Early pairing, such as occurs in wood ducks, is advantageous where nest sites are limited (Orians 1969). Dump nesting is a common phenomenon in wood duck populations and may, in part, replace losses caused by predation or disturbance from nest site use by other species (Clawson et al. 1979). Although dump nesting is reported regularly from populations using nest boxes (Grice and Rogers 1965, Jones and Leopold 1967, Morse and Wight 1969, Heusmann 1972), wild populations also exhibit this laying behavior (G. Haramis, D. Gilmer, pers. comm.). Because young hens may lay eggs but fail to incubate them, and because all ages of wood ducks commonly lay in other wood duck nests, and because wood ducks regularly incubate more eggs and rear more young than the number of eggs in the average clutch, dump nesting probably makes efficient use of scarce nest sites.

The annual chronology of events determines the types and locations of habitats required for wood duck survival. Wood ducks are resident birds throughout the South and normally move to and from southern wetlands within a general framework of calendar dates. Wintering wood ducks form loose aggregations and utilize the more permanent water areas where buttonbush, swamp privet *(Forestiera acuminata),* waterelm *(Planera aquatica),* baldcypress, and water tupelo occur. Other zones with oaks and pecans *(Carya* sp. *)* are exploited when flooding makes mast and other food resources available there. Local birds in the South begin prenesting activities before all migrants depart for northern nesting areas (Bellrose 1976). The movement into the northern extremity of the Delta normally occurs during the third week of February (Hansen 1971, Bellrose 1976), but the initiation of laying is dependent on temperature and food resources. Paired males leave their females soon after incubation begins and move to molting areas (Gilmer et al. 1977, Clawson et al. 1979). Based on returns from Missouri web-tagged wood ducks, young initiate a postbreeding dispersal toward the north after fledging. Wood ducks form spectacular fall concentrations on traditional staging areas usually associated with wooded wetlands before their return to wintering areas (Hein 1961).

Water Resource Developments

Subsistence exploitation by native Americans was commonplace throughout the Mississippi Delta before Europeans arrived in North America. Undoubtedly, the abundance of Indians in this area reflected the availability of natural foods in these forested wetlands. Following the Louisiana Purchase, conversion of lowland forests to rowcrops gradually increased as agriculture and technology expanded and as America's population increased. Eventually, some lands were placed in public ownership, but timber and wildlife management goals continued to have important implications for these wetland habitats even though the forests were not destroyed.

Drainage attempts before 1900 were largely unsuccessful because capital was not available, equipment for digging large channels was not developed, and hydrologic cycles were poorly understood (Korte and Fredrickson 1977). By 1900 the dipper dredge and the necessary capital for major drainage attempts were available. Drainage by some organized districts achieved success, but many attempts were failures. Successful drainage efforts resulted in a gradual conversion of wetland forests to rowcrops. Soybeans are particularly well adapted to soils in the Mississippi Delta and mature in the short period between the annual spring flooding and frost. Potential economic gains from soybean production were largely responsible for forest clearing of wetter sites since 1950 (MacDonald et al. 1979:54).

As drainage practices improved, agriculture continued to develop, rural populations expanded, and towns and cities developed along rivers in response to the increased flow of goods to and from agricultural areas. Eventually, levees were constructed to protect agricultural and commercial properties. By 1976 there were 2,186 miles (5,400 km) of main stem levees with another 1,050 miles (2,600 km) of levees along streams away from the main stem of the Mississippi (MacDonald et al. 1979). Levees have two important impacts on natural flooding regimes. Protected areas outside levees lack normal water fluctuations. Here, forests are either cleared and converted to rowcrops or forests become dryer and no longer maintain their wetland character (J. Gosselink, pers. comm.). Inside the levees, flooding may occur for longer periods at greater depths. Hence, leveed areas have stabilized or static water regimes that are either dryer or wetter than the natural dynamic water fluctuations. The intermediate water fluctuations no longer occur and the plant and animal communities associated with the former water regimes disappear (Table 1).

Channelization decreases flooding duration, depth, and frequency. As flooding regimes are modified, forest species composition changes (Conner and Day 1976, Fredrickson 1979a). Where forests remain, flood waters recede so rapidly that plant composition shifts toward species more characteristic of dryer sites and some wetland wildlife no longer find these areas attractive. As flooding lessens on wooded sites after channelization, landowners convert forests to rowcrops (Holder 1970).

Upstream reservoirs also modify normal water cycles. Flood waters held in reservoirs reduce the depth and duration of downstream flooding. Reservoir waters that are released during dry periods may cause lowland flooding out of the normal flooding cycle. Such modifications in water cycles result in subtle changes in the composition of forest plants (Table 1).

The obvious and significant impact of agriculture on forests is the removal of trees. Nevertheless, some wildlife regularly use crop fields where they feed on waste grain (Bossenmaier and Marshall 1958). Even though fields throughout the Mississippi alluvial plain may be flooded regularly in winter and spring, tillage

Table 1. Probable effects of water resource developments on lowland hardwood wetlands and on wood duck habitat.

Development	Effects on lowland hardwood wetland[a]		Effects on wood duck habitat[b]	
	Positive	Negative	Breeding	Wintering
Agriculture	1	2	8,9,10	16
Channelization	1	2,3,4	9,10,12	16
Drainage	1	2,3,4	9,10,12	16
Levees				
Areas within	5	4	13,14	17
Areas outside	1	2,3,4	9,10,12	16
Upstream reservoirs	1	2,3,4	9,10,12	16
Greentree reservoirs	6	4,7	15	18

[a]Wetland effects: 1 = None, 2 = Forests cleared, 3 = Flooding reduced, 4 = Composition of trees shifts toward less water tolerant species, 5 = Some forests remain, 6 = Makes plant foods available early in fall, 7 = Static water levels.
[b]Habitat effects: 8 = No aquatic macroinvertebrates, 9 = Fewer nest sites, 10 = Reduced cover, 11 = Reduced flooding, 12 = Fewer aquatic macroinvertebrates, 13 = Deep water precludes feeding on many sites, 14 = Turbidity reduces submergent plant growth, 15 = Macroinvertebrate food available early, 16 = Reduction in food resources and cover, 17 = Flooding provides roost areas, but foods are unavailable if waters are too deep, 18 = Provide roosting and feeding sites for long periods.

disrupts the substrate, making survival of aquatic macroinvertebrates, such as isopods and amphipods, unlikely in agricultural habitats. The indirect effects of agricultural practices on lowland hardwood wetlands are widespread throughout the Mississippi Delta (Di Giulio 1978). The most insidious effects on natural wetlands result from agricultural runoff. Pesticides, herbicides, fertilizers, and suspended soil particles are serious problems and readily degrade natural wetland habitat.

Wetland Management Practices on Public Lands

Currently there are about 643,000 acres (260,000 ha) of lowland hardwood habitats in public ownership. The states of Arkansas, Louisiana, and Mississippi contain the largest holdings of 322,000 (130,000 ha), 160,000 (65,000 ha), and 112,500 (45,500 ha) acres respectively (Table 2). We generally think of public lands as being free of environmental degradation because they are managed for wildlife or timber resources. Many southern management areas are subjected to unusually turbid waters because flood channels cross public lands or because management areas lie within basins that regularly receive agricultural discharges. A good example is Big Lake National Wildlife Refuge in northeastern Arkansas that receives five major drainage ditches from the bootheel of Missouri. The state-owned Saline Wildlife Area in Louisiana and the Ben Cash Wildlife Area in Missouri both receive turbid flood waters as do Hillside and Panther Swamp National Wildlife Refuges in Mississippi. In fact, it is unlikely that any public lands are free from the problem of water turbidity.

Water level control is the primary management procedure on public lands. Many areas have gross water control, but manipulation of water levels to within 1 inch (2.5 cm) are important because such subtle differences elicit plant responses. However, such precise water control is often impossible because of inadequate control structures. Greentree reservoir management is one good example of a

Table 2. Area of lowland hardwoods in public ownership in the Mississippi Delta.[a]

	Acres							
	State		U.S. Fish and Wildlife Service		U.S. Forest Service		Total	
State	Forested	Total	Forested	Total	Forested	Total	Forested	Total
Arkansas	148,500	153,000	173,500	197,000	0	0	322,000	350,000
Illinois	7,000	14,000	0	0	3,000	3,000	10,000	17,000
Kentucky	0	0	6,000	10,000[b]	0	0	6,000	10,000
Louisiana	107,000	117,000	43,000	44,500	0	0	150,000	161,500
Mississippi	11,500	14,000	30,000	44,000	71,000	71,000	112,500	129,000
Missouri	10,000	14,000	14,500	22,000	0	0	24,500	36,000
Tennessee	15,500	23,500	2,000	1,000	0	0	17,500	24,500
Total	299,500	335,500	269,000	318,500	74,000	74,000	642,500	728,000

[a] Base data from U.S. Fish and Wildlife Service, Atlanta, Georgia, but modified by discussions with state personnel. Acres rounded to the nearest 500.
[b] Includes that part of Reelfoot Lake National Wildlife Refuge that lies in Tennessee.

specific wildlife management technique where waters are manipulated on forested habitat. Forested sites are leveed and flooded in fall to make mast available for waterfowl. Typically, these man-made flooding schedules eventually result in habitat modification because of tree mortality or gradual shifts in plant composition (Fredrickson 1979a).

Managers face many difficult problems in their attempts to maintain high quality forested wetlands. In cases where managers lack an understanding of the complex water fluctuations common to lowland hardwood wetlands and how these fluctuations affect plant and animal life, management procedures are often misdirected. Even when managers have an excellent understanding of water dynamics, the management potential may be minimal. Control over incoming waters is often restricted. Few levees are built on contours; hence, low sites are flooded deeply while high elevations have little, if any, flooding (Table 1).

Management Implications

Although wood ducks exploit habitats outside the Mississippi Delta, the forested wetlands in this region encompass the principal breeding area for this species. Thus, 80 percent of the forested habitat within the principal range of the wood duck has been eliminated. Habitat quality within the remaining 5 million acres (2 million ha) has deteriorated because of agriculture, drainage, channelization, upstream reservoirs, reduction of large forested areas to small remnants, and water management practices. The 643,000 (260,000 ha) currently in public ownership undoubtedly will ensure the survival of wood ducks, but these areas probably are inadequate to supply a surplus for hunting at the 1978 harvest rate of 760,000 in the Mississippi Flyway (R. Pospahala, pers. comm.).

Even if all remaining forests were protected within the range of the wood duck, continuing adverse impacts on forests dictate that a diversity of forested wetland habitats must be made available through management. The recognition of specific food and energy requirements for wood ducks provides managers with key insights into the potential for producing foods and maintaining desirable habitat conditions for wood ducks as well as for a variety of lowland wildlife. Agricultural systems supply few requirements for wood ducks. Hens displaced by forest clearing are unlikely to move elsewhere because of their precise homing to nesting areas. The more permanent water areas where baldcypress predominate may remain after clearing, but these isolated wetlands have reduced habitat values. The more permanent water areas within large wetland tracts provide important habitats in fall and winter, and are protected on both public and private lands. Regulatory agencies recognize this wetland zone and provide protection under Section 404 of the 1977 Clean Water Act.

Desirable water depths and adequate food resources are more difficult to provide in breeding wood duck habitat. Upstream reservoirs, drainage, channelization, and levees reduce spring flooding of leaf litter where breeding wood ducks normally feed. The shallow flooding is essential to stimulate the production of protein foods and to provide desirable feeding conditions before and during egg laying and during early brood rearing. Enough sites must be flooded to provide food resources over about 2.5 months. Currently, the regulatory agencies do not interpret Section 404 of the 1977 Clean Water Act to provide widespread protection of these higher zones within lowland hardwood wetlands where protein resources for wood ducks are readily available. Until these zones are recognized as wetland habitats, these desired habitats are only protected on public lands.

Managers cannot always meet habitat objectives on public lands because of forces beyond their control. Some areas may be small islands of forests and lack diverse wetland habitats. Control of water entering or leaving some areas may be impossible. Some areas may lack the severe flooding that creates single-tree openings, whereas other areas may have extensive flooding where excessive mortality of trees occurs. Even though water manipulation in lowland hardwoods is not a precise science, the importance of dynamic water fluctuations is so obvious that acquisition, development, and manipulations on management areas must be directed toward the maintenance of diverse water fluctuations.

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River Corridor Approach to Bottomland Management

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Introduction

Having seen 90 percent of the bottomland hardwood forests of the Mississippi Valley converted to cropland or otherwise taken away from the river ecosystem, we sense that we have lost something of great value. What appears to be lost is the great power of these forest areas in their natural state to nurture fish and game, to purify streams, and to sequester flood waters. Bottomland hardwoods are among the most valuable of the riparian habitats, of which Hirsch and Segelquist (1979) comment: "Inasmuch as riparian ecosystems play a critical role in maintaining fish and wildlife productivity and diversity, more vigorous efforts are needed to protect and manage these valuable resources."

That conservers should be making a major effort now, after watching the progressive obliteration of bottomland hardwoods over several decades, is not so much oversight as the intractability of the problem under present laws, programs, and constitutional protections. Some years ago, when faced with this type of situation concerning wetlands in general, the advocate groups organized campaigns which were amazingly effective in securing protection for marshes and swamps (e.g. Section 404 of the 1972 Clean Water Act, proliferation of state wetland programs, intensified acquisition). But the hardwood bottoms were not given parity with marshes and swamps and the wetland initiatives did not succeed in providing much protection for them. The reason is that they are marginal in certain respects; that is, their connection to water ecosystems is less obvious and their functional values are less explicit.

While the hugh acreages of bottomland hardwoods and their broad sweep across the riverscape have made the easy solution of public purchase unrealistic, conservation advocates have not yet given up on other initiatives, particularly: (1) Pushing for their incorporation into the Section 404 regulatory permit program of the Corps of Engineers and the U.S. Environmental Protection Agency (EPA) by broadening the definition to include them as wetlands and (2) influencing the Corps of Engineers and other public works agencies to avoid interference with their functions when constructing flood management and other structures to control rivers. If these initiatives had been fully successful, this Special Session of the 45th North American Wildlife and Natural Resources Conference would never have been called.

Using the Section 404 Mechanism

To make bottomland hardwoods conservation more successful, it is necessary to build both a more active constituency and a stronger case for their protection. Let us assume that a stronger constituency can be formed from the advocates of stream protection, flood protection, nature study, wetlands, fish, game, waterfowl, and so forth and that these supporters will be able to make a strong enough case to convince development agencies, agriculture and forestry interests, water control and supply interests and urban and industrial development boosters. I will then concentrate on the matter of building a stronger case for their protection along with some suggestions for mechanisms.

Surely, the easiest approach to conservation of bottomland hardwoods would be to include all of them within the definition of Section 404 of the Clean Water Act of 1972. But there has been great difficulty in accomplishing this. It has taken several court decisions to convince federal agencies to extend protection to wetlands as high on the landscape as the level of the Ordinary High Water Line (Extreme High Water for coastal systems). The bottomland hardwoods lie above the Ordinary High Water Line, for the most part, and therefore beyond the bounds of Section 404 in the opinion of such important actors as the Lower Mississippi Valley Division of the Corps of Engineers who issue or deny Section 404 permits for alteration of wetlands and who has most of the national inventory of bottomland hardwoods in its Districts.

In a recent key permit case, the Vicksburg District of the Corps at first declined to require a permit for clearing of a 20,000-acre (8,093 ha) tract in central Louisiana and, when finally persuaded to do so by various pressures, declined to extend wetland permit coverage above the swamp areas (about 7,000 acres [2,833 ha] which are flooded every year) into the 13,000 acres (15,260 ha) of hardwood forest as requested by the U.S. Fish and Wildlife Service and private interests. Nevertheless, the owner of this property (variously called "The Prevost Tract", "Lake Ophelia", and "Lake Long") brought suit against the U.S. Government, denying that Section 404 applied to the 7,000 acres. The Justice Department then handled the defense (the case closed on February 15, 1980, and a decision is expected in April). Justice decided that not less, but more, of the area was wetlands under Section 404 and held in court that the permit requirement should extend to approximately 16,000 acres (6,475 ha) of swamp and bottomland hardwoods. Even though a decision has yet to be handed down, this case is very instructive because all the issues surrounding federal regulatory protection of bottomland hardwoods were involved.

First, the position taken by the Justice Department on Lake Ophelia is not fully supported by some federal agencies and is extremely unpopular with politically potent factions in the Southeast. Therefore, an effort to reduce 404 permit jurisdiction legislatively might be expected. Second, permits are even now not being required by the Corps for bottomland hardwood alteration throughout much of the Southeast and losses are mounting rapidly. Third, many Corps' river control construction projects that alter the bottomlands and endanger hardwood ecosystems are going ahead. Fourth, many other riparian areas, such as western riparian type (which has suffered losses as great as hardwoods), are being excluded from Section 404 protection.

It is my opinion that comprehensive, conservation of transitional wetlands—such as certain bottomland hardwood areas and the western riparian—cannot be fully accomplished through Section 404 as it is presently operating and that other strategies should be employed. My reasoning is that much of the bottomlands are not now receiving protection and that political resistance may force a legislative reduction of the extent of Section 404 coverage as the courts attempt to expand it. Thus, the jurisdictional boundary may be pulled back toward Ordinary High Water by redefinition of wetlands under Section 404—rather than extended above it.

Much of the issue relates to the definition of wetlands under Section 404, a major point of controversy in the Lake Ophelia case. The current definition of wetlands is: ". . . those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." (33 CFR Part 323.2(c)).

The area covered by this definition very clearly extends to bottomland hardwoods, western riparian, woody draws of the Midwest, and similar situations. The trees that dominate the bottomland hardwoods community are those obligate or facultative hydrophytes that have, in one way or another, developed adaptations to life in the seasonally saturated soils that are found in bottomlands. Yet there is much room for doubt that either the Congress or those who wrote this definition intended to embrace the full extent of river valley hardwood forests. Now that this reality is becoming evident, some correction can be expected. The protection advocates should anticipate this and be prepared with a strong position if bottomland hardwoods are to be spared further massive destruction. This paper is devoted to that end.

The River Corridor Approach

While many will argue that some bottomland hardwoods are not part of the wetlands system, none will argue that they are not a major component of the river corridor ecosystem. The facts are clear that bottomland hardwoods play a vital role for fishes, waterfowl and other animals; that they are hydrologically connected through groundwater, periodic flooding, flood storage, and overland flow to the river; and that they perform numerous functions of great value to society when left in their natural state.

In short, there is a persuasive case for protection of bottomland hardwoods as an integral component of the river corridor ecosystem. Management of the corridor must consider the river in the context of its valley which runs as a corridor through the landscape from headwaters to the sea. The entire width of the valley, from ridgeline to ridgeline, is included since all of this terrain drains into the river channel—affecting both flooding and ecological functions. For convenience, one may separately consider the parts of rivers with quite different characteristics. In a recent analysis for the Federal Insurance Administration, Clark and Benforado (1980) use the following accepted classification:

1. *V-shaped valleys,* typified by small streams with steep gradients like mountain brooks where the corridor is narrow, the stream channel is confined by steep valley walls, and the floodplain is generally indistinct and quite narrow.
2. *U-shaped valleys,* which contain a medium-sized stream flowing between valley walls that are moderately sloped and have a recognizable floodplain strip occurring in a more or less continuous belt on either side of the channel—stream meanders are accommodated, but cramped, by the valley walls.
3. *Broad valleys* typically containing a large river freely meandering in a wide, expansive floodplain that has a width at least several times as great as the meander belt and extends into a variety of flood terraces, backwaters, relict oxbows and other bottomland features that are conducive to hardwoods.

We also divided the profile (cross section) of the valley into a number of management zones which would be relevant to regional and local governments. Factors of major influence in the division of the river corridor into management zones were the identification of both ecological and jurisdictional boundaries and the matching of these into a single set of zones. The zones established were:

1. *Upland terrain* composed of the watershed slopes directly above the floodlands, or bottomlands.
2. *Floodlands,* or bottomlands, located below the upland terrain (i.e., the 100 year flood line) and above the river channel (i.e., above ordinary high water).
3. *Transition* zone occupying a strip at the lowest margin of the floodlands which has extraordinarily high ecologic and flood and erosion protection values—it includes any transitional wetlands, such as any bottomland hardwoods that lie above the Section 404 boundary and the western riparian wetlands.
4. *Fluctuation* zone lying between the high and low water watermarks of a stream which contains the primary wetlands (404 vegetated wetlands), beaches, flats and other areas subject to regular flooding.
5. *Banks,* bluffs, and natural levees that confine a river to its normal channel, often bridging the fluctuation and transition sub-zones.
6. *River channel* and bottom, between the Ordinary Low Water Marks on either bank of the river.

The major point of presenting the above classification system is to suggest how logical it is to include the transitional wetlands in a separate but no less important zone. When the valley is looked at as a whole river corridor and each zone as an integral part of the whole ecosystem, the role of the transitional bottomland hardwoods becomes clear. The bottomland transitional wetlands then stand out as an indispensable component in their own right, not just as a somewhat dubious extension of the Section 404 wetlands category. The question for protection advocates then is whether the bottomlands will be better protected or more poorly protected in this context, particularly if treated differently than Section 404 wetlands.

My proposal is that: (1) protection advocates should be aggressively developing a conservation initiative for all bottomland hardwood communities, western riparians, and the like, that do not, or may not in the future, receive protection under Section 404, and (2) this be done in the context of whole river segments, or river corridor ecosystems. It is particularly important that such efforts not be delayed until the consequences of today's controversies are known. It is obvious that some parts of the bottomland hardwood communities will be left without protection under Section 404 in the future, as indeed they are today. If nothing is done to provide a substitute for any shortfall in Section 404 protection, valuable stands of bottomland hardwoods will continue to be obliterated. I believe that the best substitute is a comprehensive river corridor management initiative, as proposed at the Harpers Ferry riparian workshop (Warner 1979).

A new national program for protective management of bottomland hardwoods as riparian systems certainly is a worthwhile and feasible cause. But the obstacles are formidable because of the extent of overlapping authorities and regional differences. In this situation the demands for research will be great. It will be a complex task in the eastern United States where so many natural processes must be known, evaluated, and sustained in a great variety of political and institutional settings. Yet it can be accomplished if the public support is there and if the plan is bold (Clark 1979).

Complicating the idea is the regional magnitude and complexity of individual bottomland systems which cut across local, state, and federal boundaries and include public and private land holdings of all kinds. Any one riparian system may be encumbered already by dozens of conservation, water development, environmental management and economic development programs. While a new regulatory program to conserve riparian habitat might not be a welcome addition to many interests, one that sought to coordinate existing conservation activities, garner local support, and provide federal aid for planning, acquisition and administration, might be better received. It seems unlikely that voluntary agency cooperation will accomplish the full need. Something new is needed in the way of federal-state-local-private partnership concept. The bottomland-riparian issue seems ripe for such an innovation (Clark 1979).

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Federal Regulations: Handles, Effectiveness and Remedies

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Background

The bottomland hardwood resource used to abound throughout the floodplains of the country's major river systems, including the Mississippi, the Missouri, the Illinois, the Red, the Tombigbee, the Apalachicola, and many others. The most extensive part of the resource historically was and still is in the Lower Mississippi alluvial floodplain. Much of that resource has been cleared and converted to other uses. In 1937, an estimated 11.8 million acres (4.8 million ha) of bottomland hardwood forests were found in the Lower Mississippi alluvial floodplain. Somewhat less than half of that amount, about 5.2 million acres (2.1 million ha), were left in 1978 (McDonald et al. 1979, Forsythe and Gard 1980).

During the period 1957 to 1977, a total of 469,771 acres (190, 257 ha) of bottomland hardwoods were cleared and converted to other uses in a five-parish region in the Red River backwater area.[1]

This conversion of bottomland hardwood forest to agricultural and other uses has been stimulated and supported by a variety of federal programs, including Corps of Engineers agricultural flood control and drainage projects, Soil Conservation Service P.L. 566 Projects, Soil Conservation Service drainage assistance to individual farmers, price support programs, disaster assistance, guarantees to farmers, and grain export policies (see Shabman 1980).

The conversion of these bottomland hardwood forests has meant the loss of aquatic functions played by these floodplain forest wetlands, including provision of fish spawning and nursery habitats, aquatic-dependent wildlife breeding habitats, nutrient recycling, regulation of sedimentation process, and flood storage (see Wharton 1980).[2]

Overview of Federal Law

In recognition of the ongoing loss of critical water-related natural resources and intensifying water pollution problems, Congress during the 1970s has passed a number of major statutes designed to conserve the nation's water resources and to abate water pollution.

These statutes include the National Environmental Policy Act,[3] the Clean

[1]The five parishes are Avoyelles, Cathahoula, Concordia, Pointe Coupee and St. Landry in which the acres lost, during 1957–1977, respectively, were 75,150 (30,435 ha), 122,272 (49,520 ha), 163,306 (66,139 ha), 56,318 (22,808 ha) and 52,725 (21,353 ha).
[2]*See* Testimony of Dr. James Gosselink, Dr. Van Connor, Dr. Dale Hall, Dr. Leigh Fredrickson, and Mr. Ray Palermo, Avoyelles Sportsmen's League, *et al.* v. Alexander, *et al.*, Civil Action No. 78-1428 (W.D. La.), Trial Transcript, February 5–February 15, 1980.
[3]The National Environmental Policy Act, 42 U.S.C. § 4321, *et seq.* (hereinafter, "NEPA").

