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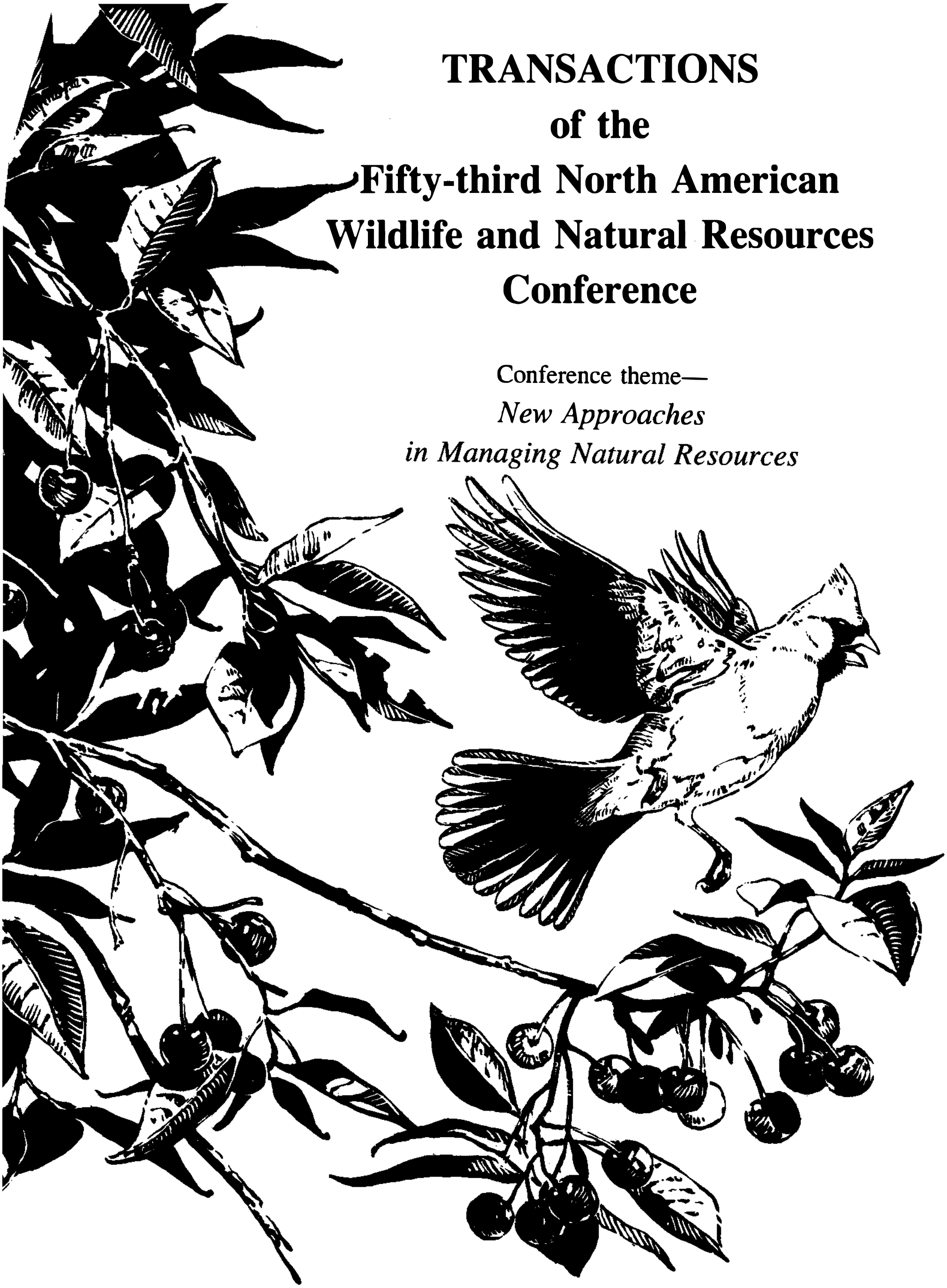
of the
Fifty-third North American Wildlife and Natural Resources Conference

Conference theme—
New Approaches
in Managing Natural Resources



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Richard E. McCabe

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GOVERNOR WALLACE G. WILKINSON
CAPITOL
FRANKFORT, KENTUCKY 40601

Greetings:

Kentucky is honored to serve as the host state for the 53rd North American Wildlife and Natural Resources Conference. I hope your meeting is a productive one and that you will find time to sample some of the hospitality for which our Commonwealth is famous.

The problems facing our wildlife resources are enormous. Growing human populations, the stark economic realities of agriculture and the pressing needs of society are placing unprecedented demands upon all our precious natural resources. The job you do focusing attention on these concerns is a positive and effective means of counterbalancing such threats to the welfare of our natural resources.

Your job is a large one and your responsibilities are great. You are the guardians not only of our natural resources but also of the long and noble outdoor traditions that all Kentuckians hold dear. I wish for you a productive and enlightening conference, as well as every measure of success when you return home to your various jobs of protecting America's natural resources. I join all Kentuckians in inviting you to return to our state to enjoy Kentucky's abundance of lakes, forests, and other natural resources.

With personal regards, I am,

Yours sincerely,

Wallace G. Wilkinson

Opening Session. *Tackling Conservation Challenges*

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DONALD L. BATCH
Dean of Natural and Mathematical Sciences
Eastern Kentucky University
Richmond, Kentucky

Cochair
HERBERT E. DOIG
President, International Association of Fish and Wildlife Agencies
Assistant Commissioner, New York Department of Environmental Conservation
Albany, New York

Opening Remarks

Laurence R. Jahn
President
Wildlife Management Institute
Washington, D.C.

We are especially pleased to convene the North American Wildlife and Natural Resources Conference in Kentucky. This is the first time this meeting has been held in the Bluegrass State. It is delightful to be here.

This 1988 international conference, like its predecessors, deals with history-setting proposals and actions. We gather here to examine successes, develop understanding and explore new approaches for integrating conservation, human population and resource development objectives in frameworks of sustainable use and management of natural resources in the best interests of the resource base and people.

Several new strategies and procedures have become available recently to strengthen resource management. Other strategies and measures remain to be designed to improve stewardship.

In 1985, for the first time in a half century, a strong conservation dimension was woven into the fabric of federal farm support programs to correct excessive soil erosion, enhance water quality, restore wildlife and fish habitats, and place agricultural land use on a more sustainable and socially acceptable basis. Unlike other federal agricultural efforts of the past 50 years that poured billions of dollars into marginally effective programs, the Food Security Act (or Farm Act) of 1985 links stewardship of land, water and wild living resources with landowner eligibility for federal farm benefits. The major objective is to help ensure that the 50 percent of net farm income from taxpayers, distributed through the U.S. Department of Agriculture, yields multiple benefits that contribute to improvements of soil, water, fish, wildlife and recreation, as well as the financial viability of landowners.

New teams of federal and state agencies are seeking practical solutions to resource and economic problems. Under a 1987 memorandum of understanding, the Farmers

Home Administration (FmHA) now works cooperatively with the U. S. Fish and Wildlife Service and state fish and wildlife agencies to assist financially troubled farmer borrowers. Conservation easements are used to restructure loans and simultaneously provide deed restrictions that help maintain wetlands on private lands for 50 years or more. As of January 1988, the Secretary of Agriculture has authority to transfer suitable FmHA-foreclosed inventory lands—such as wetlands, erodible areas and certain uplands—to federal and state fish and wildlife agencies. Similar opportunities to relieve economic and conservation stresses through agency/landowner efforts await imaginative reasonable responses.

A pressing need is to convert a substantial part of the agricultural annual set-aside acreage to multiyear agreements. Legislative proposals and U. S. Department of Agriculture administrative actions have been introduced to make that needed conversion. About 54 million acres were entered in annual set-asides in 1987. Yearly set-asides provide no planning horizon for farmers, provide few conservation benefits, and frequently are detrimental to wildlife. Acreages set-aside for multiyears (3+), on the other hand, give farmers a planning horizon and permit establishment of protective vegetative cover to help prevent soil erosion, protect water quality, enhance fish and wildlife resources, increase outdoor recreational opportunities, improve structure and qualities of the land, strengthen investments of farmers and yield economic benefits to communities and states.

These conservation and economic objectives now are reflected in eight new (1988) national priority initiatives of the federal/state Cooperative Extension System. With up to 60 percent of U.S. farmers not influenced by acreage set-asides or any other federal agricultural payments, it is imperative that extension outreach elevate and stress conservation and management of natural resources when implementing the eight new priority initiatives in every county of the U.S.

These improvements in U.S. agricultural policies, programs and procedures are paralleled with new soil conservation commitments of Canada's federal government. Refreshingly, they include cooperative ventures with other organizations to benefit wildlife, especially to rebuild populations, as called for in the Canada/United States 1986 approved North American Waterfowl Management Plan. Similar specific team actions remain to be taken by the U.S. Department of Agriculture, Department of the Army (Civil Works) and others to provide pivotal assistance in implementing the six U.S. joint habitat ventures identified in the Plan.

A 1985 pilot project involving the Department of Army/U.S. Army Corps of Engineers and National Oceanic and Atmospheric Administration/National Marine Fisheries Service to restore and create important fisheries habitats emphasize that highly desirable team actions are possible. More such responsive inter-agency initiatives are needed to advance and achieve restoration and management of natural resources in the public's best interest.