Water Act,[4] the Flood Disaster Protection Act,[5] the Coastal Zone Management Act,[6] and the Endangered Species Act.[7] Programs under the Clean Water Act (CWA) which might be used to conserve the bottomland hardwood resource include (1) Section 404, which deals with the regulation of discharges of dredge and fill materials in waters of the United States;[8] (2) Section 402, which deals with discharges of pollutants from "point sources;" and (3) Section 208, which provides for areawide water quality management planning to identify and control both point and non-point sources of pollution.

In terms of providing potential federal regulatory handles for conserving the bottomland hardwood forest resource, these statutes greatly strengthen legislation which existed prior to 1970, including Section 10 of the 1899 Rivers and Harbors Act,[9] and the Fish and Wildlife Coordination Act.[10]

Further, all federal water resource development programs which affect the use of bottomland hardwood forests are modified by President Carter's Executive Orders on Wetlands and Floodplains, Nos. 11988 and 11990, discussed below. In addition, the U.S. Water Resources Council's Principles and Standards, together with NEPA, provide a planning tool for enhancing conservation of the bottomland hardwood resource, particularly through the requirement that planning agencies prepare an alternative plan which maximizes environmental quality values.[11]

Some of these programs directly affect federal water resource development programs which could directly or indirectly contribute to the loss of bottomland hardwood resources. Other statutes primarily could be used to regulate private use of this resource.

Despite this array of legislation, bottomland hardwoods continue to disappear. There are several reasons for this. First, there is not widespread recognition of the potential application of these laws to public and private activities affecting bottomland hardwoods. Indeed, as discussed below, there is considerable debate as to whether these laws apply and, if so, what they require.

Second, effective implementation of some programs, such as Section 10 of the

[4]The 1972 Federal Water Pollution Control Act Amendments, amended in 1977 as the Clean Water Act, 33 U.S.C. § 1251, *et seq.*

[5]The Flood Disaster Protection Act as amended, 42 U.S.C. § 4001, *et seq.*

[6]The Coastal Zone Management Act, as amended, 16 U.S.C. § 1451, *et seq.*

[7]The Endangered Species Act, as amended, 16 U.S.C. § 1531, *et seq.* (1979).

[8]Section 404 of the Clean Water Act, 33 U.S.C. § 1344. Regulations implementing this program appear at 33 C.F.R. Parts 320–329 and 40 C.F.R. Part 230. The U.S. Environmental Protection Agency proposed new regulations under this provision which appeared in the *Federal Register,* 44 *Fed. Reg.* 54222 (Sept. 18, 1979).

[9]33 U.S.C. § 403.

[10]The Fish and Wildlife Coordination Act, 16 U.S.C. § 661, *et seq.* Regulations designed to implement this act were first proposed by the Department of the Interior on May 18, 1979, and they appeared in the *Federal Register* at 44 *Fed. Reg.* 29300. Under intense political pressure, however, the draft regulations were withdrawn and the Department of Interior has agreed to do an environmental impact statement prior to republication. If finalized, these regulations could substantially improve the mitigation planning process, resulting in more acquisition and better management of bottomland hardwood habitat as compensation for past and future losses attributable to federal water projects.

[11]The U.S. Water Resources Council Principles and Standards appear at 38 *Fed. Reg.* 24778 (September 10, 1973). They were prepared pursuant to the Water Resources Planning Act, 42 U.S.C. § 1962, *et seq.* The Corps of Engineers has promulgated regulations under this Act and the Principles and Standards, 33 C.F.R. Parts 290–295, 380, 393 (1979).

1899 Rivers and Harbors Act and Section 404 of the CWA depends, to a large degree, on the Corps of Engineers, an agency whose traditional mission has been to stimulate conversion of the bottomland hardwoods to agricultural use through federal agricultural flood control programs.

Third, it has not been clear—and still is not, to some people—that land conversion operations in bottomland hardwood forests constitute regulated activities under Section 404 of the Clean Water Act. The Lake Ophelia decision, discussed below, was, excuse the pun, a watershed case in this regard.

Fourth, for political reasons, and in response to U.S. Department of Agriculture policy, agencies have been hesitant to interfere with agricultural practices even though they result in the clearing and drainage of bottomland hardwoods and downstream pollution (see Schmitt and Winger 1980).

Specific Handles

Of the many potential handles that could be used to protect bottomland hardwoods, we have singled out four for discussion in greater detail. These are Section 404 of the Clean Water Act, the Floodplain and Wetlands Executive Orders, Section 10 of the Rivers and Harbors Act, and Section 7 of the Endangered Species Act. We chose these because they have the greatest potential for providing the broadest, strongest and in some cases the most novel forms of protection for this critical resource.

Section 404 of the Clean Water Act

The program with the greatest potential for regulating both federal water resource development programs and private activities which contribute to clearing and drainage of bottomland hardwoods is Section 404 of the CWA. Section 404 regulation comes into play to the extent that the bottomland hardwoods in question would be considered part of "the waters of the United States." Until the decision in *NRDC* v. *Callaway,* 392 F.Supp. 685 (D.D.C. 1975), the Corps generally had taken the position that Section 404 jurisdiction did not extend to freshwater wetland systems. The *Callaway* case held that the term "waters of the United States," as used in the CWA, included all waters that the Federal Government could constitutionally regulate.[12] Many types of wetlands fall within this broad definition.

Following promulgation of initial 404 regulations on July 27, 1977, some Corps Districts took the position that federal jurisdiction extended to cypress tupelo swamps and overcup oak, bitter pecan forest types, although the Corps had not developed a nationwide methodology for delineating wetlands.[13]

Since the objectives of the Clean Water Act are to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters," Section 404 could be an effective handle for controlling conversion of bottomland hardwood forests to other uses if: (1) bottomland hardwood forests are considered to be

[12]*See also* NRDC v. Callaway; Leslie Salt v. Froehlke, 403 F.Supp. 1292 (N.D. Cal. 1974).
[13]Cypress tupelo swamp is a designated forest Type 102 by the Society of American Foresters; the overcup oak, bitter pecan forest type is designated Type No. 96. *See* Forest Cover Types of North America, Report of the Committee on Forest Types. On November 23, 1977, the New Orleans District issued a public notice setting out a methodology for delineating wetlands under Section 404 including bottomland hardwood wetlands. The Memphis District Corps of Engineers promulgated a methodology in January, 1979.

wetlands meeting the definition of "waters of the United States"; (2) land clearing operations involve the "discharge of dredged fill material"; and (3) land clearing operations are not considered to be "normal farming or silvicultural activities" which would qualify them for an exemption under Section 404(f).

The latter two issues have been determined in favor of wetlands protection by one federal district court in the so-called Lake Ophelia case, *Avoyelles Sportsmen's League, Inc., et al. v. Alexander, et al.,* 473 F. Supp. 525 (W. D. La. 1979). The first question, regarding the extent of federal jurisdiction under the Clean Water Act over bottomland hardwood forests, is still pending before that same Court. In the Lake Ophelia case, a coalition of conservation organizations brought an action against the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency and private landowners to halt land clearing operations intended to convert 20,000 acres (8,094 ha) of bottomland hardwood forests in the Red River backwater area, Avoyelles Parish, Louisiana, to agricultural use, without a 404 permit, and without the authorization required by Section 10 of the 1899 Rivers and Harbors Act.

In its decision, the Court found that defendants' land clearing equipment, which included bulldozers fitted with v-blades and raking bladers, constituted "point sources" of pollution subject to regulation under Section 404 of the CWA.[14] Second, the Court found that sheared trees, vegetation, scraped soil, and leaf litter all constituted "dredged or fill material" and that the excavation and clearing of this material constituted a "discharge" within the meaning of Section 404.[15]

Third, the Court concluded that this type of land conversion did not constitute a "normal farming or silvicultural activity," and was therefore not entitled to a Section 404(f) exemption. The activity was not "farming," the Court said, because no farming could take place until the land had been cleared. On the other hand, the Court noted that a one-time clearcut for the purpose of converting the land from forestry to agricultural uses was not a "normal silvicultural activity" as contemplated by Section 404(f)(1).

Finally, the Court concluded that the clearing of lands for soybean production was a "change in use" since the vegetation, which is functionally an integral part of the wetlands, would be destroyed, and in the process the reach of the waters of the United States would be reduced.

In rejecting the government's position that land clearing operations were not regulated under Section 404, but that construction of drainage ditches, dikes or levees would be, the Court held, "It seems to us that the government has ignored the purposes of the Act and has applied engineering and construction methodol-

[14]The Clean Water Act defines a point source at Section 402(14), 33 U.S.C. § 1362(14) as "[a]ny discernible, confined and discrete conveyance, including but not limited to any . . . ditch, channel . . . discrete fissure, container, rolling stock . . . from which pollutants are or may be discharged. . . ." United States v. Fleming Plantations, 12 E.R.C. 1705 (E.D. La. 1978), and United States v. Holland, 373 F.Supp. 665 (M.D. Fla. 1974), similarly considered marsh buggies, dump trucks and bulldozers to be point sources.

[15]Dredged materials are defined in 33 C.F.R. § 323.2(k) as "material that is excavated or dredged from waters of the United States." The term "wetlands" is defined at 33 C.F.R. § 323.2(c) as "those areas that are inundated or saturated by surface or groundwater at frequency, and duration sufficient to support, and under normal circumstances, do support, a prevalence of vegetation particularly adapted to life in saturated soil conditions." The term "pollutant" is defined in Section 502(6) of the Clean Water Act, 33 U.S.C. § 1362(6) to include biological materials.

ogy and theory to environmental problems, totally frustrating the purposes of the Clean Water Act.'' 13 E.R.C. at 1361.

For the Ophelia case to be effective in conserving the bottomland hardwood resource, the agencies principally responsible for implementation of the 404 program, namely the Corps of Engineers and the Environmental Protection Agency, must be willing to regulate land clearing activities. The Corps of Engineers has agreed to regulate such activities within the Western District of Louisiana, but not elsewhere.[16] Further, they must be prepared to consider as 404 wetlands those bottomland forests whose plant communities are made up almost exclusively of flood-tolerant species with few or no flood-intolerant species (see Schmitt and Winger 1980, USDA 1977, 1978). It is submitted that, with respect to bottomland hardwoods, the waters of the United States should be deemed to extend to include at least all first bottoms, i.e., floodplain areas which are still subject to active fluvial deposition or river backwater or overflows.

Even with these suggested modifications to the program, the successful application of 404 in individual cases will depend upon a number of factors. First, scientific evidence must be provided to establish that these wetland forests perform valuable aquatic-type functions as described in 33 C.F.R.§ 320.4 (e) (2), including production of detrital material, provision of fish spawning nursery and wildlife breeding habitats, water quality purification, and flood storage capacity. Second, more scientific evidence is needed to show that the conversion of these forests to agricultural use will adversely affect the chemical, physical, and biological integrity of the nation's waters, through soil erosion and nutrient and pesticide runoff. Lastly, since the ''need'' to alter wetlands is a crucial factor in individual 404 permit cases, economic research is essential to establish whether there are alternatives to the conversion of bottomland hardwoods to agricultural use (see Shabman 1980). This last factor should not be difficult to establish in view of the plethora of federal, urban, transportation, water resource, housing, and other policies which induce, support and subsidize the utilization of prime farmland for other development purposes (see U.S. Economic Research Service 1974: 10–11, USDA 1975, Pimentel et al. 1976, Leigh 1978).

Beyond site-specific cases, the effectiveness of 404 in conserving bottomland hardwood forests will rest upon the willingness of all federal agencies which have programs affecting that resource to adopt this broader concept of ''wetlands.'' At a minimum, these agencies should accept the definition embodied in the government's final wetlands determination filed with the Court in the Lake Ophelia case. Interagency cooperation is also needed to avoid undermining the purposes of Section 404 enforcement. For example, the Soil Conservation Service (SCS) should refuse drainage assistance to owners of bottomland hardwood forest wetlands prior to receipt of all necessary permits, including Section 404 and Section 10 permits, and the Corps should, correspondingly, refuse to consider the prospect of such assistance as a reason for granting the permit. SCS has recently taken a step in this direction with adoption of a policy seeking to implement Executive Orders 11988 and 11990, precluding SCS technical financial assistance to alter

[16]However, the U.S. Attorney General has issued a formal opinion that EPA, not the Corps, has the final say on what constitutes a wetland under 404. Letter of 5 Sept. 1979 from Benjamin J. Civiletti to Honorable Clifford L. Alexander, Jr. This opinion binds the Corps though it would not bind a court.

bottomland hardwoods until land has been cleared and in production for three of the last five years.[17]

Furthermore, this broader view of wetlands should be applicable in planning and review of all federal water resource projects, in particular Corps and SCS agricultural flood control and drainage projects, other water resource development projects and other federally assisted projects, such as highways, schools and housing. Corps and SCS agricultural flood control projects are sometimes designed to provide flood protection to floodplain lands which have been cleared and farmed for many years. However, those same projects typically induce and accelerate further clearing of bottomland hardwood forests in the affected floodplains. Such assistance should not be forthcoming in the absence of binding and enforceable contractual agreements with the local sponsoring group and all affected landowners prohibiting clearing of any additional bottomland hardwoods.[18] Citizens with "an interest which is or may be adversely affected" for purposes of Section 505 (a) and (g) of the CWA, 33 U.S.C. § 1365 (a) and (g), should be eligible to bring actions in Court to enforce such contracts.

Further, to offset the heavy emphasis on utilization of bottomland hardwoods for agricultural purposes, the U.S. Forest Service Programs which are designed to improve management of this forest resource should be strengthened (see Spurr 1979, Putnam 1960).

Wetlands and Floodplains Executive Orders

On May 24, 1977, President Carter issued Executive Orders 11990, "Protection of Wetlands," and 11988, "Floodplain Management."[19] The purpose of the Wetlands Order is "to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative." The purpose of the Floodplain Order is "to avoid the direct or indirect support of floodplain development wherever there is a practicable alternative." The jurisdictional reach of each order is very broad. "Wetlands" are defined as "areas that are inundated by surface or ground water, with a frequency sufficient to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction." "Floodplains" are "lowland and relatively flat areas adjoining inland and coastal waters . . . subject to a one percent or greater chance of flooding in any given year [i.e., the 100 year floodplain]." The scope of federal actions covered by these Orders is, with one or two notable exceptions, all-encompassing. The Wetlands Order, however, pointedly exempts private activities involving wetlands on non-federal property for which a federal permit or license may be required, and also "grandfathers" projects already under construction and those for which an EIS was filed by October 1, 1977. Otherwise,

[17]*Cf.* 7 C.F.R. Part 650, U.S. Department of Agriculture, SCS Compliance with NEPA, 44 *Fed. Reg.* 54981 (Sept. 24, 1979); Louisiana Engineering Bulletin No. LA 40-0-5-SCS Assistance for Drainage of Agricultural Land (Nov. 20, 1979). This rule should be amended to make it clear that, under no circumstances, will SCS render any assistance to any landowner who has cleared Type 1 bottomland hardwood forests since the enactment of the Amendments to the Clean Water Act in 1977.

[18]*See* Final Report of the Obion Forked Deer Basin Workshop (Nov. 2, 1979) (unpublished). Available from Environmental Defense Fund's New York office.

[19]*Federal Register,* 42:26951, 26961 (25 May 1977).

both Orders are intended to cover every conceivable form of federal involvement in floodplains and wetlands.

These Orders impose a number of requirements upon federal agencies.[20] Procedurally, the Orders call for implementing regulations[21], public participation[22], an Office of Management and Budget (OMB) clearance process for new authorizations,[23] and restrictive covenants on conveyances of federal floodplain and wetland properties. The Floodplain Order imposes additional procedural requirements, such as including the results of the analysis required by the Order in EIS's, publishing a notice containing an explanation of why an action must be located in the floodplain, and disclosing flood hazards in federally insured financial transactions involving the floodplain.

Substantively, the Orders impose a two-part requirement. Agencies must not allow or support development in a floodplain unless they find there is no "practicable alternative"; and, if there is no such alternative, they must minimize harm to these resources. However, because these standards have yet to be judicially construed in the context of an actual dispute[24], it is difficult to know whether they meaningfully restrict the degree of discretion that an agency would otherwise have to modify these resources.

Assuming these Orders can be read as requiring that agencies give some extra weight to protection of wetlands and floodplain resources in their decision making, the question arises whether citizens can enforce noncompliance in a given case. Unfortunately, the answer is far from clear. The cases regarding private enforcement of Executive Orders are badly split.[25] The cases upholding enforcement seem to turn on two factors: (1) whether the Order has a firm statutory basis, and (2) whether it imposes specific, enforceable requirements.[26] Under those criteria, the Floodplain and Wetlands Orders stand a good chance of being enforced.[27]

The no practicable alternative/minimize harm requirements of these Orders are nearly identical to criteria found in the Corps' 404 permit regulations.[28] Of course,

[20]These requirements have been further spelled out in "Guidelines" issued by the Water Resources Council. *Federal Register,* 43:6063 (1978).

[21]These regulations were due within 1 year of the date the Orders were issued. According to the Council on Environmental Quality (CEQ), however, several agencies have yet to comply with the Directive (CEO 1979:385–86).

[22]The public participation requirements can be satisfied through the normal NEPA process (i.e., review of an EIS); however, where no EIS is required by NEPA, agencies must develop alternative procedures.

[23]When submitting requests for new authorizations or appropriations to OMB, agencies are required to indicate whether the action complies with the Orders.

[24]In National Wildlife Federation v. Adams, 13 E.R.C. 1343 (W.D. Wash. 1979), plaintiffs challenged a Department of Transportation decision to run a highway through some wetlands in Washington State on the ground that it violated the Wetlands Order. In a terse opinion, the District Court dismissed the claim, holding that DOT had adequately "considered" the Order. The case is now on appeal to the Ninth Circuit Court of Appeals.

[25]*Compare* Independent Meat Packers Association v. Butz, 526 F.2d 228 (8th Cir. 1975) (no private enforcement of the "economic impact statement" Executive Order) with Aluli v. Brown. 437 F.Supp. 602 (D. Hawaii 1977) (Historic Preservation Executive Order held enforceable).

[26]*Cf.* Farkas v. Texas Instruments, 375 F.2d 629, 632–33 (5th Cir. 1967).

[27]*Cf.* National Wildlife Federation v. Morton, 393 F.Supp. 1286 (D.D.C. 1975) (Off-road Vehicle Executive Order held enforceable).

[28]33 C.F.R. 320.4(b)(4) (1978).

the scope of activities covered by the Orders is a great deal larger than the 404 Program, and in that sense, assuming their enforceability in the courts, the Orders may augment considerably the protection afforded to bottomland forests by 404.

Section 10 of the 1899 Rivers and Harbors Act

Section 10 of the 1899 Rivers and Harbors Act (RHA), 33 U.S.C. § 403, provides that all work which "will alter or modify the course, condition or capacity of navigable waters" must be authorized by the U.S. Army Corps of Engineers. The definition of "navigable waters" under the RHA, unlike the CWA, is limited to water bodies which are, were, or could be rendered navigable in fact.[29] Bottomland hardwood wetlands would not qualify as "navigable waters" under this test. However, the clearing and conversion to agricultural or other development uses of large tracts of these wetlands can disrupt hydrological functions, cause erosion, and degrade water quality, and in that sense may "alter or modify the course, condition or capacity" of traditional "navigable waters" within the meaning of § 10.[30] This approach was successful in the Channel A case, *National Wildlife Federation* v. *Alexander* (unreported), No. 77-1687 (D.D.C. 18 Aug. 1978), *rev'd on other grounds,* _____ F.2d _____, 10 E.L.R. 20060 (D.C. Cir. 7 Dec. 1979), where the Court held that § 10 applied to an irrigation ditch that would discharge excess water and pollutants into an arguably navigable water,[31] thereby altering the "capacity and condition" of the latter. Other cases have reached similar results. *Cf. United States* v. *Sexton Cove Estates, Inc.,* 526 F.2d 1292, 1299 (5th Cir. 1976).

Once federal jurisdiction is triggered, the full panoply of environmental requirements—impact statements under NEPA, mitigation plans under the Fish and Wildlife Coordination Act, biological opinions under the Endangered Species Act—attach to the action in question. This in turn makes it possible to require examination of alternatives to that action, perhaps leading to permit denial on the ground that alteration of the wetland is not in the public interest. In this way, § 10 can be used indirectly to provide protection to the particular bottomland hardwood wetland even though the statute's principal focus is "navigable waters."

However, unless the Corps amends its nationwide permit regulations[32] to expressly include activities outside "navigable waters" that may affect their ecological condition, § 10 will not provide any generic protection for bottomland hardwood wetlands. Meanwhile, applications and enforcement will proceed on an *ad hoc* basis, spurred perhaps by vigilant citizen activists.[33]

[29]United States v. Appalachian Electric Power, 311 U.S. 377 (1940).
[30]In the Lake Ophelia case, for example, the Court found that the permitted removal of the bottomland hardwood trees and understory vegetation from the 20,000 acres in Lake Ophelia would result in the loss of detritus, that the clearing of the wetlands vegetation would seriously impair fish spawning since fish that inhabit the Red River and its Basin spawn in the backwater areas.
[31]On appeal, the D.C. Circuit Court held that the water body, a landlocked lake with no water link to any interstate waters, was not navigable under the RHA. NWF v. Alexander, *supra,* 10 E.L.R. at 20066.
[32]*Cf.* 33 C.F.R. Part 329 (1978).
[33]A caveat: The law regarding private enforcement of § 10 is still unsettled; however, a suit against the federal government, as opposed to a private party, stands a good chance of being heard. *See* Sierra Club v. Andrus, _____ F. 2d _____, 9 E.L.R. 20772 (9th Cir. 1979).

Section 7 of the Endangered Species Act

Of all the environmental statutes on the federal books, only one contains a flat prohibition against developmental activities: Section 7 of the Endangered Species Act (ESA), 16 U.S.C. 1536. That provision forbids federal actions, including permit actions, that might adversely affect a listed endangered or threatened species unless the agency can "insure" that the action "is not likely to jeopardize" such species, *or* result in the "destruction or adverse modification of habitat that the Secretary [Interior or Commerce] has determined is critical to survival of such species." The United States Supreme Court has said that this mandate "admits of no exception," and requires agencies to reorder their priorities to provide first for the preservation of endangered and threatened species. *Tennessee Valley Authority* v. *Hill,* 437 U.S. 153, 185 (1978).

Section 7 is certainly strong medicine, but it has limited application. The prerequisite is the existence of a listed species or its designated "critical habitat" in the path of the proposed development. Endangered or threatened species of animals and plants normally associated with bottomland hardwoods include fish (e.g., the Bayou Darter, a Mississippi native), birds (e.g., Bachman's Warbler, recently sighted in South Carolina), mammals (e.g., the Florida Panther), reptiles (e.g., American Alligator), and plants (e.g., *Jamesianthus albanensis,* a daisy that was proposed for endangered status in 1976).

Whether the clearing and conversion of these areas "is likely to jeopardize" these species or to "adversely modify" their critical habitat must be determined on a case-by-case basis. For that there is the § 7 "consultation process," under which the "action agency" is required to consult with and obtain a "biological opinion" from the appropriate wildlife agency (for bottomlands, that would be the Fish and Wildlife Service) regarding the effect of a proposed action on the species involved. By statute, consultation is required to be completed within 90 days, unless extended by mutual agreement of the action and wildlife agencies.[34] However, in the event there is inadequate information to render a biological opinion, consultation must continue until it is obtained, and in the interim the action agency may not make any "irreversible or irretrievable commitments of resources" that would foreclose alternatives.[35]

Should an adverse biological opinion be issued, the action agency must give it "great weight" in deciding whether to proceed. *National Wildlife Federation* v. *Coleman,* 529 F.2d 359 (5th Cir. 1976) (Mississippi Sandhill Crane). Should the action agency conclude that an "irresolvable conflict" exists between the proposed activity and § 7, it may apply for an exemption to the 7-member, cabinet-level Endangered Species Committee, which must decide, using a set of fairly strict economic and public interest criteria, whether the species or the project shall prevail. The only time the Committee has met it denied an exemption for the celebrated Tellico Dam and granted an exemption for the Grayrocks Dam.[36]

[34]16 U.S.C. 1536(a)(2).
[35]16 U.S.C. 1536(d).
[36]The Grayrocks exemption was actually *pro forma* since the parties to the litigation (Nebraska v. Rural Electrification Administration, 12 E.R.C. 1251 (D. Neb. 1978)) had previously reached a settlement agreement that the Fish and Wildlife Service had determined would preclude jeopardy to the endangered Whooping Crane. The Committee simply adopted that agreement as a "mitigation measure" in granting the exemption.