Through the 1986 Water Resource Development Act, new directions were given to federal involvements in water development projects. Reforms include cost-sharing and environmental provisions that hold much promise for improving plans and designs for proposed projects.

Criteria and guidelines are expected to be helpful in screening and eliminating unnecessary, marginal or destructive proposed projects. After more than two decades of efforts, mitigation policies and actions for fish and wildlife should be more realistic, with mitigation now handled up front for new projects, not as an afterthought or not at all, as with many old projects. Applications of the new procedures will test the promises in the new policies.

The Corps' new (1988) Office of Environmental Policy—recommended for years, together with its equally new Environmental Policy Coordinating Committee, should be helpful in formulating better policies and procedures that place water planning and development on a new level of resource stewardship. Actual achievements will depend on continuing inputs from professional resource managers and citizens.

Whether dealing with surface waters or groundwaters, more agencies and people are coming to understand that managing water resources and restoring and maintaining acceptable water quality will take new institutional, political and economic arrangements that focus on problems within individual watersheds. Iowa's precedent-setting statute to prevent further groundwater pollution signals pressing needs to reform and redesign current land and water uses. New national nonpoint-source pollution laws await prompt responses in states, watersheds and communities. Selenium contamination and associated wildlife and fish losses at Kesterson National Wildlife Refuge in California emphasize the need for corrective actions. In some western states, hope hinges on the Bureau of Reclamation's newly announced water management program—a major change in that agency's more than 80-year history (1902–1988). Innovative preventative and corrective procedures and measures are required and await application to perpetuate the health and productivity of the resource base.

While the 100th Congress faces a stream of reauthorizations for endangered species, nongame fish and wildlife, marine mammals, military and other public lands management, funding for fisheries programs, and other important resource statutes, it also plans to deal with some new proposals. Receiving increasing attention is the question of whether to allow oil and gas exploration and extraction in the Arctic National Wildlife Refuge (ANWR). While legislators will make the ultimate decision on whether to proceed with mineral development, it is up to conservationists to ensure that wildlife, fish and other natural resources are protected adequately and benefit *if* development proceeds. A core caribou-calving protective area is essential, along with provisions to maintain habitats used by waterfowl, polar bears, musk-oxen and other fish and wildlife along the Arctic coast. ANWR mineral royalties should flow into the proposed Fish and Wildlife Enhancement Trust Fund and the existing Migratory Bird Conservation Fund. Funds from minerals removed from ANWR should be used for research and management to benefit wildlife and fish, not for other purposes. Monitor the ANWR discussions and let your views on this paramount issue be known to decision makers.

Funding challenges continue to be faced at state, as well as national levels, with some proposals offered to strengthen management of natural resources. Strong citizen support of the sales tax in Missouri, and of trust funds in Alaska, Michigan and some other states, demonstrate continuing commitments to advance conservation programs. Among new proposals, Minnesota's initiative calls for establishing a $1 billion environmental and Natural Resources Trust Fund from personal, corporate and sales taxes and using the interest to fund needed natural resources programs. The sponsor aptly considers the pending legislation "a bill for self-preservation." More such imaginative approaches for funding natural resources programs are sorely and urgently needed.

As definition and enactment of such new funding mechanisms proceed, more public/private partnerships are being formed to progress with multiple-use management on public lands. Growing interests in and dollar contributions to cost-share programs for U.S. Forest Service and Bureau of Land Management wildlife, fish and outdoor recreation management activities show that people will join in partnerships and contribute their money and talents for worthy tangible projects. These broad citizen interests and concerns in wildlife, fish and outdoor recreation prompted the U.S. Forest Service to respond with new initiatives that will be discussed here in Louisville for the 191-million acre National Forest System.

Similarly, the search continues for tax and other incentives to encourage landowners to improve multiple-benefiting management practices on private nonindustrial woodlands. Problems resulting from the 1986 Tax Reform Act are being assessed to identify constraints that discourage private owners from improving management of their woodlands. With nearly two-thirds of America's woodlands held by private owners, it is imperative that new approaches be identified and used to improve multiple-benefit management of those 596 million acres.

As you participate in the special sessions on woodlands, agricultural lands, water and wetland resources, outdoor recreation and other topics, accept the challenge *personally* to generate new innovative responses that identify how to maintain and manage natural resources more effectively. Your knowledge, experience and imagination are needed now to help design improvements in laws, policies, regulations and measures or practices that will expand, improve and advance the new precedent-setting changes that will be discussed in the next few days.