When available, § 7 can be a potent weapon to protect the bottomland hardwood habitat of endangered species. However, due to its explosive political nature, especially where the lower taxa of animals and plants are concerned, it is a weapon that should be used sparingly and cautiously; and, wherever possible, during the earliest stages of project development.

Conclusion

There are a number of federal handles for conserving the remnants of the once great bottomland hardwoods of the Lower Mississippi River. They vary greatly in the scope and measure of protection afforded. In some cases their application depends on the acceptance of some imaginative, though we believe logical, legal theories. In others, political considerations may deter their application. In all cases, their effectiveness, in terms of actual acres saved, depends upon a number of variables including the right facts, the right time, and the right agency official. In other words, these tools are only as good as the people who use them.

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Economic Incentives for Bottomland Conversion: The Role of Public Policy and Programs

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Introduction

Conversion of forested river-bottom lands to cropland has been a common land-use activity in Arkansas, Louisiana, Mississippi, Tennessee and Kentucky over the past 40 years, with the greatest amount of cropland development occurring since the late 1950s (MacDonald et al. 1979). For the individual farmer, bottomland conversion is justified when the market value of the farm products produced is expected to exceed the farmer's costs of developing and farming these lands. However, bottomlands as a natural environment, may provide fish and wildlife habitat, flood water storage capacity, groundwater recharge and nutrient removal from surrounding waters (Comptroller General of the United States 1979). When these bottomlands are cleared and drained for agricultural crop production, the natural environment's services are lost, a loss which imposes costs upon other persons. These costs are not reflected within existing markets and, therefore, are costs which the farmer operator does not bear when the conversion is made. This argument has been the basis for justifying public policies to reduce future conversion (MacDonald et al. 1979: 118, Comptroller General of the United States 1979). This paper extends this argument and suggests that the profitability of bottomland conversion for individual farmers has been enhanced by federal government policies and programs. A discussion of these policies forms the basis for recommending program changes to manage bottomland conversion trends in the future.

The Private Profitability of Bottomland Conversion

Shulstad and May (1979) assessed the private economic feasibility of conversion by comparing the discounted future net returns from agricultural use with conversion costs and discounted future net returns from commercial timber production. They concluded that, under a wide range of alternative economic conditions, positive economic returns for bottomland conversion will continue to exist in the future. This discussion expands their framework (but not their empirical analysis) by (1) dividing the farm conversion operators' decision into two separate problems of private economic feasibility and financial feasibility, and (2) suggesting that government programs may account for some of the apparently positive returns from bottomland conversion found by Shulstad and May.

Private Economic Feasibility

An investment in bottomland conversion is economically feasible if the internal rate of return on the investment (r) equals or exceeds a "target interest rate" established by the farm operation (i_t). The target rate depends on the opportunity cost of the investment capital and the farm operators' attitude toward risk. The opportunity cost of capital is that return which could be earned if the funds were allocated to an alternative investment. If the investment funds are borrowed, the opportunity cost of capital is the market interest rate (i_m). It will be assumed here that the market interest rate is equal to the opportunity cost of capital for the farmer. To the extent that farmers are risk averse (a condition assumed here) the target interest rate includes a risk premium (i_p) which has the effect of raising the rate above the opportunity cost of capital. Thus, for a decision to be economically feasible:

$$r \geqslant i_t = i_m + i_p \qquad \text{(Equation 1)}$$

The determination of r by the farm operator is based upon the expected net returns from bottomland farming in each future year (R_y) and the investment necessary to initiate bottomland farming (K). Investments include costs for land acquisition and/or preparation and for purchase of machinery and equipment necessary for farming the additional acreage. Expected net returns from farming the land in any future year, y, (based upon the farmers' best judgement about future conditions) will depend upon the expected production levels of the crops being grown (Q_y), expected crop prices (P_y), expected costs of production (C_y), and the expected value of foregone timber production (T_y); specifically, $R_y = P_y \cdot Q_y - (C_y + T_y)$. In addition to returns from farming, the farmer considers the current difference in sale value for developed agricultural land and forest land (V_o), and his expectations for the rate of growth in this difference (α) as a return from conversion. In some future year, Y, if the land is sold, the net return from bottomland development in that year is $V_o\ (1+\alpha)^Y$. Equation 2 summarizes the discussion to this point and shows the basis for the calculation of r, where Y is the farmers' time horizon for the investment.

$$K = \sum_{y=1}^{Y} \frac{P_y \cdot Q_y - (C_y + T_y)}{(1+r)^y} + \frac{V_o(1+\alpha)^Y}{(1+r)^Y} \qquad \text{(Equation 2)}$$

From equation 2, r is increased by increases in P_y, Q_y, V_o, α, and/or by decreases in C_y or K, which, from equation 1, increases the economic feasibility of investments in bottomland farming. Economic feasibility is also enhanced as i_m or i_p fall (equation 1). The argument of this paper will be that government programs affect the variables in equations 1 and 2 so as to uniformly and consistently enhance the economic feasibility of bottomland conversion.

Financial Feasibility

When an investment in bottomland farming is financed, there will be fixed annual repayment requirements. Therefore, bottomland farming must earn sufficient revenue to cover annual production costs and meet load payments; this revenue requirement is termed cash flow. Assuming, as was done earlier, that farm operators are averse to risk, they will not invest in bottomland conversion unless there is only a "small likelihood" that they will default on loan payments. Therefore, the farmer will base the financial feasibility assessment on a "worst case" situation, i.e., that cash flow which results from the coincidence of minimum expected prices and production and maximum expected production costs. The financial feasibility analysis in equation 3 requires that the cash flow on the right side of the equation must equal or exceed the costs shown on the left.

$$a_{eN}\ (L) + \max(S) \leq \min(P) \cdot \min(Q) \qquad \text{(Equation 3)}$$

where: a_{eN} = amortization factor, where e equals interest rate on load and N equals term of load, in years; L = total amount of load; $\min(P)$ = minimum expected crop price; $\min(Q)$ = minimum expected production; and $\max(S)$ = maximum expected production costs. The product of a_{eN} and L (left side of equation 3) is the required annual payment of loan principal and interest.

Meeting the cash flow requirement is a necessary but not sufficient condition for investment in bottomland conversion to be feasible. Economic feasibility must also be established. From equation 3, as e, N, $\min(P)$ and $\min(Q)$ rise, and/or as L and $\max(S)$ are reduced, financial feasibility is enhanced. The argument of this paper is that government policy and programs uniformly affect these variables so as to increase the financial feasibility of bottomland conversion.

Public Policy and Bottomland Conversion[1]

Public Works

Public works projects of the Soil Conservation Service (SCS) and the Corps of Engineers (COE) increase the expected production from bottomland farming (Q_y in equation 2) by reducing the chance of flood losses and/or by improving drainage opportunities. This increased production potential results in expected increases in net returns ($P_y \cdot Q_y - (C_y + T_y)$ in equation 2) and in the market value of farmed bottomlands (V_0 in equation 2). Taken together, these effects of public works projects raise the internal rate of return for investments in bottomland development. Since flood control projects reduce the likelihood of sharp reductions in expected output which would result from flooding, they also reduce the risk premium component of the target interest rate (equation 1), further enhancing economic feasibility of private investments in bottomland conversion. Finally, reduced flood frequency also affects financial feasibility by reducing the chance of a large crop loss in any year, and reducing the potential for default on loan payments. As the risk of loss is reduced, minimum cash flow expectations (equation 3) are raised.

MacDonald et al. (1979) suggest that the influence of these projects on bottomland conversion has been significant. Using map overlays to compare areas where bottomland conversion had occurred with the areas affected by completed public works projects, they concluded that "significant correlations were observed between forest clearing and completed COE and PL-566 projects for the 1957–1967 and 1967–1977 time periods" (MacDonald et al. 1979:74). A brief discussion of the COE's Sicily Island Levee project can further illustrate the potential influence of public works on forested bottomlands. The project is located in East Central Louisiana where bottomland conversion has been a common land-use practice. According to COE planners, the project will not affect the continuing rate of land conversion (U.S. Army 1978:10), but this argument appears weak since the project is expected to increase net returns, in 1978, from farming currently forested bottomlands from \$68.79 per acre, without the project, to \$104.35 with the project.

[1]The arguments which follow do *not* imply that bottomland conversion would cease without government programs. The without policy situation cannot be known, however, it is possible to identify the tendency for government programs to support bottomland conversion.

If this increase is capitalized using a 10 percent discount rate and a 20-year time horizon, the market value of the land increases by $305.74 per acre. While some land conversion may occur without the project, this project's estimated impact on net returns suggest a great potential to influence the economic and financial feasibility of conversion.

Income Taxation

Income tax law allows farmers to shift a portion of investment costs for bottomland conversion (K in equation 2) to the general taxpayer (Internal Revenue Service 1979a). First, current tax law permits a deduction from taxable income for land clearing costs of up to $5,000 or 25 percent of taxable income. Second, deductions of up to 25 percent of gross farm income are permitted for soil and water conservation expenses including drainage. Expenses in excess of this allowable limit may be deducted in subsequent years. Subject to the limitations described above, each dollar spent on land clearing and drainage may be deducted from taxable income. Therefore, assuming for this discussion that the farmer is in a 30 percent tax bracket, 30 cents of each dollar of investment in land clearing and drainage can be shifted to the general taxpayer. Third, installation of drain tiles entitles the farm operator to an investment tax credit equal to 10 percent of installation cost. Since this is a direct reduction of tax liability, this provision shifts 10 cents of each dollar of investment costs to the general taxpayer. Fourth, the farm operator is entitled to deductions for depreciation on all capital investments necessary for bottomland farming. If the investments have an expected life greater than seven years, the tax code allows a deduction from taxable income of as much as 8 1/2 cents for each dollar invested in the year the cost is incurred. In addition, farm operators are given a special tax advantage known as the "double deduction" which may allow an additional deduction in the year the investment is made of 6 cents for each dollar spent.

Another feature of the income tax code is the deduction allowed for interest payments (Internal Revenue Service 1979b). The effect of this allowance is to reduce the effective market rate of interest paid by the farm operator on borrowed funds, i.e., the opportunity costs of capital (i_m in equation 1) in the economic feasibility formula. Again assuming a 30 percent tax bracket, the effective interest rate to the farm operator would be reduced by 30 percent, lowering the target interest rate and enhancing the economic feasibility of investments for bottomland conversion.

Income tax provisions also enhance the financial feasibility of investments for bottomland acquisition and farming. The opportunity to shift a portion of the costs of capital investments to the general taxpayer and the interest payment deduction which lowers the effective interest rate reduce cash flow requirements. An example can clarify these effects. Investment costs for bottomland clearing in Eastern Arkansas in spring of 1978 were $311.67 per acre for the most productive soil types (Shulstad and May 1979). A loan for this amount taken at 10 percent interest for a time period of 20 years would have annual payments of $36.60, an amount to be paid from cash flow. However, applying the tax advantages outlined above, the $311.67 investment cost borne by the farm operator could be reduced to $218.17. In addition, the interest rate is effectively reduced by the 30 percent tax bracket of the farmer. Using a 7 percent interest rate and the $218.17 loan, the annual payments are reduced from $36.60 to $20.59, a significant reduction in cash flow needs. The same effect would be applicable to investments in capital equipment that might be necessary for expanding bottomland farming.

Price Supports

In 1976, Nelson and Cochrane described federal price support programs in this way:

> Farm programs of the Federal government have, in various ways, supported and stabilized farm prices and incomes since 1933. . . These programs were operated in a way that reduced risk and uncertainty for farmers, affected their expectations of future income potential from farm production activities, and influenced their willingness and ability to invest. . . (Nelson and Cochrane 1976:52).

Because of their complexity, only a general description of the current programs can be presented here.

Each year a loan rate, set as a per bushel price, is announced for several crops including soybeans, rice and wheat. At harvest, the farmer may deliver his production to the Commodity Credit Corporation (CCC) and receive the loan rate as an alternative to sale at the prevailing market price. Since production will be diverted to the CCC whenever market price falls below the loan rate, the minimum market price will be at or near the loan rate. To limit growth of CCC stocks, production controls may be initiated, which also can support the commodity price at a minimum level. At the same time that loan rates are established, target prices in excess of the loan rate are announced for several crops including rice, wheat and corn. If, at harvest, the market price is below the target price, the producer is entitled to an income "deficiency payment" equal to the amount of production times the difference between the target and market prices. These programs are available, in different combinations, for each of the major crops grown in rotation on bottomland soils.

The price support program can increase expected price (P_y in equation 2), however, the effect will vary with the crop. Gardner (1979) concludes that loan rates alone (soybeans) or target prices alone (cotton) are unlikely to affect expected market prices. When the loan program and the target price program are both available for a crop (wheat and rice) the expected price will be increased over the case without any program coverage (Gardner 1979). Since the loan program is not likely to affect the expected price for soybeans, and since the dominant bottomland crop is soybeans, it may appear that government crop price support policies will have little effect on bottomland development decisions. Nonetheless, it is the case that the wheat and rice crops, in the soybean dominated rotation, can have their expected price increased by these programs. However, of more importance for investment decision making is the risk-reducing effect of these programs.

The loan and target price programs establish both minimum price and income guarantees for crop producers, therefore shifting a good deal of the price/income risk of crop production to the general taxpayer. Of particular importance is that producers, when viewing the history of farm programs since 1933, must conclude that prices will be supported at levels which ensure the farmer against sudden decreases in farm income.

Several results favoring bottomland investments arise from the risk-reducing effect of price support programs. First, by reducing the risk of sharp price declines the risk premium (i_p in equation 1) is lowered. Second, the minimum income guarantee of these programs increases the demand for land as an investment, raising the value of farmland (V_0 in equation 2). (Castle 1979, Nelson and Cochrane 1976).

Third, the program's minimum price (min(P) in equation 3) guarantee affects the financial feasibility of long-term investments in bottomland clearing, as the risk of loan default is reduced. This reduced risk of loan default also increases the willingness of lenders to provide loans for land acquisition and development (Schertz 1979). The increased willingness to lend improves the terms and availability of credit (e and N in equation 3) which reduces cash flow requirements.

Direct Assistance Programs

Three federal programs provide assistance directly to farmers which may encourage them to convert bottomlands. The Farmers' Home Administration (FmHA) offers loans to qualifying farmers at below market interest rates. Since these loans may be used for investments of agricultural drainage, the reduced interest rate can enhance the economic and financial feasibility of bottomland clearing. For qualifying farmers the Agricultural Conservation Program (ACP) of the Agricultural Stabilization and Conservation Service (ASCS) makes direct payments to farmers who drain wet agricultural soils as part of their cost-sharing programs. The FmHA and ACP do not direct a large part of their program to these areas and the extent of their influence on bottomland conversion is not certain; however, they do allow farmers to shift a portion of conversion cost to the general taxpayer.

Of perhaps more importance is the technical assistance program of the SCS. SCS advises farmers on the techniques and feasibility of bottomland conversion and helps develop a plan for each farm situation. While no funds are offered, the information and advice offered by SCS may encourage a conversion decision which would not otherwise have been made.

Disaster Assistance Programs

The disaster payments program reduces risk of investment in bottomland farming by compensating producers for financial losses which result from natural hazards such as flooding. As a result, farmers who develop bottomlands shift the cost and risk of flood damages from themselves to the taxpayer. The current disaster payments program allows producers to claim one-half of the target price (one-third for cotton) on a proportion of their "normal" production if natural disasters destroy a portion of their crop or if they are prevented from planting. "Normal" production is established by ASCS based upon historical yields and harvested acreage. For crops not under the target price program, such as soybeans, farmers can reduce flood risk through USDA's Federal Crop Insurance Program (FCI). FCI's overhead costs are paid from general tax revenues. Insurance premiums charged the farm sector cover expected claims and each farmer's premium is set for his own particular risk situation (USDA 1979). No similar insurance program is available in the private sector.

Since bottomlands are flood prone areas, these programs may encourage bottomland farming by reducing the risk premium (i_p in equation 1) in the economic feasibility analysis. Furthermore, the risk of loan default is reduced in the financial feasibility analysis.

Toward a Preservation Policy on Bottomlands

The preceding discussion suggested that public policies and programs may encourage bottomland conversion. Meanwhile, bottomland development may result in a loss of environmental services; a loss which has been an unrecognized cost of the farmers' conversion decision. Thus, changes in current policies and programs designed to slow the rate of bottomland development are justified. However, program changes will be constrained by a recognition that in the future, as in the past, the conversion decision will remain with the bottomland owner based upon his own assessment of the economic and financial feasibility of investments in bottomland development. Within this constraint, the objective of program change should be to insure that a farmer's choice to convert bottomlands is based upon an economic assessment which compares the returns from increased agricultural output with total conversion costs, including environmental costs.

Economic Evaluation of Public Works Projects

Many of the authorized, but not constructed, public works projects for the delta states were evaluated with benefit and cost estimation guidelines which were made obsolete by publication of the *Principles and Standards* (P&S) (U.S. Water Resources Council 1973) and by recent revisions to the P&S (U.S. Water Resources Council 1979). Since the P&S, with revisions, reflects the current "state-of-the-art" for benefit-cost analysis, its broadest application to public works construction is essential to insure that these projects remain economically justified.

The Sicily Island project illustrates the importance of reexamining projects (not yet constructed) by the new evaluation guidelines. Agricultural benefits in 1978 were the improvements in net farm income "with" versus "without" the project. This improved income was projected to grow in subsequent years at a rate equal to the historical growth in the nominal value of farm sales in the project area. This calculation contradicts current guidelines which, with minor exceptions, do not permit projections of growth in net farm income.[2] Application of current guidelines to Sicily Island reduces project benefits from $3,768,000 to $2,379,044 and net benefits fall below zero.

Careful application of existing evaluation guidelines should be accompanied by improvements in those guidelines. Two improvements are of particular importance for projects in the delta. First, crop prices used in agricultural benefit analysis should be adjusted downward to account for the market price supporting effect of government programs. Second, within the limits of the "state-of-the-art" for valuing nonmarket goods (Midwest Research Institute 1979), improved procedures for documenting the environmental costs of bottomland conversion are needed. Both these improvements were called for in President Carter's June 1978 water policy message, but were not included in the recent P&S revisions.

[2]This prohibition reflects the need (1) to conduct benefit analysis in current real prices rather than nominal prices, and (2) to avoid attributing agricultural productivity increases to the project which will occur without the project.

Modifying Policies Which Affect Private Profitability

Modification in federal policies and programs should reduce the farmers' opportunity to shift the cost and risk of bottomland farming to the general taxpayer. First, the tax code should be altered to eliminate deductions and tax credits for land clearing and drainage expenses incurred in development of bottomlands. Also, interest payments on loans for bottomlands conversion should be ineligible for an income deduction.

Second, price and income support policy should be modified. For some crops, ASCS can specify the acreage (cotton, rice, wheat, for example) on which production will be eligible for price and income supports. ASCS policy could be modified to deny such specification to all acreages which are created from forested bottomlands after the policy change becomes effective (hereafter referred to as "newly developed lands"). An extension of this policy change would be to withdraw eligibility for the price support program from any crop grown on newly developed lands. However, the impact of these changes may be limited. The market price supporting effect of these programs extends to farmers regardless of their participation in the program. Thus, denying farmers an opportunity to participate in price and income support programs will only discourage bottomland conversion if the expectations of producers are (1) that they will receive direct payments under the target price program or (2) that they will utilize the CCC loan option because the market price is expected to fall below the loan rate. Since soybeans, the dominant bottomland crop, are covered only by a loan rate which has historically been far below market prices, these expectations are likely to be small. However, for other crops in the rotation, and as part of a broader set of policy changes, these program modifications should be considered.

Third, programs of direct federal assistance to farmers for bottomland conversion should be eliminated. Also, the disaster assistance payments program and the FCI program should not cover flood damage losses on newly developed lands.

A source of authority for these changes is Executive Order 11990 issued by President Carter in 1978. This order specifies that federal agency programs are to "avoid, to the extent possible, the long and short term adverse impacts associated with the destruction of modification of wetlands." In addition to the authority of Executive Order 11990 there also is precedent for such program modifications. For example, "In 1962, the Congress placed a limitation on wetland drainage assistance in North Dakota, South Dakota and Minnesota (Public Law 87-732). Financial and technical assistance was prohibited if USDI determined that wetland preservation would materially contribute to wildlife preservation." (Comptroller General 1978:21).

Finally, cost sharing policy for federal public works projects should be mentioned. Farmers should be willing to support construction of public works projects by paying the costs of projects which make bottomland farming possible, if such farming is economically feasible. However, this economic feasibility test is not applied because a substantial portion of the cost of rural flood control and drainage projects is paid from federal funds. The Sicily Island project, discussed earlier, illustrates current cost sharing requirements. Ninety-eight percent of the average annual project costs attributable to agriculture are to be paid by the federal government, an annual per acre cost of $49.72. Required repayment of these costs would surely alter the private economic and financial feasibility of bottomland conversion; and, hence support for this project among farmers. Cost sharing reform is needed, although the calls for such reform in the recent past have had limited impact on policy.

Improving Payment Programs

Currently the private returns from bottomland ownership are determined by the lands' agricultural and commercial timber production potential. If monetary incentives were offered to bottomland owners who retain their lands in a natural state, these landowners would face an opportunity cost of conversion equal to the value of the incentive payment (raising C_y in equation 2). In the past the Water Bank program of ASCS and programs of the Fish and Wildlife Service have used incentive payment plans to preserve wetland areas for wildlife habitat. During the last congress, the Water Bank Act Amendments (P.L. 96-182) increased the funds available to ASCS for making incentive payments and extended coverage of the Act to forested bottomlands (Environmental Law Institute 1979). However, the amount of funds that will be appropriated to this program is uncertain and, most likely, will be limited. Furthermore, incentive payments must be justified solely on whether the area provides wildlife habitat. For payment programs to be a signfiicant influence on bottomland conversion decisions, larger budgets and broader criteria for spending must be developed.

An important goal to include in the design of incentive payment programs is to achieve program objectives at the lowest total cost. Toward this end, incentive programs should be designed with clear criteria for establishing the landowners' eligibility for receiving payment and for determining the level of payment to be received.

Preservation objectives must specify how many areas should be preserved and where those acres should be located. With this information, payments can be directed where these program objectives are most likely to be achieved. Therefore the first criterion for determining a farmer's eligibility for receiving payments should be the environmental value of the bottomlands he owns. To implement this criterion, bottomland evaluation procedures must be developed to assess the value of the multiple environmental services ascribed to bottomlands and the relative contribution of particular bottomland areas in providing these services. However, development of precise quantitative tools will be a major challenge to the biological, physical, and economic sciences at this time (Midwest Research Institute 1979, Shabman and Batie in press). A program of basic research to develop procedures should be given high priority.

The costs of an incentive payment program will depend upon the number of acres for which payments are made and the level of incentive payments per acre. One means of minimizing program costs is to restrict payments to only those acres where farmers would convert the lands to agriculture in the absence of payment not to do so. Therefore, a second criterion for establishing eligibility for incentive payments should be based upon the profitability of farming the bottomland areas deemed to be of high environmental value. To avoid the need to establish specific payments for each unique farm situation, a basic payment schedule should be developed where payments vary according to constant factors which determine profitability of conversion, such as soil type. Continuous modification in the payments schedule should then be made to reflect annual changes in factors such as interest rates, which will alter financial and economic feasibility of bottomland conversion in that year. Some limited flexibility of this type is available in the amended Water Bank Act (Environmental Law Institute 1979). Clearly, implementation of payment schemes of this nature will require improved information on the economic and financial feasibility of conversion for specific geographic areas of concern based upon the types of models presented earlier in this paper. Further research in this area would appear warranted.

Finally, new sources of funds for making payments need to be developed, because the future funding from general federal and state revenues will be limited. One promising revenue source would be to initiate beneficiary tax programs at all levels of government. A national program to coordinate the collection of revenues and disbursement of payments should then be considered. One possibility would be to initiate this coordination under the Water Bank program. Beneficiary taxes assess the groups who benefit from the continued existence of services from particular bottomland areas for part of the costs of incentive payment programs. Thus, for example, local governments or special flood control and water quality management districts, could assess their citizens and make payments for water quality and flood control benefits received from natural bottomlands. Increases in hunting and fishing license fees and earmarked excise taxes on sporting equipment should be considered as a source of revenue from those who benefit from the wildlife habitat provided by these areas. Revenues from these sources, combined with available general tax revenues, could substantially increase the funds available for incentive payment programs. With these increased funds, the potential for developing successful bottomland preservation policies will be enhanced.

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Atchafalaya Basin, Louisiana: Wetland Conservation Alternatives

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Introduction

Much of the surface water runoff from 41 percent of the continental United States is funneled through the Atchafalaya Basin (Figure 1). Following a major flood in 1927, Congress passed the Flood Control Act of 1928 giving the U.S. Army Corps of Engineers (Corps) authority to formulate and construct a flood control project in the Atchafalaya Basin as part of the Mississippi River and Tributaries Project. Upon project completion, half of the Lower Mississippi River project flood would be diverted through the Atchafalaya Basin Floodway System to the Gulf of Mexico. This system consists of three units (West Atchafalaya Floodway, Morganza Floodway, and Atchafalaya Basin Floodway) bounded by perimeter levees east and west of the Atchafalaya River.

Corps' studies indicated that by 1975 the Mississippi River would change its course by making the Atchafalaya River its main channel to the Gulf. To protect water-dependent investments along the Mississippi River in the Baton Rouge-New Orleans area, Congress authorized in 1954 the construction of the Old River Control Structure. That structure allows 30 percent of the combined flow of the Red and Mississippi Rivers to enter the Atchafalaya River; the remaining 70 percent continues down the Mississippi River.

Sedimentation has accelerated in the Atchafalaya Basin floodway primarily because the Corps has constricted the natural river floodplain between perimeter guide levees. The Corps, recognizing that sedimentation reduced flood-carrying capacity, implemented a program to restrict overbank flow. Levees adjacent to the Atchafalaya River were raised and strengthened, the upper and middle reaches of the river were channelized, and many major distributaries were closed. This greatly reduced overflows into adjacent backswamps. Funds were exhausted for center channel enlargement in 1968; flood control efforts have since been restricted to raising perimeter levees. In 1971, an agreement was reached between the National Wildlife Federation and the Corps postponing work to further enlarge the center channel until an Environmental Impact Statement could be prepared.

In 1972 Congress directed the Corps to review the existing project in cooperation with state and federal agencies with a view toward developing a comprehensive plan for the management and preservation of the water and related land resources of the Atchafalaya Basin. This plan was to include provisions for reduction of siltation, improvement of water quality, and possible improvement of the area for sport and commercial fishing.

In 1975, an interagency group chaired by the Corps developed a Multipurpose Concept Plan that included structural features for sediment reduction and water management, and non-structural features (i.e., fee or easement acquisition) to

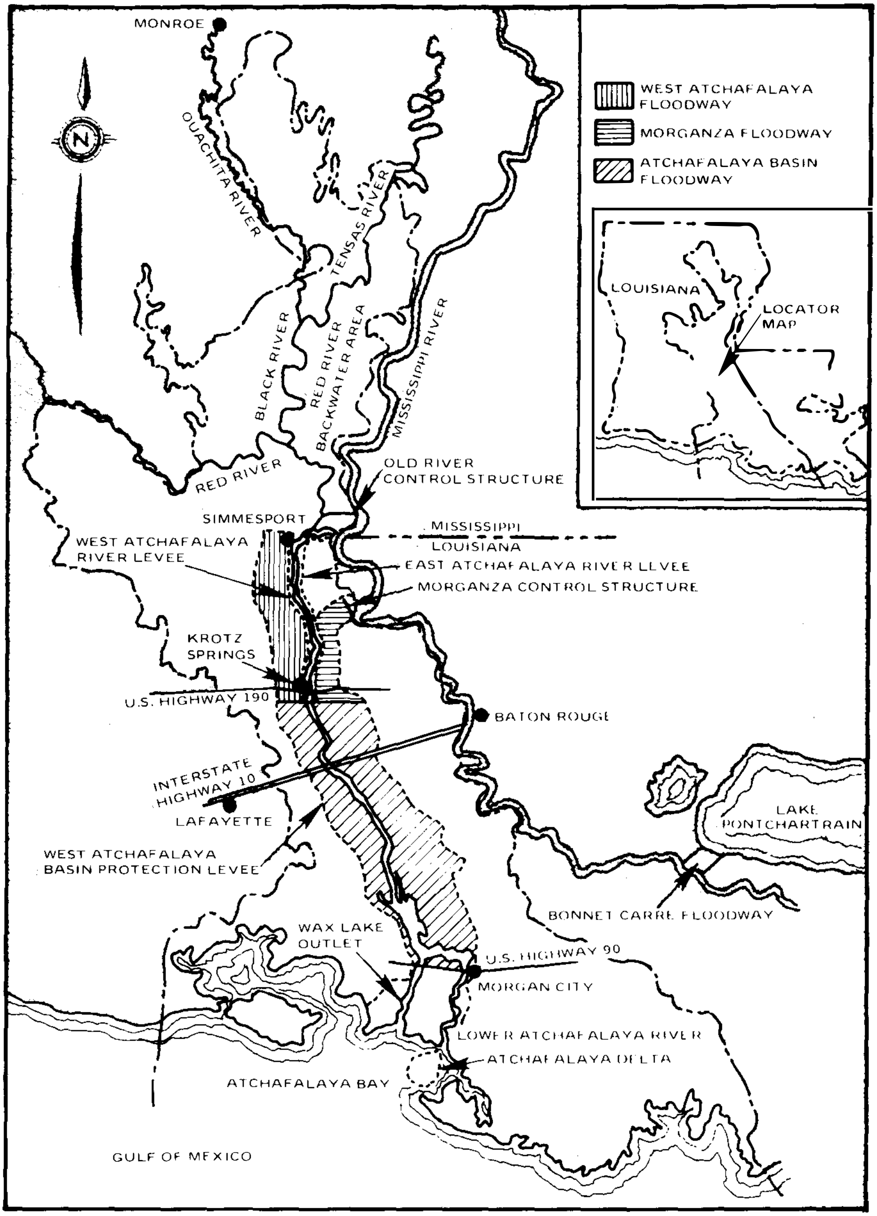

Figure 1. Atchafalaya Basin

prevent forest clearing and provide public access for hunting, fishing, and other outdoor recreation. In 1976 the Corps announced its willingness to help refine the Multipurpose Concept Plan into a proposal for submission to Congress. Efforts to clarify specifics of the plan have continued since that time; however, the complexity of the problem has hindered progress.

Fish and Wildlife Resources

Despite extensive land clearing within the upper Atchafalaya Basin and tremendous sedimentation in the lower Basin, a vast forested wetland complex remains largely intact in the Atchafalaya Basin Floodway (U.S. Fish and Wildlife Service 1978). The 575,000-acre (232,690 ha) floodway contains a maze of overflow swamps, lakes, bayous, and distributaries and is among the most productive fish and wildlife areas in North America. A great abundance of wildlife occurs in this vast wetland complex. In addition, this area supports an extremely productive sport and commercial fishery and provides unique recreational opportunities to hundreds of thousands of persons annually.

Over 300 species of resident and migratory birds occur in Louisiana (Lowery 1974) and most are expected to utilize the Floodway at some point in their life cycle, including approximately 50,000 wading and colonial nesting birds (Portnoy 1977). Every year, great flocks of migratory waterfowl winter in the overflow swamps and lakes of this area. The lower floodway lakes and the emerging delta in Atchafalaya Bay support one of the largest wintering concentrations of canvasbacks in the Mississippi Flyway. The floodway's wooded wetlands provide vital nesting habitat for wood ducks. According to Glasgow and Nobel (1974), the floodway probably winters the highest population of American woodcock of any area of comparable size in North America.

The Atchafalaya Basin Floodway supports wild turkey, white-tailed deer, and one of the last remaining black bear populations in Louisiana. Abundant small game mammals include gray and fox squirrels, eastern cottontail, swamp rabbit, and raccoon. The area also supports a tremendous population of commercially important furbearers including nutria, muskrat, mink, river otter, beaver, raccoon, bobcat, gray fox, and opossum.

At least 65 species of herpetofauna occur in the Floodway (Keiser 1976). The American alligator, classified as threatened in this area, occurs throughout most of the Floodway. The largest nesting concentration of the endangered bald eagle in the south-central United States is located within the natural Atchafalaya Basin just southeast of the Floodway. Although the ivory-billed woodpecker is believed by many to be extinct, Louisiana State University Professor Robert B. Hamilton has recently found evidence of its presence in the floodway. Other endangered species that may be present include Bachman's warbler, peregrine falcon, and Florida panther (U.S. Fish and Wildlife Service 1979).

The Atchafalaya River and a myriad of bayous, distributaries, and overflow lakes and swamps are responsible for a great abundance of fishes and crustaceans. The floodway's annual cycle of flooding and dewatering is the major factor contributing to its productivity. Overflow during late winter through early spring is essential to providing spawning, feeding, and rearing habitat for these organisms. Annual overflow also flushes aquatic systems, transports valuable nutrients, allows for the distribution of fishes among various habitats, and induces spawning in certain species. Dewatering during summer and early fall allows the oxygenation of soils, permits decomposition of excessive organic matter, concentrates forage fishes, and allows growth of vegetation utilized by fish and crawfish for food and cover when reflooded.

According to Bryan et al. (1976), over 85 species of fish occur in the floodway. Sabins (1977) notes standing crop estimates of more than 1,000 pounds per acre

(1,120 kg/ha) in the floodway. Important sport-fishes include largemouth bass, white crappie, black crappie, warmouth, bluegill, redear sunfish, and channel catfish. Red swamp crawfish, white river crawfish, and blue crabs are also important from a sport harvest standpoint. A study conducted by the Corps and the Louisiana Department of Wildlife and Fisheries revealed that sport fishermen spent an average of 702,000 man-days annually in the floodway during 1971-1974, and harvested 2.9 million fish, 1.6 million pounds (725,750 kg) of crawfish, and 216,000 blue crabs (Soileau et al. 1975).

The commercial fishery and furbearer resources of the Floodway are outstanding. Crawfish support an annual commercial harvest of nearly 22 million pounds (10 million kg) (Soileau et al. 1975), comprising approximately 85 percent of the world's wild crawfish havest. Annual flooding is extremely important to crawfish production and harvest. During the high water year of 1973, approximately 43 million pounds (19.5 million kg) of crawfish were harvested from the floodway. Additionally, more than 6 million pounds (2.7 million kg) of commercial finfish and over 40,000 furbearers are harvested annually from the floodway (Soileau et al. 1975).

Although a vast majority of this floodway's forested wetlands is closed to public use, considerable public access to bayous, lakes, and distributaries is still available. Pleasure boating, water skiing, swimming, camping, picnicking, pleasure driving, and other similar activities account for an estimated 426,000 man-days of use annually (Soileau et. al. 1975).

The economic value of the fish, wildlife and related recreational resources of the Atchafalaya Basin Floodway is tremendous. Using average annual participation rates for 1971–1974 from Soileau et al. (1975) and monetary values adjusted to 1977 price levels, we estimate that the value of sportfishing and hunting approaches $52 million annually, and that non-consumptive recreational activities are worth over $36 million annually. Annual commercial fish harvest and furbearer harvest in the floodway averaged nearly $9 million during 1971-74. Thus, the fish, wildlife, and related resources of the Atchafalaya Basin Floodway annually contribute nearly $100 million to the nation's economy.

Problems

The floodway is threatened today by the same factors that have led to the destruction of forested wetlands throughout the Lower Mississippi River Valley, namely federally-supported flood control projects and private agricultural expansion (U.S. Fish and Wildlife Service 1978). Congressional authorization of the Mississippi River and Tributaries Project in 1928 led to the construction of the Atchafalaya Basin Floodway System. Corps activities in this system have promoted a gradual but definite deterioration of fish and wildlife habitat, a trend which may destroy this nation's largest remaining contiguous tract of wet bottomland hardwoods.

Prior to construction of the Old River Control Structure, increased natural diversion of the Mississippi River into the Atchafalaya River filled many of the larger lakes of the Atchafalaya Basin Floodway with river-borne sediment. Perimeter levees confined flows to the central part of what was once a much larger floodplain. The normal pattern of greatest sedimentation along the natural levees was changed to one of heavy deposition in the interior floodway lakes and swamps and in Atchafalaya Bay. Normal alluvial deposition has been greatly accelerated by Corps activities. Channelization of the river and most major distributaries, together with associated spoil placement, severely reduced overbank flow during non-flood years, altering that all-important flooding and dewatering cycle.

North of the Atchafalaya Basin Floodway, the West Atchafalaya and Morganza Floodways are protected from annual river overflow by artificial levees. The West Atchafalaya Floodway, which has never been used for flood control, has undergone widespread agricultural development and settlement. Although the Corps originally purchased a flowage easement at 50 percent of fee value over this entire 170,000-acre (68,796 ha) area, a 1972 census by the Corps indicated 3,524 persons residing in the floodway and 874 permanent homes. Over 50 percent of this area has been cleared and placed into agriculture, primarily soybeans; land clearing continues at a rapid pace. A comprehensive easement was purchased at full fee value over the entire 57,000-acre (23,067 ha) Morganza Floodway; however, nearly 50 percent of this floodway has also been cleared and converted to agriculture.

Within the Atchafalaya Basin Floodway, early attempts at agriculture and settlement were abandoned because of increasing overflow from the Atchafalaya River. However, increased land elevations within the floodway, resulting from spoil deposition, sedimentation, and declining water levels attributed to center channel enlargment, have invited new attempts at settlement and agriculture. Although Congress in 1928 authorized the purchase of simple flowage easements on 68,000 acres (27,518 ha) in the Atchafalaya Basin Floodway, easement on only 9,100 acres (3,682 ha) has been acquired.

Recent land clearing operations leave little doubt that the fate of the Atchafalaya Basin Floodway will be identical to that of the Morganza and West Atchafalaya floodways if the present landowners control its destiny. Over 13,000 acres (5,260 ha) of wet bottomland hardwoods have been cleared in the floodway, with a 27 percent increase in cleared land over the past four years alone. The Corps predicts that an additional 180,000 acres (72,843 ha) of forested floodway may be cleared within the next 50 years (Atchafalaya Basin Agency Management Group 1978). This is equivalent to over 40 percent of the privately-owned land of the floodway. The Corps also predicts the following within the next 50 years:

1. up to a 40 percent loss of open water areas due to siltation and reduced water levels;
2. up to a 40 percent reduction in average crawfish harvest;
3. up to a 30 percent reduction in average commercial fish harvest;
4. up to a 30 percent reduction in waterfowl usage;
5. up to a 40 percent reduction in songbird usage;
6. up to a 55 percent reduction in the squirrel population; and
7. up to a 60 percent reduction in the deer population.

The Solution: Acquisition or Easement

Acquisition

There is little hope that the remaining woodlands within the West Atchafalaya and Morganza floodways can be preserved. However, the nation's largest forested wetland complex remains relatively intact in the Atchafalaya Basin

Floodway. The Floodway contains nearly 500,000 acres (202,342 ha) of hardwood swamp, an area larger than the vast Okefenokee Swamp of Georgia and Florida. Because of the tremendous value of the fish and wildlife resources of this floodway and its crucial importance for flood control, the Department of the Interior, through its Fish and Wildlife Service, proposed that the privately-owned land of the floodway be acquired in fee by the Corps as an integral part of any multipurpose plan to be recommended for Congressional authorization (U.S. Fish and Wildlife Service 1978).

In its proposal, presented to the Atchafalaya Basin Agency Management Group in October 1978, the Department of the Interior sought to accomplish three basic goals. These goals, outlined by the Honorable James A. Joseph, Under Secretary of the Interior, before the Lafayette, Louisiana, Chamber of Commerce, on November 19, 1979, include (1) eliminating further development and agricultural expansion that threatens future use of the floodway to pass flood flows; (2) retaining and restoring, where possible, the unique environmental features of the floodway in order to protect their long range productivity; and (3) maximizing access to the public who will pay over $1 billion to complete the plan ultimately selected.

In its proposal, the Department of the Interior recommended public acquisition of 443,000 acres (179,275 ha) of privately-owned land within the Atchafalaya Basin Floodway for establishment of an Atchafalaya Fish, Wildlife, and Multi-Use Area. This area would not be a national wildlife refuge, national park, national recreational area, or preserve. Instead, it would blend natural resource conservation with multifaceted public utilization. It would be a natural area where the general public could hunt, fish, trap, birdwatch, hike, camp, canoe, boat ride, and study nature.

The proposed Multi-Use Area would be highly compatible with any proposed flood control plans for the floodway. The difficulties of implementing an adequate flood control program while satisfying landowners, conservationists, commercial fishermen, and other interest groups are presently severely hindering progress toward the goals of flood control and wetland preservation. With public acquisition, resolution of these conflicts would be greatly expedited. In addition, the threat of further development interfering with flood passage would be removed. The objectives of flood control and environmental quality could be achieved in a showcase fashion, utilizing the technical expertise of the Corps, Department of the Interior, U.S. Environmental Protection Agency and appropriate state agencies.

During the heated debates following the release of the fee acquisition proposal, five major issues surfaced. Concerns focused on the impact of fee acquisition on state-owned lands in the floodway, on mineral rights of private landowners, on oil and gas exploration activities, on the tax base of parishes (counties) that would lose lands through acquisition, and on the price that would be paid to private landowners for their land.

Many of these concerns were easily addressed. For example, since the proposal calls for the acquisition of only privately-owned lands, all state-owned lands would remain under state control. Thus, any oil royalties or other income to be derived from state property would continue to accrue to the State of Louisiana. Although approximately 100,000 acres (40,468 ha) of state-owned land are known to occur in the floodway, the location of most of these lands is unknown.

According to the Interior proposal, present landowners would retain all oil and gas rights in perpetuity. Even with this provision, landowners argue that with federal acquisition, severe restrictions would be imposed on oil and gas exploration activities. In order to resolve these fears, the Fish and Wildlife Service, on March 1, 1979, began to work with the Mid-Continent Oil and Gas Association, an organization representing the major oil and gas producing companies operating in the floodway, toward the preparation of language which would guarantee the continued efficient and effective operation of that industry in the basin. Since that time, mutually acceptable language has been drafted which essentially recognizes oil and gas activities as fully compatible with any multipurpose plan and states that such activities within the floodway would not be subject to any additional restrictive regulations. The Fish and Wildlife Service has indicated that it is amenable to inclusion of that language into any authorization for establishment of the Atchafalaya Fish, Wildlife, and Multi-Use Area.

Because sizable portions of six parishes would be acquired under this proposal, the potential for seriously reducing parish property tax receipts is of major concern. However, the Louisiana Congressional Delegation can recommend that the Revenue Sharing Act of 1935 and amendments of 1978 be made applicable to lands purchased within the Atchafalaya Basin Floodway. Under this Act, affected parishes could receive annual federal payments equal to either three-fourths of one percent of the fair market value of the purchased lands, $0.75 per acre, or 25 percent of the net receipt from the sale of land products (such as timber), whichever is greater. Accordingly, it is estimated that parishes would receive annually over three times the amount presently derived through taxes from private landowners.

Finally, landowners believe that the presently appraised fair market value of $87 million for the privately-owned land of the floodway is ridiculously low. This figure, which averages nearly $200 per acre was established in 1977 by a firm under contract to the Corps and is based on prices paid during recent exchanges of parcels within the floodway. Since 11 individuals, companies, or estates own up to 80 percent of the private land in the Atchafalaya Basin and because most of these holdings were acquired for speculative purposes, with few if any recent sales or exchanges of parcels, it is likely that the 1977 appraisal was based on outdated per-acre prices. Thus, new appraisals resulting in greater compensation to landowners would be required should fee acquisition be authorized.

Easement

The Fish and Wildlife Service has carefully addressed and resolved most of the primary concerns regarding the acquisition proposal. However, certain groups, individuals, and, in particular, political leaders have recommended that a compromise be sought to provide the necessary environmental safeguards while guaranteeing flood protection. Many believe that the adoption of a compromise by the Fish and Wildlife Service would enhance the probability of political acceptance, the key to success for any proposal.

In order to preserve the natural productivity of the Floodway, Congress would be required at a minimum, to authorize and fund the acquisition of a comprehensive easement package that would eliminate all development inconsistent with fish and wildlife conservation and flood control, eliminate agricultural expansion, and eliminate timber management practices inconsistent with the needs of fish and wildlife productivity. The cost of such an easement is estimated at approximately 70 percent of the cost of fee acquisition, and, yet, that easement would contain no provision for public access. In reality, public funds would be expended to preserve a resource for the benefit of an extremely limited segment of the population, the present landowners. The cost for public access rights would likely exceed 20 percent of fee acquisition costs. If this amount were added to the cost of development and agricultural controls, the total expense incurred would approximate 90 percent of total fee value.

The administration and management of a comprehensive easement on privately-owned land would be a monumental task. Lengthy and costly legal battles to clarify interpretations of the easements are likely. Governmental officials could also be pressured not to enforce easement provisions. Thus, the fish and wildlife resources and public investment in the Floodway could be shortchanged. The cost associated with the attempted administration of such an easement may well exceed the 10 percent saved by taking only the comprehensive easement.

We believe that the likelihood of an easement protecting the fish and wildlife resources of the Floodway and preserving its continued use for flood control is highly questionable. Use of the easement concept out of compassion for present landowners may result in a massive expenditure of public funds without achieving the objective of preserving one of America's greatest natural resources.

Conclusion

Establishment of the Atchafalaya Fish, Wildlife, and Multi-Use Area provides a rare opportunity to achieve the goals of flood control, protection of fragile wetlands and associated fish and wildlife resources, and maximization of public access. Conversion to public ownership would also greatly facilitate compliance with two often ignored Executive Orders relating to floodplain management and wetland preservation. By means of Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands), President Carter has directed federal agencies to avoid adverse impacts associated with the occupancy and modification of floodplains and wetlands and to avoid support of wetlands and floodplain development wherever there is a practical alternative. Clearly, federal acquisition would not only remove the threat of further development within the Atchafalaya Basin Floodway, but would allow the Departments of the Interior and Army to satisfy those portions of Executive Orders 11988 and 11990 requiring agencies to restore and preserve the natural and beneficial values of floodplains and wetlands. Furthermore, fee acquisition of the privately-owned lands of the floodway would also be in compliance with President Carter's June 6, 1978, Water Policy Directive, which directs acquisition of flood-prone lands where consistent with primary project purposes.

The key factor that will determine the ultimate fate of the Atchafalaya Basin Floodway is one of ownership. If the floodway is left in private ownership, its fate can be expected to be identical to the rest of the privately-owned hardwood forests of the Lower Mississippi Valley, i.e., conversion to cropland. No incentive has yet been or is likely to be found that will convince landowners to halt clearing of their land when it becomes even marginally profitable to do so. Conversion to public ownership is the only way to guarantee the continued existence of the vast Atchafalaya Basin Floodway as a vital part of our nation's irreplaceable wetland heritage.

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The Cache River Basin, Arkansas: Tragedy and Opportunity

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History of the Project

In the early 1950s, the Cache River Basin, located in the Mississippi Alluvial Valley, the Delta, of eastern Arkansas, was somewhat developed by agricultural interests and characterized by expanding farming operations in the upper basin where local interests had previously channelized the upper reaches of the Cache River and Bayou DeView. The middle and lower reaches of both streams remained intact and were essentially a continuous expanse of bottomland hardwoods/wetlands. Although woodland acreages are not known for 1950, it is certain that more were present than the 285,000 acres (115,338 ha) of bottomland hardwoods the Fish and Wildlife Service (FWS) inventoried in 1959. Through the mid-1960s this trend of rapidly expanding agriculture in the upper basin was in sharp contrast to the restraint toward farming in the immediate floodplain of middle and lower basins as evidenced by review of circa 1965 U.S. Geological Survey topographic sheets of the basin.

With the passage of the Flood Control Act of 1965, a new resurgence of interest for flood control in the basin was evidenced. The 1965 Act reaffirmed the original channelization project and together with the widespread introduction of the soybean and continuation of a dry cycle, landowners and speculators ventured into the 10-year, 2-year, and even to the stream banks in every increasing numbers. It is interesting to note that after almost 20 years of federal planning efforts and authorizations, it took the soybean and a dry cycle to prompt the local landowners to agree to sponsor the U.S. Army, Corps of Engineers (Corps) project.

By 1978, many changes had taken place. Lawsuits challenging the adequacy of the Corps' Environmental Impact Statement (EIS) had been filed and a new EIS had been written and accepted by the courts. Approximately 7.5 miles (12.1 km) of authorized channel had been dug. Almost 10,000 acres (4,047 ha) of mitigation lands had been acquired. On the surface it seemed that project completion was just around the corner.

Nothing could have been farther from the truth. Construction of the project was halted in 1977 and except for certain minor measures, no work has taken place since that time. The Cache River project was one of the 19 identified by President Carter in 1977 as appearing unsupportable on economic, environmental, or safety grounds and one that the President recommended no funds be provided for in Fiscal Year 1978. With this critical review by the President, opponents of the channelization project intensified their efforts to halt contruction of a project that had now been questioned by the highest office in the land.

Foremost in the minds of those seeking a more environmentally acceptable solution to development of the basin was the stark reality of the loss of the basin's woodlands/wetlands. In 1978, only an estimated 151,000 acres (61,109 ha) of woodlands were left in the basin, including the three management areas owned by the Arkansas Game and Fish Commission (AGF). Thousands of sportsmen had no place to hunt and they only had to look at the 7.5 miles (12.1 km) of completed ditch to realize their fishing would also soon be a thing of the past. Even the prospect of the authorized mitigation lands didn't appear to provide much relief since over half of the money allocated had been spent to provide protection to fewer than 10,000 (4,047) of the authorized 70,000 (28,329) acres (ha).

Resources of the Cache River Basin

A logical question of anyone not familiar with the Cache River Project would be: why all the controversy? The answer is quite simple. As long ago as 1959, FWS cited the Cache River Basin habitat values for waterfowl as being "among the highest remaining within the lower Mississippi Flyway" and "are of both national and international importance." More recently, FWS (as part of a five-member Task Force) concluded that "Any further deterioration of the acreage or quality of woodlands/wetlands in the Cache River Basin will impose further damages on an already stressed wintering waterfowl population. Such deterioration will ultimately cause a decline in the continental migratory waterfowl population." These rather strong statements indicate the importance of the basin's woodlands/wetlands to an overwintering population of almost 250,000 mallards and the estimated 30,000 resident wood ducks.

These same woodlands and wetlands provide excellent habitat for a wide variety of resident wildlife species. White-tailed deer reach densities of 1 individual per 20 acres (1 to 8.1 ha) in parts of the Cache Basin and in excess of 1,100 deer were harvested during the 1971-1972 season. Recently stocked wild turkeys are expanding in several locations and huntable populations are found in four counties. Fox and grey squirrel numbers are estimated to average about 70,000. Furbearers such as mink, beaver, muskrats, opossum, river otter, raccoon, coyote, gray and red fox, bobcat, and striped and spotted skunks are common and their annual value (as pelts) was estimated to be almost $40,000 in 1978.

Non-consumptive resources are also present in impressive numbers. Midwest Research, Inc. (MRI), lists 268 species of birds including the bald eagle, golden eagle, and the osprey as recorded in the Cache River Basin. MRI also listed 65 species of herptiles and 59 species of mammals including the protected (by the state) black bear.

Although declining in recent years due to loss of habitat and high levels of pesticides, herbicides, and turbidity, fishery resources of the Cache River Basin have historically been important. MRI noted 56 species of fishes in the Basin and the FWS reported in 1978 (using AGF data) a diverse fish population in the natural stream reaches of the middle and lower basins with a standing crop up to 300 pounds/acre (336 kg/ha) in the natural reaches of Cache River and 239 pounds/acre (266 kg/ha) in the natural reaches of Bayou DeView.

The Authorized Project

Physical Characteristics

The authorized Cache River Project would channelize the Cache River from its confluence with the White River upstream for 155 miles (250 km) and its major tributary for 77 miles (124 km). Over 156 miles (251 km) of natural stream reaches are included in these totals. In the lower portions of the Cache River, the bottom-width of the newly formed ditch would be 200 feet (61 m) with a depth of 23 feet (7 m). At the extreme upper end of the project, actually in the state of Missouri, the bottom-width would be 25 feet (7.6 m). Bottom-widths on Bayou DeView would vary from 140 feet (43 m) to 50 feet (15 m). Total project rights-of-way would require 18,992 acres (7,686 ha) and approximately 115,000,000 cubic yards (87,920,489 cu m) of spoil material would be deposited. Construction would take 17 years.

Projected Benefits and Costs

The previous sections described what is present in the Basin, what would happen should the project be completed, and what the project actually encompasses. What about the benefits—who receives them and in just what form? Simply stated, benefits have been determined for all lands where the frequency, depth, and duration of flooding will be reduced by the project.

Another way, however, of stating what the benefits would be, or where the benefits would come from, presents an entirely different picture. While the project is touted to be a flood control project, only 35 percent of the benefits come from flood damages prevented. Over 50 percent of the benefits come from either more intensively utilizing agricultural lands that continue to flood or to clear existing woodlands and convert them to agricultural lands that would flood without the federal project. What would seem to be a flood control project could just as properly be called a reclamation project.

With the recent inflationary trend, the overall costs of the authorized project go up. What was reported as a $25,100,000 project in 1959 grew to an $80,020,000 project in 1974 and then to a $104,560,000 project in 1977 (the last year figures are available). Curiously enough, the benefit:cost ratio improved during this same period from 1.5 to 1 in 1959 to 2.8 to 1 in 1977. Another way of looking at these escalating dollars is to relate total project expenditures to each acre protected. This is particularly appropriate since only 4.5 percent of the benefits are derived from protection to non-crop or non-agricultural features. Dividing the acres to be protected into the 1977 *estimated* project cost shows that $132.00 is going to be spent to protect each acre (0.40 ha), most of which are eligible to participate in the Federal Crop Insurance program and many of which are utilized to grow crops that are frequently in surplus and eligible for federal price supports.

Impacts of the Authorized Project

The magnitude of the identificable project impacts, particularly to migratory waterfowl, prompted the FWS in 1978 to conclude that "the authorized Cache River project. . . , is the single most damaging project to waterfowl resources in the nation today." The same conclusions were reached by the Mississippi and Central Flyway councils. Others on record as opposing the authorized project include 10 individual states, the International Association of Fish and Wildlife Agencies, the National Wildlife Federation, the Wildlife Managment Institute, the Environmental Defense Fund, the National Audubon Society, the Izaak Walton League, the Sierra Club, the Sport Fishing Institute, the American Forestry Association, the Outdoor Writers Association, the Welder Wildlife Foundation, the Ding Darling Foundation, 8 other national organizations, and over 20 local organizations.

These agencies and organizations are opposed to the destruction of fish and wildlife resources of the Cache River Basin; but more specifically they are opposed to the destruction of a functioning ecosystem as well as its renowned public resources by the expenditure of public funds for private gain. Unchallenged is the acceptance that fish and wildlife resources are public resources. Certainly the tax dollars expended to construct the project are public resources. At the same time the anticipated on-farm agricultural benefits are first and foremost to the private sector.

In terms of dollars, FWS in 1978 performed an evaluation of the authorized plan as presented in the Corps' Final EIS and estimated a net loss of $1,022,000 in identifiable fish and wildlife recreational values. Not included are downstream impacts resulting from higher water levels, the discharge of as much as 22,000 tons/day (19,800 metric tons/day) of sediment into downstream waters, the value of the woodlands/wetlands for storage of flood waters, ground water recharge, filtration and nutrient removal, and a host of other known and accepted functions of natural ecosystems.

Directly in the path of the authorized project are the Dagmar, Black Swamp, and Bayou DeView state wildlife management areas. Two of these areas were purchased and are managed with Pittman-Robertson (P-R) funding and the third, Black Swamp, was purchased with Land and Water Conservation Funds and managed with P-R funds. Approximately 700 acres (283 ha) of these three areas would be destroyed by the project. The Dagmar area would be severed and fragmented to such an extent that over 1,000 acres (405 ha) would become almost impossible to manage.

The Alternatives

Past federal planning efforts for the Cache River project have been less than objective; a fact recently pointed out by Mr. Charles Warren, chairman of the Council on Environmental Quality. In the winter, 1979, issue of *Water Spectrum*, Mr. Warren addressed the history of the Cache River project and how recent changes to the National Environmental Policy Act (NEPA) would have changed this history. Mr. Warren explained that under today's NEPA, "the Corps would have been explicitly required to explore and objectively evaluate all reasonable alternatives to channelization with the same detail and thoroughness it accorded its preferred action. Simply put, it would have had to take the alternatives seriously rather than—as was the case—dismissing them. It would have been required to explain, if it rejected the alternatives, why it rejected them."

The existence of more environmentally acceptable alternatives to channelizing the Cache River is unquestionable. In their Final EIS the Corps presented three such alternatives, all of which are engineeringly feasible and have benefits that exceed costs. However, these alternatives were simply pushed aside in favor of the authorized plan. Therein lies the dilemma. After rejecting environmentally acceptable alternatives, alternatives that at the same time provide reasonable levels of flood control, how can channelization of the very heart of the basin's woodland/wetland complex be made environmentally acceptable. The answer is that it can't.

In an attempt to resolve the issue the AGF and the Arkansas Wildlife Federation (with grant assistance from the Winthrop Rockefeller Foundation) commissioned Coastal Environments, Inc. (CEI) to study the needs and opportunities in the Basin. CEI's report, *Cache River Basin, A Study in Floodplain Management*, was completed in August, 1977. This report pointed out the ultimate error inherent in all single-purpose flood control projects; that merely pushing your troubles downstream provides at best only a very short term solution to the problem(s). Instead, CEI studied the entire floodplain and more importantly proposed to manage the entire floodplain. Problems, they said, that originate in a basin should be also managed in that same basin. These problems should not be pushed downstream to add to the woes of others.

As might be expected, this concept of total floodplain management was not universally accepted. Federal costs were higher, identifiable benefits were lower, and the point that really killed any chance of acceptance was that the project beneficiaries, the local sponsors, found the increase in costs (to them) was unacceptable. In a federal water resource project, without a sponsor you have nothing.

By October of 1977, proponents and opponents of the authorized project were completely polarized. To try and reach a compromise solution, the Environmental Protection Agency, FWS, AGF, Arkansas Pollution Control and Ecology, and a citizens' representative formed a task force to look at the problems and opportunities of the Basin and proposed solutions that would hopefully be agreeable to all parties. The recommended solution, a floodway concept, combined features of the authorized plan, engineeringly feasible features previously discarded by the Corps, and features from CEI's study. Unfortunately this effort also failed to gain support and like 21 previous studies of the Cache, it too has been placed on the shelf.

No monies have been included in the last two fiscal years for federal works in the Cache Basin. The project is authorized, but in limbo. Some changes from woodlands/wetlands to agricultural lands are taking place. Flooding is occurring and will continue to occur.

The Future

The authorized Cache River project is a single-purpose approach to solve problems that were identified in 1950. Today, in 1980, this approach cannot hope to address the complex issues that have surfaced in the last 30 years. Time has shown the current authorization represents an unworkable solution. To be successful, any project must begin with the recognition that there are legitimate environmental concerns *and* legitimate flood concerns in the basin. Any water resource development project must address both.

Perhaps the only solution to resolution of the long standing controversy would be to deauthorize the project and restudy all the basin's problems and needs under the U.S. Water Resources Council's Principles and Standards and the new National Environmental Policy Act. Now NEPA's scoping process requires substantive input from *all* parties and must identify key issues and alternatives at the earliest date possible. A new study could address flood control, fish and wildlife, water quality, water supply (for irrigation), outdoor recreation, and other problems and needs of the basin. Hopefully, such an effort could begin with an objective approach that has been conspicuously absent while the authorized ditch is still around.

Certainly any further work on the authorized project would cause a continuation of unresolved conflicts while unnecessarily destroying a large portion of a unique wetland ecosystem. However, these very wetlands are presently being lost in bits and pieces, even without the project. The prospect of eventual flood protection by the authorized project and the fear of losing lands to the mitigation process have stimulated continued conversion of woodlands to agricultural lands. Thus, each year the cry for flood protection is louder since more agricultural land is flooded. The federal planning process has failed by both action and inaction. Nothing is being protected in the Cache River Basin.

Because of the importance of the wetlands in the Cache River, the FWS recently began to address one of these complex issues. As part of the Bottomland Hardwood Preservation Program (BLHP), the FWS in 1978 identified lands in the Cache River Basin critical to the Mississippi Flyway population of migratory waterfowl. Under BLHP, Migratory Bird Stamp Act funds derived from the sale of federal duck stamps are used to acquire lands from willing sellers for protection of migratory waterfowl and other wildlife species. Once acquired, lands become a part of the National Wildlife Refuge System.

As the first step toward possible land acquisition efforts in the Cache River Basin, the FWS began the scoping process required by NEPA. A Notice of Intent has been written. Later this year a draft EIS will be circulated. Scoping meetings are being held with both proponents and opponents of the authorized project. Willing sellers of wetland areas have come forward. Interest is widespread. A proposal to spend public dollars to protect public resources for all the public is available.

There is still an opportunity to save the wetlands of the Cache River Basin.

Importance of Bottomland Hardwoods as Wildlife Habitat in an Urban Environment

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Introduction

Utilization of wildlife for nonconsumptive recreational purposes has become increasingly important in recent years (Leedy et al. 1978). With human populations and accompanying recreational demand increasing while wildlife habitat decreases, the remaining habitat becomes even more important. This is particularly true when that habitat is near urban areas, thereby providing an opportunity for large numbers of people to enjoy its presence and its wildlife. As energy supplies become scarcer and energy prices rise, demands for outdoor recreation in close proximity to urban areas will also rise. Our study focused on determining the wildlife utilization and habitat value of a bottomland hardwood forest community surrounded by an urban area. Lists of all species observed are not included here. More detailed information is available from the senior author.

Study Area

The study was conducted on a 334-acre (134-ha) tract of land that is part of the St. Paul (Minnesota) Downtown Airport. The area, directly adjacent to the Mississippi River, is surrounded by residential and industrial land uses (Figure 1). Four distinct habitat types are present. A bottomland hardwood forest covers 130 acres (52 ha) and consists of two distinct successional stages: a climax forest dominated by cottonwood *(Populus deltoides)*, black willow *(Salix nigra)*, red maple *(Acer rubrum)*, and American elm *(Ulmus americana)*; and a densely stocked shrubland community of young saplings of the above species. Understory vegetation includes sprouts of the above species plus elderberry *(Sambucus canadensis)*, stinging nettle *(Urtica dioica)*, and goldenrod *(Solidago* spp.). Other habitat types present include an 86-acre (34-ha) wetland dominated by bulrush *(Scirpus fluviatilis)*; transmission line right-of-way and other disturbed areas occupying 51 acres (20 ha) dominated by ragweed *(Ambrosia* spp.), wormwood (*Artemisia* spp.), and alien species; and a shortgrass meadow covering 67 acres (27 ha). The meadow, maintained by mowing, is predominantly fescue (*Festuca* spp.) and blugrass (*Poa* spp.).

Methods

Avian populations were censused using a transect method modified from Hall (1946) and Kolb (1965). Transects were established so that each covered the interior of one or more of the four habitat types. Three observation periods occurred during the year and were designed to census fall migrants, spring migrants, and breeding birds. Surveys were conducted morning and late afternoon for four days during each of the census periods.

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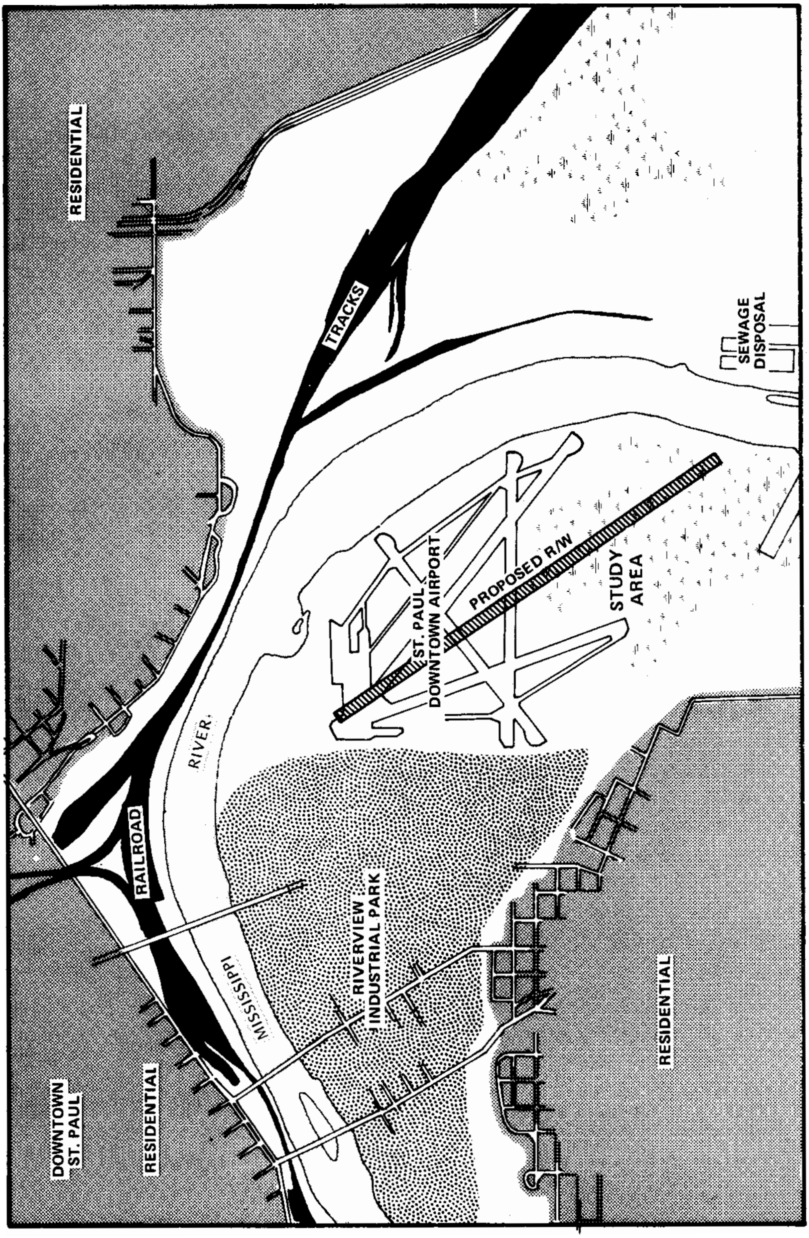

Figure 1. Location of study area in relation to surrounding land uses.

Live trapping was the primary method for collecting data concerning mammalian habitat utilization. Live traps of four different sizes were set in each of the major habitat types, baited, checked, and reset each morning for four days during early May; a total of 480 trap nights was recorded. Mammals seen during bird census operations were also noted as to species, number, and habitat utilizaiton. All mammal data were collected for qualitative analysis only.

Results

Fall Bird Survey

A total of 27 bird species was observed during the fall census period. Tree sparrows *(Spizella arborea)* were the most abundant species overall, followed by black-capped chickadees *(Parus atricapillus)*, snow buntings *(Plectophenax nevalis)*, slate-colored juncos *(Junco hyemalis)* and ring-necked pheasants *(Phasianus colchicus)*. Tree sparrows and black-capped chickadees were also most abundant in the forest habitat.

In terms of relative number of birds within each habitat type, average daily sightings were highest in the hardwood forest (41), followed closely by disturbed areas (40). Much fewer numbers of birds were observed in the wetland (8) and meadow (2).

In addition to the highest number of birds, more species showed a preference for the hardwood forest than any other habitat type. Twenty of the 27 species in the study area were observed in the forest, and nine of these were observed only in the forest. This compares with two species restricted to each of the wetland and disturbed areas and one to the meadow.

Spring Bird Survey

Thirty-five bird species were observed during the spring study period. Red-winged blackbirds *(Agelaius phoeniceus)* were the most abundant overall, followed by slate-colored juncos, tree sparrows, song sparrows *(Melospiza melodia)*, and common grackles *(Quiscalus quiscala)*. Within the forest, slate-colored juncos were most abundant, followed by tree sparrows.

In terms of relative numbers of birds within each habitat type, average daily numbers were highest in the hardwood forest (83) followed by the wetland (78). Much fewer numbers were observed in the disturbed (15) and meadow (10) habitats.

As was the case with the fall survey, not only were the highest numbers of birds observed in the hardwood forest, but most species preferred this habitat type. Twenty-nine of the 35 species observed were present in the forest, and five species were seen nowhere else. This compares to only three species restricted to the wetland and two species to the meadow.

Breeding Bird Survey

Sixty-six avian species were observed during the breeding bird census, including 12 species of wood warblers. Common grackles were the most abundant overall, followed by red-winged blackbirds, yellow-headed blackbirds *(Xanthocephalus xanthocephalus)*, cowbirds *(Molothrus ater)* and robins *(Turdus mig-*

ratorus). Within the hardwood forest, yellow warblers *(Dendroica petechia)* were most abundant, followed by common grackles.

In terms of relative numbers of birds within each habitat type, average daily sightings were highest in the wetland (111), followed by the hardwood forest (97). Much fewer numbers were observed in the disturbed (22) and meadow habitats (6).

Birds again showed preference for the bottomland hardwoods. Forty-seven of the 66 species were observed in this habitat, including 13 which were seen only in the forest. This compares to seven species sighted only in the wetland, three in disturbed areas and one species only in the meadow (Table 1).

Mammal Observations

Seven mammalian species were captured during trapping operations and eight other species directly observed in the study area. Of these 15 species, nine were observed in the hardwood forest; seven were observed only in the forest (Table 2).

Discussion

The results of the avian census operations revealed both the importance of the

Table 1. Bird species sighted in one habitat type only, breeding bird survey, May, 1978.

Species	Habitat			
	Bottomland hardwood forest	Wetland	Meadow	Disturbed
Great blue heron		X		
American bittern		X		
Sora rail		X		
American coot		X		
Least sandpiper		X		
Great horned owl	X			
Belted kingfisher	X			
Hairy woodpecker	X			
Downy woodpecker	X			
Least flycatcher	X			
Horned lark				X
Cliff swallow				X
Tree swallow		X		
Blue jay	X			
White-breasted nuthatch	X			
Ruby-crowned kinglet	X			
Black and white warbler	X			
Tennessee warbler	X			
Black-throated green warbler	X			
Chestnut-sided warbler	X			
Palm warbler				X
Meadowlark			X	
Yellow-headed blackbird		X		
Rose-breasted grosbeak	X			
Vesper sparrow	X			

Table 2. Mammalian species and habitat utilization observed at the Holman Field study area.

Species	Habitat			
	Bottomland hardwood forest	Wetland	Meadow	Disturbed
Short-tailed shrew	X			
Striped skunk	X			
Coyote			X	
Woodchuck	X			
Thirteen-lined ground squirrel			X	
Eastern gray squirrel	X			
Eastern fox squirrel	X			
Red squirrel	X			
Beaver		X		
White-footed mouse	X	X		X
Meadow vole			X	
Muskrat		X		
Whitetail jackrabbit			X	
Eastern cottontail	X			
White-tailed deer	X	X	X	X

entire area as avian habitat and the particular value of the bottomland hardwoods. Of the 94 species observed during the study, 68 were observed in the forest. In addition, of the 27 species sighted within one habitat only throughout the study, 16 of these were restricted to the hardwood forest (Table 3). Of 12 species of wood warblers, 11 were observed in the forest and four were observed nowhere else.

With the exception of the breeding bird survey, total number of birds was higher in the hardwood forest than in the other habitat types. The higher numbers observed in the wetland during the breeding bird survey were due primarily to large numbers of red-winged and yellow-headed blackbirds. Species diversity (as number of species) was much higher in the forest with 47 species observed, compared to 28 in the wetland.

The structural and species diversity of the vegetation within the forest attracts the birds, particularly during the breeding season. Slash piles and undergrowth are preferred nesting habitat for such species as the chestnut-sided warbler (*Dendroica pensylvanicum*), black-and-white warbler (*Mniotilta varia*), and Tennessee warbler *(Vermivora peregrina)*, all of which were observed only in the forest habitat. Other species with similar nesting requirements which were observed in the forest as well as in other habitats during the breeding season include the brown thrasher *Toxostoma rufum)*, yellow warbler, cardinal *(Hesperiphona vespertina)*, and white-throated sparrow *(Zonotrichia albicollis)*.

The large cottonwoods, box elder *(Acer negundo)*, and red maples provide the branches and foliage for those species such as the least flycatcher *(Empidonax minimus)* and blue jay *(Cyanocitta cristata)* which nest high above the ground. Sightings of these two species during the breeding season were restricted to the forest habitat. Species with similar nesting requirements observed in this habitat type as well as others during the breeding season include the mourning dove *(Zenaida macroura)*, robin, and northern oriole *(Ictarus galbula)*.

Table 3. Bird species observed in one habitat type only during the entire study period.

Species	Habitat			
	Bottomland hardwood forest	Wetland	Meadow	Disturbed
American wigeon		X		
Shoveler		X		
Great blue heron		X		
American bittern		X		
Sora rail		X		
American coot		X		
Least sandpiper		X		
Great horned owl	X			
Belted kingfisher	X			
Pileated woodpecker	X			
Hairy woodpecker	X			
Least flycatcher	X			
Eastern phoebe	X			
Horned lark				X
Cliff swallow				X
Tree swallow		X		
White-breasted nuthatch	X			
Brown creeper	X			
Ruby-crowned kinglet	X			
Northern shirke	X			
Black-and-white-warbler	X			
Tennessee warbler	X			
Black-throated green warbler	X			
Chestnut-sided warbler	X			
Rose-breasted grosbeak	X			
Purple finch	X			
Snow bunting				X

The large trees also provide cavities for nesting which may be utilized by the hairy woodpecker *(Dendrocopus villosus)*, downy woodpecker *(Dendrocopus pubescens)*, white-breasted nuthatch *(Sitta carolinensis)*, and great horned owl *(Bubo virginianus)*, observed only in the forest during the breeding season. Other cavity nesting species observed during the breeding season in the forest were the wood duck *(Aix sponsa)* and common flicker *(Colaptes auratus)*.

The bottomland forest also provides valuable avian habitat during winter and the fall and spring migrations. Mast from mature trees and seeds and fruits from elderberry, goldenrod and other species provide a food source for black-capped chickadees, slate-colored juncos, and blue jays (Martin et al. 1951). Roosting habitat is present for many species, and small mammals are present for raptors such as the great horned owl. The dense growth of the saplings provides winter cover for the resident species such as the black-capped chickadee, white-breasted nuthatch, blue jay, and hairy and downy woodpeckers (Dodge et al. 1971).

The mammal species restricted to the forest habitat were present because of the food and cover provided. Den trees and mast were available for the three species of squirrel, while the dense shrub growth provided the eastern cottontail *(Sylvilagus floridanus)* concealment from predators and a source of foliage for food.

White-tailed deer *(Odocoileus virginianus)* were present throughout the study area during all observation periods. The heavy vegetation of the sapling growth within the forest provides necessary cover for fawn rearing. The abundance of trees of the genus *Populus* and the understory plants associated with these trees are an important food source to deer of this region (McCaffery et al. 1974, McCaffery and Creed 1969, Mooty 1971).

Conclusion

A bottomland hardwood forest community and surrounding habitats were found to support a high diversity of wildlife, including 94 avian and 15 mammalian species. Of this total, 68 avian and nine mammalian were observed in the bottomland hardwoods, and 16 of the avian species and seven of the mammalian species were observed only in the forest. Included in the avian total were 14 species which were found breeding exclusively in the bottomland hardwoods. These results show the value of this habitat type to wildlife populations.

This high wildlife diversity was partially due to the location of the habitat in an otherwise urban environment. As urbanization continues, available wildlife habitat declines, and wildlife must move into areas such as airports' buffer zones where suitable habitat exists (Harrison 1976). The presence of this habitat and its wildlife population within the city limits of St. Paul is a valuable resource and could provide recreation for hiking, bird watching, and other nonconsumptive recreation. Preservation of such areas should be given high priority in urban planning endeavors.

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Natural Resources Management in the Caribbean

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Brief Comments on the Mexican Wildlife Directorate's Factual Positions

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In my country, Mexico, we believe in the equivalence of the uses, users, and administration of our wild resources. This broadens conservation and ecology into a social science which covers the laboral and educational problems that arise from the actual environmental problems of our country and our world.

From ecology we can establish that a species' population is the direct measure of adaptation to its environmental condition, and that the actual status of some species—defined in the extreme and opposite categories of "endangered" and "pest" status—is a result of both human settlement and nature's simultaneous impact on the species and biological community. Thus, the environmental complex is a result of the biotic, abiotic and social spheres which we call the ecosystem, and in which, as a matter of fact, wild flora and fauna are the most important elements from qualitative and quantitative points of view.

It must be clear also that these circumstances are a result of an historical process which has resulted in social stratification and political dominion of minorities. Nature has been exploited under the same criteria and for the same group, but we are facing the end of this era.

Broadly speaking, we think of natural resources management as a three-link chain, postulated as:

I. The free appropriation of natural resources.
II. The regulated appropriation of natural resources.
III. Incorporation of natural resources to the economy.

Of these aspects, our country is in the transition from the free to the regulated appropriation stages, and federal wildlife legislation is the youngest of our natural resources laws. The first wildlife statute was the 1940 Federal Hunting Law, followed by the 1951 Federal Hunting Law, now in effect. We are anticipating a new Federal Wildlife Law in 1980.

As a matter of public interest, wildlife are included in forest and inland water management laws, and are included in Articles 27 and 73 of our National Constitution. But those same Articles define the private activities of cattle and poultry management and agriculture. A fundamental distinction between domestic and wild animals and public and private property is not made in those Articles—a distinction that is needed to enable us to deal with today's complex biological problems.

At both national and international levels, conservation policies have established some economic, ecological, scientific, educational, recreational and aesthetic values for wild animals. But we think it is socially necessary to include the "laboral values" of ecology and conservation as a social praxis of maximum priority and as an answer to the basic causes of free appropriation of natural resources and the consequent environmental degradation. Simultaneously, these laboral values provide a tool for social control and welfare in the rural communities. Conservation programs that do not include the working necessities of our country and our people, who use nature in free appropriation for the satisfaction of the fundamental requirements of food, dress, home and work are unrealistic and utopic. Their social consequences will cause them to be labeled unresponsible and they will cause more social difficulties than the ecological ones they were designed to solve.

With such a criteria of public interest, the Direccion General de la Fauna Silvestre is working on conservation activities with 15 wildlife programs, 8 in the regions and 7 nationwide. These programs include management of migratory birds, such as waterfowl and white winged doves; desert sheep management, endangered and pest species experiment stations, the first national wildlife inventory, to be developed in 1980-1981; and 17 wildlife refuges, 9 of which have been established in the last three years. These programs are operated in desert, tropical and temperate climates and diverse habitats which contain about 3,000 species of vertebrates of both nearctic and neotropical faunas. In addition, we receive the annual migration of holarctic birds.

Our management programs are based on the rational use of the resources, and utilize basic and applied investigation and law enforcement. They are executed by about 200 individuals belonging to the Direccion General de la Fauna Silvestre. This figure includes the technical, administrative and operative personnel classes.

On the international level, we believe that international forums are the correct way for facing the immediate future. Thus, we are members of IUCN, we will go to CITES this year as members; we observe the migratory birds convention with the United States and Canada; we belong to the White-Winged Dove International Council, which embraces us from the South of the United States to Costa Rica, through Guatemala, Nicaragua, Honduras and El Salvador, our Central American brothers; and we are proud to be here in Miami Beach, Florida attending the 45th North American Wildlife and Natural Resources Conference. We are going to be any place where our country can contribute to the world ecological scene.

Our economic support comes from the federal government and is equaled, this year, with the money we earn from hunting permits . . . the control or regulated appropriation level.

But we live in the age of the so called "demographic revolution." The greatest human population densities are now in the original colonial countries and in the colonized countries, now mostly free. These high demographic pressures on developing countries define their different political and economic requirements and philosophies of social welfare.

Consequently, in Mexico, we must address these population and labor problems in the immediate future and intensify our efforts on behalf of wildlife using all of the technical, law enforcement and management resources at our command. We must prepare our people for the multiple use of our renewable resources and the only way to accomplish that is through a program of public education.

This public education must concern itself with changing attitudes about wildlife. But because Mexico has only a few wildlife schools for its large area and population, it is more efficient for us to develop strong wildlife education programs in our 38 forestry schools. Now, courses about wildlife are taught in these schools by members of the D.G. de la Fauna Silvestre's wildlife staff. We are also developing a system in the next 3 years to enable us to go to our people in rural areas and develop wildlife-based recreation programs. This will enable us to create systematic employment in guiding services, hunting and forest development activities for these rural people.

These programs must evolve from simple classroom instruction through more varied successive stages. They must also encompass communications activities, including radio and television. The main objective of this multipurpose and multivariate program is to instill in our people a responsible, socially based conservation ethic—an ethic in which the future welfare of wildlife is based on the laboral welfare of our people.

I wish to express my personal thanks to The Wildlife Society for this invitation to speak here in Miami Beach and, to all of you, thank you for your attention.

Conservation of Natural Resources in the Caribbean: The Avifauna of Jamaica

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Introduction

Since the days of Charles Darwin the study of island biology has contributed significantly to the development of evolutionary ecological theories and concepts. By studying species on individual islands or groups of islands, biologists view a simpler microcosm of that seemingly infinite complexity of continental areas. By their very multiplicity and variation in shape, size, degree of isolation, and ecology, islands provide the necessary replications in natural experiments by which evolutionary and ecological hypotheses can be tested (MacArthur and Wilson 1967, Cruz 1977, 1978, Wiley and Cruz 1981).

Unfortunately, the unique characteristics of island populations that have attracted the attention of biologists have also contributed to the extinction and endangerment of a disproportionately large number of species as compared with continental areas. This extreme vulnerability is indicated by the fact that of the 217 bird taxa which have disappeared in the last 400 years, 200 were insular species (Halliday 1978). Yet of the world's avifauna, only 20 percent are insular species. Today, 58 percent of the world's 405 endangered or threatened avian taxa are insular forms. In the Antilles as a whole, there are 39 threatened or endangered bird taxa. Eight threatened forms occur on Cuba, eight on Puerto Rico, five on St. Lucia, and lesser numbers occur on several other islands. Of special note in the Antilles is the threat to 5 species and 3 subspecies of *Amazona* parrots (King 1978). Reasons for a higher rate of extinction on islands include:

a. Limited distribution (species restricted to a single or small group of islands).
b. Limited habitat.
c. Small population size.
d. "Specialist" species—island species have evolved in isolation and lack adaptations needed to deal with introduced birds.

Physiography and Vegetation

Jamaica lies at 18° north latitude in the western Caribbean, approximately 145 km south of Cuba and 160 km west of Hispaniola. The nearest mainland is Honduras, approximately 610 km southwestward. With an area of 11,740 km^2, Jamaica is the third largest island in the West Indies, exceeded in size only by Cuba and Hispaniola. Most of Jamaica is mountainous with more than one half of the island over 305 meters (1,000 feet) in elevation.

The island was at one time covered by forest and wetlands. Several hundred years of human settlement has reduced forest cover to 24 percent of the land. In addition, exploitation of this remnant since the nineteenth century has reduced the amount of moderately intact natural forest to 7 percent of the area. In recent decades there have been sustained attempts to create new forests in place of over-exploited ones, but these man-made forests are completely different from the original (Asprey and Robbins 1953, Symes 1971).

There are, therefore, three classes of forest in Jamaica: natural, "ruinate" and plantation. Major types of natural forest include dry limestone forest, wet limestone forest, lower montane rain forest, montane mist forest, and mangrove swamp. "Ruinate" forests have been derived from the original destruction of the vegetation by man in clearing and burning for cultivation and settlement, and in excessive exploitation of the timber resource. Ruinate is, therefore, a secondary (successional) type of forest. Man-made forests include deforested areas that have been planted with fast-growing tree species. The exotic Caribbean Pine *(Pinus caribaea)* is now being planted at the rate of up to 2,000 acres (809 ha) annually, in addition to nearly 1,000 acres (405 ha) of other species including the native Blue Mahoe *(Hibiscus elatus)*.

Jamaican Land Birds

Sixty-eight species of land birds (birds of prey to passerines) occur in Jamaica, 36.8 percent of which are endemic to it, a figure greater than that for any other Antillean island (Cruz 1973). The breeding passeriformes of Jamaica consist of 38 species, 13 of which are endemic (34 percent). In addition, ten species (26 percent) are shared with other West Indian islands. These figures indicate the significance of the endemic and West Indian element. Another interesting aspect is that while of the four islands comprising the Greater Antilles, Jamaica is only third in size, it has more endemic species of land birds than any other (see also Smith 1968, Bond 1971, Lack 1976).

The number of resident species of land birds in Jamaica has remained almost the same during the last 150 years, with only two extinctions and no new natural arrivals. This is in marked contrast to the big extinctions among the land birds on islands greatly disturbed by man (e.g. Hawaiian Islands). The stability of the Jamaican avifauna can be attributed to the continuing presence of sufficient main natural habitats on the island. The records indicate that in the last 150 years only two species of land birds have become extinct. First, there was probably a small green macaw (*Ara* sp.). Macaws, formerly found in both Greater and Lesser Antilles are now everywhere extinct in the West Indies (Greenway 1967). Secondly, the endemic pauraque *(Siphonorhis americanus)* was last collected in 1859. This genus *(Siphonorhis)* is endemic to the Greater Antilles. It includes the least pauraque *(S. brewsteri)* of Hispaniola and the Jamaican species *(S. americanus)*. Considering habitat requirements of the least pauraque, it is possible that the Jamaican species still exists in semi-arid limestone regions, as suggested by Bond (1971); although research by R. Sutton, P. Fairbairn and others in such conditions on Portland Ridge proved fruitless, and the provenance of the last few specimens of record indicates a moister habitat. Nevertheless the recent discovery of *Caprimulgus cayennensis* in Martinique, *C. vociferus* in Puerto Rico, and the continued presence of the least pauraque in Hispaniola (Dod 1979), islands heavily infested with mongooses, leads one to suspect that the Jamaican *Siphonorhis* may survive locally.

Outside the pigeons to passerines, two other birds have become extinct in Jamaica—the crake *(Amaurolimnas concolor)* and the petrel *(Pterodroma hasitata),* the former probably as a result of the introduction of the mongoose in 1872. Of the Jamaican land birds, two species are rare—the plain pigeon *(Columba inornata),* probably from excessive hunting as well as habitat changes, and the golden swallow *(Kalochelidon euchrysea),* for unaccountable reasons, seeing that it inhabits parts of the interior uplands which are seemingly free from significant human disturbance.

The Future

Much of the Hellshire Hills and Portland Ridge (dry limestone forest areas) have been spared from destruction up to now by their aridity, much of the Cockpit Country (wet limestone forest) by inaccessibility of the terrain, much of the montane forests by the extremely steep slopes. Even so, each of these areas is being nibbled away, by squatters who cultivate patches as soon as there is a trail, and more drastically by foresters, who have clear-cut much montane forest and replanted with Caribbean Pine and Eucalyptus, which are extremely poor for native Jamaican animals, including birds. Moreover the eastern Hellshires are now developed as an extension of Kingston, roads are being extended into the Cockpit Country and forestry is encroaching on the central core of both the John Crow and Blue Mountains which, although designated on maps as national park areas, have never been accurately delineated on the ground or given any special protection.

How long the native avifauna will survive is uncertain. Probably the main factor in the survival of the Jamaican birds has been that enough of their natural habitats have survived up to the present time. This record is far better than for many other islands in the world, and could be maintained since the remaining species could be saved by keeping much of the natural forest intact. Furthermore, Jamaica has been almost completely spared the menace of introduced birds, although rats and mongoose (introduced in 1872) have destroyed much (see Smith 1968 for further information).

The population of the island is increasing at an annual rate of over one percent (1.3 percent in 1978—Department of Statistics 1979). Jamaica's limited coastal plain will bear the brunt of pressures caused by these population increases, and it is the avifauna of this region that have already suffered most extensively at the hands of man. Freshwater swamps are especially threatened avian habitats and the pressure on those that remain can be expected to increase daily. The West Indian tree duck *(Dendrocygna arborea),* masked duck *(Oxyura dominica)* and Caribbean coot *(Fulica caribaea)* are uncommon and increasingly threatened. Mangrove swamps and mudflats are other important coastal avian habitats that are dwindling rapidly. Landfill of large tracts of mangrove in Kingston Harbour is endangering the survival of the largest known egret and heron colony in Jamaica, including the largest group (70) of glossy ibis *(Plegadis falcinellus)* and the only (30) white ibis *(Eudocimus albus).* The Urban Development Corporation, a government agency, is in the process of developing parts of the Hellshire Hills region (St. Catherine Parish) into a new town.

The largest wetlands—the Black River and Negril Morasses—have been extensively drained for agriculture and are currently the object of study to determine the feasibility of mining and burning their peat deposits as a substitute for petroleum. Although agriculture for rice production drastically alters habitat, it has proven highly attractive to many wintering migrants including snipe *(Gallinago gallinago),* upland sandpiper *(Bartramia longicauda)* and blue-winged teal *(Anas discors)* as well as the three Jamaican *Zenaida* dove species, the white winged dove *(Z. asiatica),* Zenaida dove *(Z. aurita)* and mourning dove *(Z. macroura),* these latter three recently reaching pest proportions in rice cultivation areas.

Extraction of the peat on the large scale proposed would effect a change far more drastic than agriculture in the original wetland conditions. No commensurately thorough project proposal has yet been advanced to assess the multiple-purpose development of these wetlands as wetlands—for food (fish and shrimp), fiber (*Phragmites* reed and *Sabal* thatch palm) and recreation (boating, sport fishing, wildlife and scenic values). The environmental impact assessment of the proposed peat extraction is currently underway, and the results are scheduled for publication by July 1981.

In 1971, the National Physical Plan for Jamaica (1970–1990), sponsored by the U.N. Special Fund Project, was published (Ministry of Finance and Planning 1971). This was and still is a very valuable study that showed remarkable foresight and understanding of the island's ecology, and the necessity to protect the many ecosystems that make up the whole. Many areas (including the Blue Mountains, John Crow Mountains, Portland Ridge, Cockpit Country and major swamps) were designated as potential National Parks and included under Categories 3 and 4 (Wilderness Recreation and Scientific Study) of the plan. Special emphasis was placed on the Forestry Department's studies of vegetation within the Cockpit Country, and the need to protect the trees indigenous to the area. Yet in the same report it was noted that extensive tracts of the southern Cockpit Country had been leased to the Alcoa and Revere bauxite companies to undertake exploratory mining.

Unfortunately, means of reconciling the potentially conflicting claims of land hunger, forestry, mining and national parks development were not described in the plan. This problem of optimal land-use allocation is currently being addressed by the Town and Country Planning Department of the Ministry of Finance and Planning, in the form of New Development Orders for each of the island's 14 parishes. To date, two have been confirmed and published, and the remainder are to be completely redrafted by 1981.

Institutionally, Jamaica is well set up to practise good husbandry. In 1975 the Natural Resources Conservation Department (NRCD) and its nine-member board of appointed overseers, the Natural Resources Conservation Authority (NRCA), came into being, the result partly of an amalgamation of extant bodies, partly of the addition of new functions. The NRCD's functions are threefold—environmental research, monitoring and management, the first two being conducted largely by the department's Resource Management Division and Aquatic Resources Division, the last largely by its Watersheds Engineering Division and Recreation and Conservation Division.

Much commendable work has been pioneered by the NRCD in environmental impact assessment and public education, but environmental management is still mainly restricted to the original functions of beach control and watershed protection, despite the department's mandate to enforce conservation laws and develop wildlife reserves and national parks. The state of economic recession both nationally and abroad has obliged Jamaica to concentrate on relatively short-term options for economic development. The prevalence of this outlook in official planning circles may be seen in the Five-Year-Development Plan 1978–1982, in which conservation as a general concept appears only once in the 150-page *Main Document,* in a map entitled Proposed Development Strategy, without a word in the text by way of explanation (National Planning Agency 1978).

The supporting document for the Five-Year-Development Plan is embodied in a revised *National Physical Development Plan 1978–1998,* the text of which is currently [May 1980] at the printers. An entire chapter is devoted therein to long-term approaches to conservation planning which, if taken seriously, should ensure the survival of the island's diminished wildlife.

Immediate remedies lie close at hand in the form of improved liaison between the NRCD and other physical development agencies. The first steps in this realistic and modest new direction have already been taken with the Forest Department, to enhance the recreational appeal of the Blue Mountain Peak; and with the Fisheries Division, to coordinate protection of sea turtles, manatee, crocodiles, fish and the terns *(Sterna fuscata and Anous stolidus)* whose eggs are seasonally collected on the outlying Morant and Pedro Cays. Improved education and coordination of all relevant field officers is essential to the success of this joint venture in wildlife conservation.

The first big test of Jamaican wildlife management capabilities will take the form of a manatee project, funded in large part by the Organization of American States and scheduled for implementation beginning in 1980. The plan is to keep several manatee *(Trichechus manatus)* in a semi-captive state for public education, display and study. The clear, slightly brackish waters of the undisturbed Alligator Hole River of south Manchester are to be used for this purpose, with expected attendant benefits to all other wetland species resulting from enhanced public appreciation of such a habitat. Key to the success of this venture will be close cooperation among several government agencies, consultants, local citizens and private-sector interests.

Recommendations

1. Preservation of habitat—the key to species preservation—must be ensured by confirming the areas defined in the National Physical Plan as national parks and other conservation areas. Boundaries must be clearly demarcated and wildlife, watershed protection and forestry laws strictly enforced.
2. Additional areas, no matter how small or scattered they may be, should be identified for inclusion in a comprehensive natural preserve system. Further close study of rare or endangered species should be undertaken to help in the identification of every habitat essential to their survival.
3. Expansion of the National Parks Branch of the NRCD is the ultimate institutional means of ensuring sound habitat management for crucial wildlife areas. Until that end is achieved, there must be especially close coordination between

the NRCD and other relevant physical development agencies such as the Forestry Department, Town and Country Planning Department, Ministry of Construction and Urban Development Corporation.

4. The Cockpit Country and similarly remote places should be kept as roadless areas. No improved means of access should be permitted until a comprehensive management plan is drawn up, with guaranteed means of regulating all future development.
5. Slash-and-burn (shifting cultivation) agriculture should be prohibited in areas best left in natural forest.
6. Preserves should be as large as possible. A larger reserve will have a greater number of species and individuals of each species. This is especially important for species with large home ranges. In practice, the area available for reserves must represent a compromise between competing social and political interests. Given a certain total area available in a particular habitat, the reserves should be divided into as few disjunctive pieces as possible. Many species that would have a chance of surviving in a single large reserve would have their survival chances reduced if the area were apportioned among several smaller reserves. If the available area must be broken into several disjunctive reserves, then these reserves should be as close to each other as possible, and if possible, corridors maintained between the reserves. Many species, especially those of tropical forests, are stopped by narrow dispersal barriers. Proximity will increase immigration rates among reserves and help to maintain the maximum biotic diversity (Terborgh 1974, Diamond 1975).
7. Education of the general public with regard to the economic benefits from conservation of natural resources is needed. An effective public education program is essential in obtaining the cooperating of the public and its long-term support for the preservation of a sufficient portion of the species' habitat. Residents should be educated to the esthetic and economic values of natural resources (e. g. birds in relation to tourism) and learn to take pride in endemic species of the island, for the responsibility of perpetuating the remarkable fauna of Jamaica rests primarily with Jamaicans.
8. Care should be taken to prevent the importation of exotics that might have a deleterious effect on the indigenous fauna.
9. Exportation of the avifauna, especially the Amazon parrots and other endemic birds, should be most strictly regulated (Cruz and Gruber unpublished ms.).

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Seabird Research in the U.S. Virgin Islands

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Introduction

The breeding biology and distribution of seabird species in the U.S. Virgin Islands are not well known. Most of the literature on breeding seabirds occurs in summaries, and reflects descriptions from boats or on short visits to the more accessible islands (Leopold 1963, Robertson 1962, Nichols 1943, Beatty 1930, Wetmore 1927, Danforth 1935). Prior to 1975 there were no long-term programs on seabirds in the U.S. Virgin Islands, primarily because the rookeries are often inaccessible. They are made inaccessible by the islands' physical nature and the long distances from shore. Furthermore, the unreliability of the boats used and the cost of lengthy observations have prohibited long-term studies.

In 1975, the Bureau of Fish and Wildlife, a division of the Virgin Islands Department of Conservation and Cultural Affairs, began a wildlife survey of the uninhabited cays, funded by the U.S. Fish and Wildlife Service Federal Aid in Wildlife Restoration (Pittman-Robertson) Program. In this paper we delineate the research problems encountered in this survey as they relate to the study of the nesting seabirds on the uninhabited Virgin Islands (Table 1) and offer some solutions to those problems which would be applicable to similar research elsewhere in the marine tropics. These seabirds include the following species: Audubon shearwater *(Puffinus iherminieri),* red-billed tropicbird *(Phaethon aethereus),* white-tailed tropicbird *(P. lepturus),* brown pelican *(Pelicanus occidentalis),* brown booby *(Sula leucogaster),* blue-faced booby *(S. dactylatra),* red-footed booby *(S. sula),* laughing gull *(Larus atricilla),* roseate tern *(Sterna dougallii),* bridled tern *(S. anaethetus),* sooty tern *(S. fuscata),* Sandwich tern *(Thalasseus sandvicensis),* and noddy tern *(Anous stolidus).*

Methods

The methods we have developed to produce consistent island surveys are simple in design. They form the basis of an extensive seabird survey on islands of both extreme beauty and proven treachery. Preparations for research on any seabird island must take into consideration the physical nature of the island and those factors which determine its accessibility (weather, time of year, seas, etc.), the field skills of the biologist, the boat, and equipment needed for the research. Each survey has five separate but interrelated stages: The approach to the island, anchoring, landing, climbing of the island, and the return.

The Approach

The use of two powerboats was necessary to insure operational continuity. We found that 18- to 22-foot (6-7 m), open, center console, V-hull single-engine boats are the most cost-effective. Use of a full complement of safety equipment including VHF radio is mandatory.

For the most economical, trouble-free use servicing of the boats every 100 hours is recommended and an "overpowered" engine run at ½ to ¾ power should be used.

We recommend that the predominant user maintain the boat.

Anchoring

Because shifting currents and unexpected squall winds are routinely encountered, we recommend the use of both bow and stern anchors with 3 meters of chain attached to a nylon rope. Anchors must be visibly checked after being set. Adjacent to islands with poor anchorages (60 to 90 foot [18-27 m] depths in areas of surge or currents) it is essential that the anchor(s) be hand-set on the bottom with SCUBA diving gear. Since all of the seabird islands are approached by swimming, the boats are maneuvered as close to the rocky shores as possible. Conservative and confident operation of the boat near submerged obstacles while encountering current and wind is necessary.

Landing

After anchoring, everyone swims ashore using mask, fins, and snorkel. Dry gear is transported in 48-quart (45.5 l) Igloo ice chests and maneuvered ashore. Careful timing to land on the rock at the crest of a wave is sometimes essential. In nearly 1,000 swim-in landings we have not had any serious injuries, nor have we ever had our island gear get wet or damaged.

Climbing and Return

Confidence and climbing skills are required for the more difficult islands (Table 1). The death of one of our biologists on the cliffs of Cockroach Island in 1974 still remains a constant reminder to the hazards of this work.

On return, a descent rope can effectively aid less skilled members of the party, and the outgoing surge from large waves can be used to aid in getting clear of the near shore rocks and turbulence. Influence of currents should be considered when freeing the anchors and getting underway.

Biological Methods

During tallying surveys of nesting seabirds it is usually cost-effective to record the various species as they are found along designated routes. Error in field data is increased when tallying is combined with banding, tagging nests, and photographing more than one species.

Most of our work is scheduled between dawn and 10:00 a.m. to avoid exposing eggs and chicks to heat stress. Censuses are done by area (sooty terns), transects, direct counts, and nest counts (tropicbirds, brown, red-footed and blue-faced booby, Audubon shearwater, roseate, bridled and Sandwich terns), and partial counts when time does not permit greater accuracy. Care is taken to avoid or abbreviate all potentially hazardous situations to the birds such as handling of roseate terns, chicks in precarious positions, or hatchlings subject to heat stress.

Results

Between June, 1975 and December 31, 1979 the authors, with assistants or volunteers, have landed 971 times on 35 seabird rookery islands. Table 1 provides a summary of our findings on species diversity compared to a subjective rating of the accessibility of each island.

The islands in Table 1 can loosely be categorized according to either natural or human-related factors that either limit or promote the existence of seabird colonies. The natural factors include the islands' size and their diversity of preferred nesting habitats. The human-related factors all are related to the various accessibility levels of each island to human approach. The varying level of island accessibility has impacted seabirds due to direct disturbance, has permitted the establishment of rats and feral animals, has allowed the harvest of eggs and/or chicks, and has permitted different degrees of historical and present day environmental enforcement and habitat alterations (such as controlled burning).

Natural Factors

Island Size

The islands (Table 1) with the largest number of nesting seabird species (Saba, Flat, Cockroach, Frenchcap) all have a diversity of nesting habitats, including cliffs with ledges or holes (favored by tropicbirds and noddy and bridled terns), windward ridges (favored by roseate terns and laughing gulls), and shallow to steep slopes with low vegetation (favored by sooty terns).

Several small islands provide extensive nesting habitats but characteristically have fewer species. These islands (Table 1) include Shark, Kalkun, Pelican, Sail, Cricket and Carval. Access to all of these islands except Shark Island is difficult and they will probably remain active rookeries. Shark Island is highly accessible to human intrusion in all respects and owes its marginal success to recent protection.

Seabird Adaptations to Human Disturbances

It appears that both roseate and sooty terns nesting in the Virgin Islands prefer steep to near cliff-type sites that are not only abnormal choices for the species, but in many cases reduce egg and chick survival. A hypothesis to explain this abnormal site preference is that, under selective pressure from eggers who primarily collect from level land or shallow slopes, there may be selection for individuals that nest on steep slopes.

Human-related Factors

Rats

Rats are well-known predators on the smaller seabirds such as terns (Austin 1945). Most of the "rat islands" are populated by *Rattus rattus*. While there have been no thorough studies of rat species on the cays, the presence of scat or runways has been used to determine the data listed as "present" or "not-present"

Table 1. Seabird islands in the northern U.S. Virgin Islands and the geographic, biological and human-related factors that limit or enhance breeding. The accessibility factor relates to the distance from the nearest uninhabited area and the subjectively rated, from one to ten, difficulty of anchoring, landing and climbing each island. A rating of one is considered "easy, no danger" while a 10-rating is considered "dangerous."

Island	No. of visits	Present No. nesting seabird species	Island acreage	Species that successfully fledged some chicks[a]	Rats present	Goats present today	Egging in last 10 years	Accessibility factors: Distance	Anchor	Landing	Climbing	Average
L. Saba	217	7	30.9	T,AS,SoT,RT, NT,BT,LG	no	no	yes	4	3	3	1	2.75
Cas	175	1	14.8	T,(RT)[b]	yes	no	?	¼	1	1	3	1.06
Turtle Dove	92	3	3.7	NT,BT,LG	no	no	yes	4	3	3	2	3.2
Congo	68	3	25.5	T,NT,BP	yes	yes	yes	3	3	5	5	4.00
Shark	52	1	1.3	RT	no	no	yes	¼	3	5	3	2.8
Flat	71	6	3.3	RT,NT,SoT, BT,LG,ST	no	no	yes	3½	5	4	1	3.4
Cockroach	32	5	19.0	T,BB,BfB, NT,BT	no	no	?	10	7	8	9	8.5
LeDuck	62	2	13.5	BT,LG	no	no	yes	1	2	5	2	2.5
Pelican	11	3	4.1	SnT,RT[c],LG	no	no	yes	6	5	6	2	4.75
Dog	18	2	12.2	RT,LG	yes	no	yes	3	4	6	1	3.5
Kalkun	25	4	3.5	BB,T,RT[b], NT,BT	no	no	?	8	9	6	4	6.75
Buck	18	0	41.6	(NONE)	yes	no	no	5	1	1	1	2.0
Capella	8	1	22.0	T,RT[b]	yes	no	no	5	3	3	1	3.0
Dutchcap	10	4	31.8	BB,RB,F[b], NT,BP	?	yes	yes	10	10	10	6	9.0
Frenchcap	25	5	10.5	BB,SoT,NT, BT,LG	no	no	yes	8	9	9	8	8.5
Mingo	4	1	48.4	T	?	yes	?	2	3	4	2	2.75
Stevens	6	1	2.0	LG	yes	no	?	1	3	4	1	2.25
Sail	1	2	1.6	NT,BT	no	no	?	15	10	10	10	11.25

Cricket	4	4	2.5	BB,NT,RT,BT	no	no	?	10	9	8	2	7.25
Flanagan	10	4	21.6	RT,NT,BT,LG	?	no	?	4	3	2	2	2.75
Current Rock	2	1	0.4	LG	?	no	?	¼	5	3	1	2.25
West Cay	2	1	40.3	T	?	yes	?	7	3	2	1	3.25
Carval	1	3	0.4	T,NT,BT	no	no	?	2	10	10	9	7.75
Outer Brass	5	1	108	T	?	yes	?	3	3	4	4	3.5
L. St. James	8	1	68.7	LG,RT[c]	yes	no	?	2	2	2	1	1.75
G. Hans Lollik	6	1	489.2	T	?	yes	?	4	3	2	1	2.5
L. Hans Lollik	8	1	100.5	LG	?	yes	?	5	4	3	2	3.5
Total	971											

[a]Seabird Symbols:

Tw-white-tail tropicbird
Tr-red-billed tropicbird
As-Audubon's shearwater
BB-brown booby
RfB-red-footed booby
BfB-blue-faced booby
F-frigates
SnT-Sandwich tern
SoT-sooty tern
RT-roseate tern
NT-noddy tern
BT-bridled tern
LG-laughing gull
BP-brown pelican

[b]Historically present before 1975

[c]Unsuccessfully attempted 1975 to 1979

in Table 1. Review of Table 1 with regard to rats indicates that (1) the most inaccessible islands have no rats, and (2) the small islands which have no rats may be devoid of them more as a function of severe limiting factors during some stage in their life history, rather than that they have been introduced. On Dog Island, rats are common and roseate terns nest successfully although nest success is low (10 to 20 percent). The island closest to Dog, Little St. James has a rat population that seems to have been responsible for 100 percent mortality of two separate roseate tern colonies (rat runways and dens held numerous chick carcasses, and no chicks survived to fledge). It is notable that Kepler (1978) found *R. norvegicus* on Monita Island (west of Puerto Rico), but found no apparent predation on the nesting sooty terns.

Other Feral Animals

Other introduced animals that have obvious effects on breeding seabirds in the U.S. Virgin Islands are goats and mongooses. Goats exist on numerous cays where they are periodically hunted. The only seabird islands where they exist are Dutchcap (32 acres) and Congo (25 acres) Cays. Both cays have about 4 to 8 goats, a number which probably represents the island's carrying capacity. Since the number of goats is small and they do not readily interfere with seabirds, it is felt at this time that they are not detrimental. On Congo Cay, which is mostly rocky, they do not promote erosion. On Dutchcap, however, the goats seem to benefit the brown boobys by keeping the brush down. About 300 to 500 brown booby pairs probably owe their nesting area to these animals.

Mongooses *(Herpestes auropunctatus)* are cunning and vigorous predators against which no seabird can survive. Historically introduced into the West Indies in 1872 to control rats, the islands that now have mongooses simply do not have nesting seabirds. All the main inhabited islands and several of the smaller private islands have mongooses. With the threat of accidental or deliberate introduction of mongooses to any natural environment, and no biological information upon which to base control of the mongooses, the Bureau in 1977 began a program to study the effects of introduced mongooses on the typical island ecosystem. The ecological changes to the island have been recorded while the mongooses have been studied by radiotelemetry.

In 1980, the mongooses will be removed and the island ecosystem will be monitored until 1985 to determine its successional return.

Egg and Chick Poaching: Illegality and Enforcement

The taking of both seabird eggs (Table 1) and chicks for home consumption are felt to be traditional rights by the native people that reside in the West Indies.

Before World War II, the Virgin Islands' population was small and the seabird populations were probably "limitless" on the more accessible cays. The population of the U.S. Virgin Islands has skyrocketed and seabird breeding colonies have decreased as the harvest of "booby eggs" (as any spotted seabird egg is called) has increased. The increase in harvests during the 70s is felt to be a function of an increased population, an increased market value of the eggs ($2.50 per dozen in 1977), and the greater mobility of the population brought about by the common use of the outboard engine. By 1975, the very fishermen that relied on the "mobs" of seabirds to help them locate pelagic fish schools (Erdman 1967) were lamenting the disappearance of the great flocks while they egged the colonies.

Table 1 indicates the islands that are reported or were observed to have been egged or from which the chicks were taken. The 1976 *Report of the Cambridge Ornithological Expedition to the British Virgin Islands* does not mention egging or the legal seabird egging season. However, it is clear from this report that colony nesting seabirds are doing very badly in the British Virgin Islands. No brown pelicans were nesting; only two small brown booby colonies existed; roseate terns were held to two colonies of 10 to 30 nests; and one remaining sooty tern colony existed with less than 100 nests. Informal interviews with the older British Virgin Islands' fishermen indicate that many years ago, when they were children, the seabird colonies were "everywhere."

In 1977, Virgin Islands' environmental enforcement officers arrested two fishermen who egged about 1,600 sooty tern eggs from Saba Island in less than 2 hours. Their subsequent conviction in Federal Court under the Migratory Bird Conservation Act of 1928 provided the legal precedent for conservation and management of local nesting seabirds. Although egging will probably never cease, the threat of ever increasing, legally backed enforcement makes protection of these birds an apparent reality.

While the taking of most seabird chicks for food is not well known even by local fishermen and the extent of actual loss remains to be determined, it may still be a significant cause of brown pelican chick mortality.

Habitat Alteration

Fire and the introduction (deliberate or accidental) of exotic plants on the islands can have important consequences to Virgin Islands' nesting seabirds. Fire is only important on the islands with brush or grass and existing seabirds. These islands include Saba, Turtle Dove, Cockroach, Shark, and Dog Islands. The Saba sooty terns nest in exceedingly heavy grasses, which have been maintained by past burning. Because the grass tends to be replaced with a flora that may not be conducive to sooty nesting, burning may be beneficial if properly directed. Because the blue-faced booby, a ground nesting species, needs open runways to nest, controlled burning may be an important management tool in the colony on Cockroach Island.

The introduction of exotic trees and shrubs has not been a threat to the seabird colonies, although it is conceivable that it might be in the future.

Summary

Prior to 1974, the distribution, seasonality and breeding biology of seabirds on the uninhabited northern islands of the U.S. Virgin Islands were largely unknown due to the expense of surveys, distance and the physical inaccessibility of the seabird islands. Since 1975 the authors, with the support of adequate funding, have developed methods that have allowed more or less consistent surveys of all but the most dangerous islands.

Although our research and survey analysis are yet to be done, our results indicate that most of the uninhabited offshore islands are either potentially or

presently very important seabird breeding islands. The relationship between the seabirds' presence on these islands and their species-specific breeding requirements has been found to be associated with both the size and availability of the breeding habitat as well as to the island's relative inaccessibility to direct or indirect human disturbance. The complete biological status of the respective seabird species will be presented in later publications.

Recommendations

As knowledge of the seabird's breeding biology and limitations becomes known, management for increased nest success and overall abundance should be biologically and economically feasible and can be shown to be desirable. Long-term management of our seabird resources should be accomplished through education, enforcement, rat control and eradication, and rehabilitation of specific "disturbed" nesting areas.

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Conservation Practice with Relation to Habitat Loss in the Southeast Caribbean Region

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Introduction

It is a well-attested fact that the ecosystems of small islands are particularly susceptible to habitat loss, since their depauperate flora and fauna exist within already limited resources, that are less flexible than those of larger land masses. The Caribbean islands are second only perhaps to the Hawaiian islands in witnessing the extinction of a significant proportion of their native bird species within comparatively recent times; an unenviable distinction indeed. The disappearance of these and other species of flora and fauna can usually be attributed to man-made causes. However, unlike in the Hawaiian islands, where bold programs of protection have been introduced, in most of the Caribbean islands conservation action seems to have been slow and piecemeal. In this paper I hope to detail the problems and the attempted solutions, with particular reference to the southeast Caribbean, especially Trinidad, of which I have firsthand experience.

Natural Habitat Loss

Although it hardly falls within the scope of this paper, I should briefly mention the major sources of habitat destruction which occur naturally. Principally, damage caused by periodic hurricanes can be catastrophic to wildlife. Within the past 25 years, four storms have caused serious habitat destruction on Grenada, Tobago, Trinidad and Dominica. In 1963, a hurricane (only the third to do so in two centuries) devastated the island of Tobago, destroying the entire forest reserve on the island's Main Ridge. Less than seven percent of canopy trees survived at all, and few of those re-formed anything like a normal crown. Immediate results of this disaster included drastic changes in the humidity and soil moisture relations of the area, erosion and soil loss through landslides, flooding, and silting of reservoirs. Wildlife was evidently hard-hit, especially the typically montane species. For example, the endemic race of a common montane hummingbird was almost completely extirpated. Forestry experts predict that it could take up to 100 years for the rain forest to regenerate, and that provided no further destruction takes place.

The full extent of the 1979 hurricane in Dominica has not yet been published, but one fears that the devastation may have been even more comprehensive, insofar as Dominica was more completely forested than Tobago. This is particularly unfortunate, since Dominica seemed to be in the forefront of recent conservation action within the region.

Occasionally, forest fires are thought to have been started by natural causes, and certainly they are far more prevalent in extra dry periods; but the opinion of most people who have studied the problem of bush fires is that the vast majority are caused deliberately by man. In Trinidad alone, approximately 2,000 acres (810 ha) are burned annually, and this figure is on the increase.

I also very briefly mention coastal erosion, which removes a fairly significant part of the coasts of south and west Trinidad annually; and also occasional eruptions of volcanoes, such as La Soufriere on St. Vincent, as being additional causes of natural habitat loss on the islands.

Habitat Destruction by Man, and Its Effects on Wildlife

Ever since man arrived in the Caribbean islands, he has proceeded to exploit the natural environment for his own purposes, and the process has accelerated alarmingly in recent times. Only in the last few years has there been any attempt to apply ecological standards to decisions concerning physical development; such attempts, few as they are, may have come too late.

In an early review of conservation in the Caribbean, Westermann (1952) referred to poor agricultural practices, depletion of forests, waste of soil, water and forest resources, while at the same time commenting on the rapidly increasing human population of the area. To a certain extent these problems resulted from a traditional lack of settled agricultural policies, a greater prevalence of subsistence farming with shifting cultivation, and the failure of authorities to come to grips with squatting, illegal forest-cutting and the like.

In more recent times the problem has become more complex. Trinidad is probably the most noteworthy example of a comparatively prosperous Caribbean island. Its population growth has now leveled off after doubling within the last 30 years, while at the same time valuable mineral resources have ensured a steady rise in the standard of living and economic expectations of the people. Under these circumstances we find physical development proceeding at a breakneck pace, with new industries mushrooming, housing estates proliferating, and an increasing public demand for more and better roads, water supply and basic services. On the other hand, the machinery of government is still in the hands of a people who traditionally eschew efficiency, whose easygoing nonchalance cannot keep pace with the demands of modern technology, and who are faced daily with bureaucratic problems they cannot handle. It is small wonder that when short cuts are taken, and decisions concerning the environment hastily made, the interests most likely to suffer are those of minority groups such as environmentalists and conservationists. Big business, the material prosperity of a few, short-term answers to problems, vote-catching gestures of politicians, these are the factors that still control the environmental situation in the Caribbean.

One of the most notorious abuses is shown in the systematic depletion of natural forests. This comes about in a variety of ways. First, as a matter of deliberate government policy, forests are cleared to provide agricultural land for small farmers. Often this is done without due regard for the suitability of the terrain. Some years ago, a university professor on a field trip in the Aripo Savannahs of Trinidad (an area comprising natural savannah and specialised palm forest) was startled to find a large portion of the area being cleared by bulldozers. Enquiries led him to discover that the Agriculture Ministry had ordered this to be done, without first finding out that the soil of these savannahs was totally unsuitable for agriculture of any kind, being extremely acid and almost devoid of nutrients. Under the soil is an impervious layer of clay, so that plants are waterlogged in the wet season but suffer from drought in the dry season. The few plants that survive are botanically most interesting, and the area is a unique section of Trinidad's ecosystem, but the government officials had not bothered to check with the experts before sending in the bulldozers to clear the land for farms that would never produce anything. Meanwhile, productive land in other parts of the country is gradually being abandoned by peasants, whose traditional methods cannot compete successfully with modern economic pressures.

In several islands, so-called Government Forest Reserves are officially exploited for timber production. The only limitation placed on woodcutters is a "girth limit." In Trinidad, as an additional control a Periodic Block System was introduced, which limited felling to certain areas to be harvested annually within a 25-year cycle. However, woodcutters always take the best trees available to them, and it was discovered, after 25 years, that the exploited blocks were not regenerating adequately, probably due to lack of suitable controls over woodcutters. Within recent years more scientific selection has been introduced, and this may rectify the situation. Meanwhile, intensive timber removal has resulted in the loss of diversified habitat in many places, and the damage to wildlife must be considerable. I have personally found many areas of forest, which were rich in bird life 20 years ago, reduced to habitat that is little more than secondary scrub, with many vines and grasses and correspondingly depauperate fauna.

In spite of voicing, in its Annual Forestry Report for 1979, an apparent concern for the loss of wildlife habitat, the Government of Trinidad is proceeding to open up even more areas of forest for timber exploitation, the most recent being two sections of forest, respectively 11,000 acres (4400 ha) and 60,000 acres (24,000 ha) in size. Access roads are being constructed for the purpose, one of which is 100 feet (30.5 m) wide, a seemingly unnecessary waste of forest land.

Where reafforestation has taken place, it is largely done by planting exotic but commercially valuable species, the teak *(Tectona grandis)* and Caribbean pine *(Pinus caribaea)*. In Trinidad alone total plantations of these two species covered 33,851 acres (13,705 ha) by 1979, about one-eighth of the island's reserved forests. As wildlife habitats, teak and pine are almost worthless, but of course they are easier to manage than natural mixed-species forests.

Swamps and marshland, also important areas of wildlife habitat (ffrench 1966), have not escaped the notice of the agricultural developers. While the Caroni mangrove swamp in Trinidad has been treated with respect by the authorities, owing to a large tourist revenue resulting from the presence of the spectacular scarlet ibis *(Eudocimus ruber)*, the smaller mangrove swamps in other areas, such as Point Lisas, have been cleared and filled, without any regard for the possible effects on the ecosystem. Meanwhile, over-exploitation of the tourist potential has probably been the cause of the scarlet ibis abandoning the Caroni Swamp as a nesting ground in favour of a site in Venezuela.

The large freshwater Nariva Swamp in eastern Trinidad has for some time been interesting developers, who hope to establish rice or soya bean cultivation after drainage. Although this is still in the planning stage, when it happens, development will undoubtedly destroy the only Caribbean habitat for the blue-and-yellow macaw *(Ara ararauna)* and several other rare species of birds and reptiles. As a further example of government apathy in this respect, soon after declaring a wildlife sanctuary in a forested island within the Nariva Swamp, the authorities permitted woodcutters to enter the area to extract valuable matchwood trees

(Didymopanax sp.*)*. The resulting devastation led to the abandonment of the area by several rare mammals, for which the sanctuary had originally been created.

The disastrous effects of shifting cultivation on hillside forests is too well-known to require description. In the southeast Caribbean, the phenomenon follows the usual pattern, "slash and burn" followed by two or at most three years of subsistence farming, then abandonment and the reverting of the land to unproductive bush. The lack of forest cover leads to landslides, erosion, increased water run-off, silting of streams and reservoirs, and eventual flooding in areas adjacent to foothills. This last has reached extremely serious proportions in Trinidad recently; but in spite of a much wider recognition of the problem among the general public than heretofore, no serious attempt has been made by the authorities to curb the activities of squatters and shifting cultivators, even within forest reserves.

During the dry season, bush fires rage constantly on the hill-sides, usually out of the range of fire-fighting facilities, if these exist in the area. In 1978 a sizeable portion of rain forest on Trinidad's second highest mountain, El Tucuche, was burned, and much of the habitat of several rare montane species, including the endemic Golden Tree-Frog *(Amphodus auratus)* was destroyed. Bands of volunteer fire-fighters eventually brought the fire under control, but the official government position, broadcast in the news media, was that the fire never happened, so nothing need be done!

One inevitable result of the recent boom in physical development is the increased demand for housing land and for materials for construction. The steady population rise in all the islands, coupled with much-needed improvements in living standards, has led to a considerable urban spread.

Wildlife habitat has inevitably suffered as the demand for development has claimed land for water reservoirs and quarries to provide road materials and the like. In Trinidad, much forest has been cleared in order to lay pipelines for an island-wide water distribution system. Sometimes quarrying and excavation works can be done in low-lying, unproductive lands where the effects of the habitat loss are minimal for wildlife. But on the other hand, considerable damage has been done where quarrying has been allowed to proceed in fairly remote hilly areas, where controls are not easy to enforce, and where public opinion is largely silent. In Trinidad, during 1976, a major controversy arose when an area of foothills adjacent to one of the scenic drives near the capital of Port of Spain was devastated by excavators. The resulting publicity probably benefited the conservation movement, but in spite of promises to restore the scarred hillside, to date the contractors have done nothing, and the area remains devoid of vegetation. The Government now plans to set up a 2,000 acre (810 ha) quarry estate in the heart of forested land, whose only benefit to the environment may be that it will probably put out of business the many small private quarry operators who up to now have paid little heed to conservation principles.

Problems of industrial pollution plague the islands on a rather smaller scale than in the metropolitan countries; but to add to our difficulties is the tendency of multinational pesticide producers to dump on our less well-informed inhabitants those products, such as the persistent hydrocarbons, that have been banned in the north as a result of public outcry. Only recently I discovered in my own home town the widepread use of Dieldrin by a company to eliminate a common but tiny insect that causes no more than a minor nuisance to householaers. Such "over-kill'' methods are quite common among farmers, and pesticide control legislation is very much in its infancy. In our area, effective action against haphazard and dangerous pesticide use always has to emanate from private individuals or organizations, since government authorities can never be relied upon to take notice.

The general effects of industrial pollution upon the land, air and water that are essential to wildlife habitat have not yet been studied in detail over a sufficiently long period in the Caribbean for any pertinent conclusions to be drawn. But environmentalists are becoming increasingly concerned about the likely effects of a multi-million dollar industrial complex currently being established on the west coast of Trinidad at Point Lisas. The chief anxiety is about thermal pollution in the offshore waters of the Gulf of Paria, where effluent from new steel and aluminum industries is likely to raise the sea temperature by several degrees, with possibly catastrophic results for marine life.

Turning briefly to coral reefs in Tobago, Grenada, Barbados and St.Lucia, the story here is of many previously fertile reefs being over-exploited by an uncontrolled tourist trade. Coral souvenirs are broken off, careless anchoring smashes the formations, spear-fishers decimate the fish population, and in some areas, notably the Grenadine Islands, pollution of the reef by waste and litter from passing yachts gradually destroys the habitat. In one instance, in Tobago a neighboring mangrove swamp was being drained by a development company ''to eliminate mosquitoes in the interests of a proposed holiday housing estate,'' until it was pointed out that the mangroves provided a valuable nursery feeding area for many of the reef fauna.The mangroves here were saved just in time; other areas have not been so lucky.

Conservation Practices

Fortunately, all these abuses have not been allowed to proliferate without some action from conservationists. The questions are, how effective is this action, and is it in time to save a unique habitat?

Many islands have an enlightened system of government reserved forests, dating back well into the colonial era. The oldest forest reserve in the New World may well be that in Tobago, officially established in 1765 as ''woods for the protection of the rains.'' Between 1900 and 1960 some 330,000 acres (133,600 ha) of forest reserves in 36 areas of Trinidad and Tobago were set aside by the authorities, constituting about one-quarter of the islands' total area. Similar forest reserves constitute rather smaller percentages in the other islands, though on highly developed Barbados the only forest reserve covers a mere 46 acres (18.6 ha), less than point one percent (0.1%) of the island's area.

But we have already seen that reserved forests in the Caribbean may be used and exploited against the interests of wildlife. Even wildlife sanctuaries are not immune to timber exploitation, though the justification for this surpasses credibility. Hence, several territories have proceeded further and set up national parks, specifically to protect wildlife habitat. This movement, only just beginning in the area, has resulted in the 1975 establishment of a 15,800 acre (6,400 ha) national park in Dominica, about eight percent of the island's area. Other national parks are about to be set up in Barbados, Trinidad and Tobago, safeguarding unique or important areas of wildlife habitat. If the management of these parks can match in efficiency the meticulous and comprehensive nature of their plans, all will be well.

In addition to public reserves and sanctuaries, some private individuals and organizations have established wildlife sanctuaries, notably the Asa Wright Nature Centre at Springhill in Trinidad, and at Grafton in Tobago. While the size and scope of these ventures are small, the comparative effectiveness of their operation and the attending publicity go a long way towards bending public opinion in the right direction.

Most of the islands maintain legal safeguards on hunting, involving closed seasons, bag limits, and restrictions on methods of operation. But in many years of observation I have remained unconvinced that these safeguards do more than satisfy conservationists that the government's *intentions* are right. Lack of personnel training, inefficient legal procedures and downright apathy account for the poor record in this field. The official summary of wildlife offenses during 1972 for Trinidad and Tobago gives typical statistics for a staff of ten: 22 cases reported (mostly minor technical infringements), 21 caution notices issued, one case postponed, no penalties inflicted. And yet one sees and hears constantly of serious infringements. There were nearly 6,000 licensed hunters in Trinidad during 1978, most of whom hunt to sell their game (now retailing at over two dollars (U.S.) per pound).

However, probably the most significant development in conservation action during recent years has been in the field of the education of public opinion. The Eastern Caribbean Natural Area Management Programme was launched in 1977 to train personnel in resource management, to encourage strategic planning and environmental education, and to initiate development projects. The work is executed through the Caribbean Conservation Association, a regional body, and the School of Natural Resources of the University of Michigan. It has already produced encouraging results in Dominica, Grenada and elsewhere. Other territories are beginning to follow Venezuela's 1977 example of establishing a Ministry of Environment and Renewable Natural Resources in their governments. National trusts have been set up in St. Lucia, St. Vincent and Barbados, where environmental education is now beginning to be provided through the agency of the University of the West Indies. Trinidad and Tobago, while lagging behind the neighboring islands in the formation of national bodies, has begun to emerge from a position of gross ignorance in wildlife matters. An active field naturalists' group has doubled its membership in the last four years, and is spearheading the promulgation of environmental issues. An Institute of Marine Affairs has been established to promote a better understanding of the marine environment, and to help formulate better informed government policies; it too has started an environmental education program. Public lectures, exhibitions, seminars and conferences are much more frequently held, highlighting environmental issues, while public opinion has undoubtedly been favorably affected by a number of recent publications, including a regular bi-monthly illustrated magazine, entitled *The Trinidad Naturalist*. In one notorious case in 1976, several environmentalist groups joined in putting pressure on the government to discontinue allowing the use of the Caroni mangrove swamp as an industrial throughway, since this was considered a threat to the ecology of the swamp. Eventually the government bowed to the pressure.

The critical question in conservation action within the region remains: Can the various measures outlined above sufficiently withstand the economic pressures of developing nations in time to safeguard enough of their fast dwindling natural resources? To a certain extent, we have been preaching effectively up to now only to those already committed to conservation. Governments faced with alternatives, leading either to further economic development or to preservation of unique natural areas, tend towards the former as the more obvious, attractive and popular choice. Thus, if we are to succeed in putting our message across, apart from encouraging the trend toward environmental consciousness, now at last happily increasing, we have to recognize the importance of the mass media to the conservation movement, to enlist their help—which to date has rarely been forthcoming—and to incorporate their methods in our approach to the problems. Time is running out, for the islands are small, their populations still growing, their needs ever more articulately stated. The next 20 years will be critical if we are to safeguard any significant portions of wildlife habitat before they become obliterated in the name of economic progress.

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Overview of Conservation in the Caribbean Region

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The Region and Its Diversity

In this paper, the Caribbean region is somewhat arbitrarily defined as all nations bordering the Caribbean Sea, except Mexico, which is considered essentially a Gulf nation. With a population of approximately 135 million, some 29 political entities, and 4 major languages, it is one of the most diverse regions of the world. An understanding of this diversity is central to understanding the status of conservation and the measures which are required to improve the management of living natural resources.

The cultural elements of the region (European, African, Asian, Amerindian) vary considerably as to the particular mix in any given area. In terms of language, Spanish clearly dominates and is spoken by 86 percent of the population, while French Creole (7 percent), English (5 percent), and French (1.7 percent) follow (United Nations 1977a, Rickards 1978). However, it is more significant to note that English is the official language of 15 of the political entities of the region, Spanish of 10, French of 3 and Dutch of 1.

Politically the region is composed of independent states, overseas departments, associated states, commonwealths and colonies, but the number of independent states is increasing rapidly as decolonization accelerates. The largest is Colombia (just over 1 million km^2) which is more than 10,000 times larger than the smallest, the island of Montserrat (100 km^2). Population density varies from the island of Barbados with 568 inhabitants per km^2 to Belize with 6 inhabitants per km^2 (United Nations 1977a). By far the greatest population densities are found on the islands of the Lesser Antilles.

Resource endowments of the region are extremely varied. Oil is exported by Venezuela and Trinidad. There are 56 large-scale mining operations in the region with 30 in the Greater Antilles. Some 50.3 percent of the region is forested, 9.7 percent is arable land, 22.7 percent is pasture and 17.3 percent is other (FAO 1976). Again each country varies considerably, e.g., Barbados has about 77 percent arable land while Belize has 1.4 percent.

Contrary to what is found in the temperate seas, the marine resources of the Caribbean are concentrated in the coastal areas. The major fishing nations of the region (Cuba, Panama, Venezuela) are much less dependent on fish protein than are the insular nations which are not self-sufficient in fish production. On the other hand, the insular nations receive the major portion of marine-oriented tourism. Indeed, the British Virgin Islands, the Netherlands Antilles, and Antigua annually receive numbers of visitors in excess of their own population (Gajraj 1978).

Finally, it should be noted that the countries with per capita incomes of less than $500 (Haiti, Honduras, St. Vincent, Grenada, Dominica) are concentrated in the insular Caribbean where population densities are greatest (Gajraj 1978).

Some Major Obstacles to Conservation

It is commonplace to blame natural resource degradation and social and economic problems in the developing world on the uncontrolled growth of population. This is obviously a contributing factor, but of equal or more importance is the magnitude of resource consumption of the industrial countries which have about one-fifth of the world's population but consume about four-fifths of the world's resources traded through international markets (Myers 1979). U.S. per capita income is more than seven times that of the average for the Caribbean and is reflected in resource consumption, where the disparity is even more marked.

The combination of rapidly increasing demands for raw materials, generated mainly outside of the region, and the rapidly expanding population within the region result in ever increasing exploitative pressures on natural resources. The effects are large in magnitude and for all practical purposes, permanent. Although there is again great diversity in the region, deforestation appears to be proceeding at between 2 percent and 10 percent annually. This would mean that if the deforestation rate remains steady, Central America would be essentially deforested in 10 years and incredible numbers of plants and animals made extinct. Worldwide, it is estimated that from half-a-million to a million species will be extinct within 20 years (Myers 1979).

The demand, from outside of the region, for its raw materials, which causes from 40 percent to 70 percent of the region's products to be exported, are generated and effected mainly by large multi-national corporations and assisted greatly by international aid agencies. Traditionally, these agencies have funded large projects designed for short-term, high economic gains to export raw materials or semi-processed products to the industrialized nations. With the notable exceptions of U.S. AID, the World Bank, and recently the Inter American Bank, none of the donor or lending agencies requires environmental impact statements.

Perhaps the most spectacular example of the consequences of externally generated demand is the deforestation of Central America which is in large measure due to the demand for cheap beef for the hamburger and fast food trade of North America (Myers 1979). Enormous expanses of forest have been felled to make way for artificial pasture for beef herds. Since 1950, the area of man-established pasturelands and the number of beef cattle have doubled in Central America. However, the beef does not go to improve the protein intake of local populations, but rather to assure low prices for hamburgers in the U.S. and Canada. The same is true in the marine area where lobsters, turtles, and conch have been wiped out to satisfy customers from outside of the region.

Likewise, the population increase, coupled with chronically inadequate land distribution in the region has caused the rural poor to move to ever more marginal lands, or to the cities, swelling the ranks of the unemployed. Already between 40 and 50 percent of the region's population lives in urban areas.

The occupation of marginal lands has contributed significantly to deforestation trends as well as to accelerating erosion, with all of its consequences, and the impoverishment of soils. Thus, even with an 8.6 percent increase of land under cultivation in the region during the last decade, dependence on imported food is increasing rapidly (United Nations 1980). Further, the contribution of agriculture to the Gross Domestic Product has dropped in all countries except Honduras and

Venezuela. The drop is particularly spectacular for the islands of the Lesser Antilles (United Nations 1977b).

The vicious cycle of occupation of marginal lands, loss of fertile soil, and movement to even more marginal lands is difficult to break. The movement of the poor is spontaneous and makes planned utilization of wildlands difficult if not impossible. This is especially critical since some 40 percent of the region's land still remains in a wild state. The options for land use planning are still open over large areas, but are being closed at a very fast rate.

A partial solution to the occupation of marginal lands is agrarian reform, but as long as the land-owning oligarchies of the region remain a powerful force in governments, meaningful reform will not take place. And the trend in Central America (C. MacFarland, pers. comm., 1980) and probably region-wide, is for more and more land to be concentrated in the hands of a few families.

A further major obstacle to effective conservation in the region is the lack of trained leaders in natural resource management. This is due to the poor salaries offered, the difficulty in obtaining scholarships, and the incentives offered to bright young leaders in other fields, often outside of the region. As long as this situation remains, conservation action will remain on the periphery of governmental and private interest group concern in the region. In fact, *if one factor is to be singled out as the most important bottleneck in Caribbean conservation, it is the lack of human capacity to manage.*

Importance of Caribbean Conservation to the United States

Before going into some of the recent developments in conservation in the Caribbean, it is perhaps useful to ask why the U.S. should be concerned. The central reason is the growing interdependence of the world. With each passing year this interdependence increases and the concept of national sovereignty becomes more obsolete. Events of the past few months underscore this concept and have proven how dependent the U.S. is on natural resources from outside its borders. Many of the vital resources of the U.S. come from the Caribbean and are all the more vital because of their proximity.

It is certainly, therefore, in the interest of the U.S. to assist the nations of the Caribbean on a cooperative basis to manage and conserve their natural resources and to promote conditions which enhance stability in the region and the flow of goods. This is fairly obvious. But what is less obvious, and just as true in the Caribbean as in the rest of the world, is the extent of U.S. dependence on the genetic resources, ecological systems and bio-physical processes of the region. Oil is now obvious in its imporatnce, but much less is made of the importance of genetic resources, ecosystems, or biophysical processes because they are not a single item nor can their value be calculated. In many cases the value is not apparent or even known or, is potential and not actual. Be that as it may, the strategic importance of genetic resources, ecosystems and biophysical processes should not be underestimated. Further, most of the environmental problems mentioned in the previous section lead to the destruction of species (and thus, of genetic potentials), ecosystem stability, and the disruption of biophysical processes.

Examples are needed to illustrate this point because it is not commonly known. For this I am relying on two recently available documents. The first is a book by

Dr. Norman Myers entitled *The Sinking Ark* (1979). I would urge you to read it because of its excellent explanation of the importance of genetic resources and the factors which operate to cause the extinction of species on a scale never imagined until recently. The second, the *World Conservation Strategy* (IUCN 1980) is particularly useful for its analysis of global conservation problems and synthesis of conservation requirements and priorities.

Perhaps the best example of the importance of genetic resources is in agriculture since it comes very close to the question of national security itself. As we know, the U.S. presently is able to pay for its imported energy largely through the sale of agricultural produce, especially grains. However, agricultural production in the U.S. rests on a very narrow genetic base and is heavily dependent on foreign genetic reservoirs. The cultivated crops have such a narrow genetic base that they are highly susceptible to some form of pathogen, insect pest, or severe envrionmental stress such as unusually cold or arid conditions. It is known that insect pests can develop new strains to overcome the genetic defenses of plants in three to ten years. They can do the same to build up resistance to chemical toxins in as little as 15 generations. Thus, the continued bounty of U.S. agriculture is dependent on constant access to genetic materials of wild cultivars which only exist in foreign countries. What if this access were denied by a grouping such as OPEC, or if the places where this genetic material exists were to be used for other purposes and the genetic material destroyed? The former possibly is perhaps remote because of the many nations involved, but the latter is happening now.

Other examples of the importance of wild species are to be found in abundance in medicine. As many as half of the drug prescriptions in the U.S. contain a drug of natural origin. This is indicative of the present value of wild species, but the potential value is difficult to imagine. For example, a Caribbean sponge was found to yield a compound that is effective against herpes encephalitis, a deadly brain infection striking thousands yearly and for which no cure was previously known. This is of critical importance because the sponge's compound has supplied a breakthrough in the treatment of viral diseases much as penicillin did for diseases of bacterial origin (Myers 1979). Also, several seaweed species have been found to contain an active agent that inhibits the growth of two forms of virus that cause the common cold sore, a severe eye infection, and a widespread type of venereal disease. Sea cucumbers yield glycosides with anti-tumor activity. The list of examples can go on and on, not only for food and medicine, but for industrial applications as well, especially for waxes, oils, lubricants, and bioenergy. All point to the enormous value, some present but mostly potential, of wild species and genetic stocks.

To safeguard the world's priceless genetic heritage, the first and most essential step is to protect representative samples of the world's living organisms, and of the support systems on which they depend. Programs to this end are currently underway through the Commission on National Parks and Protected Areas of the International Union for the Conservation of Nature and Natural Resources, and the Man and the Biosphere Program of UNESCO. But progress is very slow, and it is obvious that the donor countries do not consider this to be a high priority item. Yet, if the security of the United States is at stake, can we afford to ignore the problem and hope it will be solved by underfunded and overburdened international programs? Rather it would seem logical for the U.S. to sponsor a major effort, not as concessionary aid, but as a cooperative effort that is clearly in its own interest as well as that of other nations.

The interdependency of the world will not disappear no matter how hard politicians shout about national sovereignty. Species' losses in any country are a loss for all. It is estimated that at least two-thirds, and probably three-quarters of the world's species are in the tropics (Myers 1979). Where better for the U.S. to start cooperative efforts to seriously protect the world's genetic heritage than at its tropical doorstep in the Caribbean?

Recent Advances in Conservation

Progress within the Caribbean region in conservation has been uneven, but, a considerable amount has been accomplished, especially during the last five years. From the outset I should indicate that it is almost impossible to know of all the conservation activities throughout the region, so I hope you will excuse me if my remarks skip over important work with which some of you may be familiar. I am especially ignorant of activities in the northwest Caribbean and specifically exclude from my remarks the nations of Mexico, Cuba, Jamaica and Haiti.

One of the main indicators of conservation activity seems to be the establishment of national parks and protected areas, and more importantly, their effective management. The first national park in the region, Henry Pittier in Venezuela, was created in 1937. The Venezuelan system of parks was followed by that of Colombia and Costa Rica in the late 1960s. Since then, national parks and protected areas have proliferated so that presently there are some 142 legally established areas. Although precise data are lacking, it is probable that only about half of these actually have management in the field.

The parks and protected areas of the region (excluding Mexico, Cuba, Jamaica, and Haiti) as specified in national legislation, are as follows: Antigua and Barbuda–2 areas (2,500 ha); Belize–12 areas (308,459 ha); Colombia–31 areas (3,779,408 ha); Costa Rica–21 areas (198,000 ha); Dominica–1 area (6,840 ha); Dominican Republic–5 areas (219,800 ha); Guadeloupe–1 area (21,500 ha); Honduras–8 areas (1,300,000 ha); Martinique–1 area (400 ha); Netherlands Antilles–6 areas (13,500 ha); Nicaragua–3 areas (117,300 ha); Panama–5 areas (350,939 ha); St. Lucia–5 areas (2,518 ha); Trinidad and Tobago–13 areas (24,049 ha); Venezuela–18 areas (4,592,997 ha); Virgin Islands, British–8 areas (655 ha); Virgin Islands, U.S.–2 areas (6,429 ha). Together these 142 areas occupy some 10,945,294 ha, or about 4.2 percent of the region's land surface. This is just about equivalent to the size of the U.S. National Park System which occupies about 1.1 percent of the U.S. land area. It is a rather remarkable achievement for the nations of the Caribbean over a very short period of time and with very few resources. At the same time, it should be noted that there is an urgent need for the systems of parks and protected areas of the region to be modified to include full representation of the region's diverse ecosystems and better maintain the region's essential ecological processes and life support systems.

It is encouraging to note the recent trend within the region towards strategic and programmatic planning. Until recently, international assistance to conservation efforts in the region was totally sporadic, uncoordinated, and hit-and-miss. This is now changing through the development of regional strategies for conservation, such as for the marine environment (Putney 1978, IUCN 1979) and for the Lesser Antilles (Putney 1979), and the development of a regional action plan for environmental management (United Nations 1980). Each of these efforts is an attempt to understand problems at the regional level so that attention can be focused in a coordinated manner on the most critical ones.

Another important advance has been the increased availability of training opportunities for the region's natural resource managers and conservationists. Universities in the United States, such as the University of Michigan, the University of Rhode Island, and the University of Miami, have tailored programs to the specific needs of the Caribbean region. Within the region, Costa Rica, Colombia and Venezuela now offer university programs aimed at producing qualified natural resource managers. The Tropical Agricultural Center for Research and Training (CATIE) has for the past several years had a very active Wildlands and Watershed Management Unit as part of its Renewable Natural Resources Program. The Unit has played a key role in stimulating management of wildlands in the Central American Region as well as offering graduate level and shorter term training opportunities. The Eastern Caribbean Natural Area Management Program has offered workshops in the insular Caribbean for national park planning and management and has worked directly with the governments and private organizations of the area to stimulate the management of living natural resources.

With the increased availability of training opportunities and technical assistance from a variety of sources, capable and dynamic leaders have come to the forefront in several countries. Wherever this has happened, notably in Costa Rica, Colombia, the Dominican Republic and Dominica, rapid improvement has taken place in the management and conservation of living natural resources. It is this fact that has led many to the conclusion that human capacity to manage is the critical factor in developing effective resource management programs in the region.

It is also interesting to note that active nongovernmental conservation organizations have tended to develop in those countries where effective leaders have taken over the management of living natural resources in government agencies. In most cases, these new leaders have seen the value of nongovernmental organizations and have spurred inactive organizations into more effective roles in support of management activities.

Both the CATIE Wildland and Watershed Management Unit and the Eastern Caribbean Natural Area Management Program (a cooperative program between the University of Michigan School of Natural Resources and the Caribbean Conservation Association) have been supported by the Rockefeller Brothers Fund, which has continuously funded regional conservation programs in Latin America and the Caribbean during the past decade. This support has been a critical element in stimulating action through the governments of the region, nongovernmental organizations, and international programs. Even with relatively small financial resources, the Fund has been able to generate considerable action. The key to their success has been the flexibility and pragmatism of their approach coupled with an ability to respond rapidly at critical moments.

Further encouragement is added by the U.S. Government's new directions in providing assistance to the region in environmental concerns. This is a new departure which has been caused by pressure by nongovernmental organizations in the U.S. on the Agency for International Development (AID). Their efforts have paid off handsomely and AID has been directed by both the President and Congress to fund "environmental projects" as well as to take proper account of the environmental consequences of their other projects in the recipient countries. Specifically, AID is now funding a regional project to assess training needs within the region in wildland and wildlife management and to recommend an action program. They have also initiated major natural resource projects in Panama and Costa Rica. Others will be brought on stream within the near future.

Hindsight as a Guide to the Future

The last few years have witnessed great strides in the Caribbean towards conservation action. This period has provided a series of opportunities to test ideas and methods and to extract guidelines for future activities. I would like to suggest several that seem critical which are based on the experiences of a variety of individuals and organizations who have worked for long periods in the Caribbean region:

1. Qualified leadership at the national level is a prerequisite for long term and effective conservation action. Thus, the training of key natural resource managers should be a high priority item for international assistance.
2. Most of the already developed "technology" and methods for natural resource management are not directly applicable to the natural and institutional environment of the Caribbean Region. It is therefore critical that technical inputs from outside of the region be adapted to fit particular needs and circumstances by those fully knowledgeable about the local scene, and that local solutions be sought as a first priority.
3. Training of resource managers should be based on the experience gained from pilot and demonstration projects in the region. Thus, it is crucial for training programs to be firmly linked with on-the-ground action projects.
4. There is a continued need for nongovernmental organizations within and outside the region to pressure bilateral and multilateral development programs to integrate environmental concerns into their regular programming process.
5. There is a need for the further development of theoretical tools and practical assessment methods adapted to the conditions of the region so that conservation efforts can move toward the conservation of the biophysical systems which support and maintain development.
6. For conservation to become a part of the development process it must de-emphasize the concern for single spectacular or appealing species and emphasize concerns which orient and guide the development process in harmony with the natural and cultural environment, and acknowledge the dependencies of human and natural systems.
7. Programs of international assistance should be small in scale and not overwhelm or dominate the recipient agency. At the same time, a holistic approach should be taken so that all elements of management, such as law, policy, research, planning, field implementation, public education and training, are dealt with together as part of a single integrated process.

8. The team approach to management is essential so that a full spectrum of views and disciplines is consulted in the management process, and so that an ambience of cooperation and mediation is fostered instead of one of conflict, confrontation and competition.
9. Management must take full account of the needs and opinions of local citizens whose lives are affected by management decisions.

And finally, I would urge that we in the United States take cognizance of the importance of supporting, in pragmatic ways, the management of living natural resources in the Caribbean, not as a goodwill gesture or with an attitude of concessionary aid, but rather as an element of the United States' concern for its own, and the world's, security.

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REGISTERED ATTENDANCE

ALABAMA
Ronald J. Field, Raymond D. Moody, Joy Sims, Kenneth R. Sims

ALASKA
Don W. Collinsworth, Raymond Corning, Clayton Hardy, Wayne Heimer, Sig Olson, John A. Sandor, Keith M. Schreiner, Ronald Somerville

ARIZONA
William H. Beers, Steve Gallizioli, Roger Hungerford, Robert A. Jantzen, Jerome J. Pratt, William W. Shaw, Harry R. Woodward

ARKANSAS
David G. Criner, Rex Hancock, Brad Kennedy, William P. Mathis, Jesse N. Masters, Hays T. Sullivan, James S. Walter, Fletcher Ward, Tim Wargo, Jr., Steve N. Wilson

CALIFORNIA
Harvey Bray, Geraldine Dana, Richard H. Dana, Charles Fullerton, Ed Greenhood, Bob Jones, Archie S. Mossman, Bob Nelson, Dennis G. Raveling, Kent A. Reeves, Vern Smith, William E. Talley, Richard D. Teague, Elizabeth L. Venrick

COLORADO
Arch Andrews, Delwin E. Benson, R. Bruce Bury, Len H. Carpenter, David E. Chalk, Marla Kay Chalk, Richard L. Divelbiss, Donald A. Fernandez, Ernest Gluesing, Ladd S. Gordon, A. F. C. Greene, Billie Greene, Jack R. Grieb, Retha Grieb, John E. Heasley, Thomas W. Hoekstra, C. Eugene Knoder, Grace Knoder, Harvey W. Miller, Don W. Minnich, Lanny Reed, Ken Russell, Wayne W. Sandfort, Robert Sanz, John L. Schmidt, Charles P. Stone, Edward Ambrose Sullivan III, Gustav A. Swanson, Jean K. Tool, Dee Torres, John R. Torres

CONNECTICUT
John M. Anderson, Mrs. Edward F. Barrett, Edward F. Barrett, Bonnie Corey, Leslie N. Corey, Jr., R. F. Dietz, Charles H. W. Foster, Barbara Kamman, Jack F. Kamman, Stephen Kellert, Mrs. E. S. McCawley, E. S. McCawley, Richard S. Miller, John Mitchell, Charles Nilon, Douglas Painter, Elaine Parker, Jack S. Parker

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KENTUCKY
Rank R. Holland, John L. Mechler

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MAINE
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