One who will not join in our discussions is C. R. "Pink" Gutermuth, a distinguished conservationist and long-standing associate and friend of many assembled here today. He passed away December 20, 1987. For fully a half century, Pink was a prominent mover in advancing sound management of natural resources, especially wildlife. At the very hub of action was Pink, his head jutted forward, his forefinger jabbing the air for emphasis, and his words not asking—but demanding—that natural resources be accorded the attention and management emphasis due a treasured national heritage held in trust for all citizens. He showed us that a caring person with insights, energy and dedication can make a difference, even when faced with seemingly insurmountable obstacles and odds. He proved that improved stewardship and management of natural resources is absolutely essential, proper, practical and possible.

Let us join together in a few moments of silence in respect for our esteemed, departed colleague.

Thank you.

Implementing Conservation Provisions of the 1985 Farm Bill

The Honorable Peter C. Myers
Deputy Secretary of Agriculture
U.S. Department of Agriculture
Office of the Secretary
Washington, D.C.

It is indeed a pleasure for me to be here today, especially since I'll be speaking about two of my favorite subjects—farming and wildlife—under the general topic of implementing the conservation provisions of the 1985 Farm Bill. I share your interests in wildlife management on both a personal and a professional level. Wildlife habitat management has a high priority on my farm in Missouri. And, I served as a commissioner on the Missouri Department of Conservation before joining the Department of Agriculture in Washington.

So, you see, it really is a pleasure for me to talk to you about what I consider the most important resource conservation legislation to be passed in the past half century. This is an exciting time. What we are engaged in now—implementing the conservation provisions of the 1985 Farm Bill—is the beginning of tremendous long-term benefits for

- the productivity of our farmland,
- our wildlife, and
- our water quality.

When Congress passed the 1985 Farm Bill, it brought soil and water consistency to USDA farm policy. Under the conservation provisions, landowners now must protect soil and water resources to qualify for commodity and other program benefits. This Bill had strong support from both farm and environmental groups.

Most farmers are as interested in protecting the natural resource base as are environmentalists—although perhaps for different reasons. But whether you want to protect soil and water in order to maintain productivity or to provide habitat for wildlife, it's important to recognize that we need to work together to make these provisions work.

If the saying "money talks" is true, then these provisions should have a big impact on the protection of our natural resources. At stake is some $21 billion in farm program benefits nationwide, including price and income supports, disaster payments, crop insurance, Farmers Home Administration loans, Commodity Credit Corporation storage payments, and farm storage facility loans. About 80 percent of the nation's 2 million farmers participate in these programs.

The final rules for the highly erodible lands and wetlands provisions—except for conservation plan and system requirements—were published in September 1987. The final rules on conservation plan and system requirements were published in February 1988. A lot of work went into making these rules *practical* and *economically* feasible. More than 8,400 public comments on the interim rules were evaluated and considered in the final rulemaking process. USDA agency staffs worked closely with other federal agencies including the Fish and Wildlife Service and EPA, as well as with producer and environmental groups. We feel that these are balanced rules. We are confident that they serve the needs and interests of farmers, environmentalists and the American public.

Progress to Date

Let's take a look at these provisions—conservation reserve program, conservation compliance, sodbuster and swampbuster—and the progress made so far.

The goal of the *conservation reserve program* (CRP) is to retire 40–45 million acres of highly erodible cropland from production. Farmers bid to put their land in the program. They receive an annual rental payment for putting this land into protective cover, such as grass or trees, for a period of 10 years. The benefits are many:

- CRP will reduce soil erosion—and associated sediment—by taking marginal farmland out of production and putting it into grass or trees.
- This in turn will help improve water quality and improve habitat for fish and wildlife.
- It will also reduce surplus commodities as will as government program payments. Half of the cost of operating the conservation reserve will be recovered in reduced commodity program payments.

The Agricultural Stabilization and Conservation Service (ASCS) received bids submitted on 4.5 million acres during the sixth signup in February. The acreage accepted from that signup will be announced around May 20. However, we had already reached the halfway mark in the goal as of the July 1987 signup, with 23 million acres entered into the program. Of those acres, 905,000 will be put into wildlife habitat. We've accepted more than 200,000 bids from 45 states. The average rental rate is about $48 per acre. After this 23 million acres is put into protective vegetative cover, there will be 467 million tons less soil erosion on our nation's farmland every year.

Some attractive incentives from an environmental and wildlife standpoint were added to the program during the last signup.

- For the first time, farmers were allowed to bid to put their land in grass filter strips. The strips must be 66–99 feet wide and must be planted next to streams, lakes and estuaries. They must actually prevent additional sediment from entering the stream and, of course, along with that, keep the nutrients that are attached to the sediment out of surface water. The strips also provide food and cover for wildlife. By improving water quality, these strips also benefit fish habitat.
- Two incentives to promote tree planting were introduced in 1988. The erosion criteria for producers opting to plant trees was reduced from three to two times the normal soil loss tolerance. Also, only one-third, instead of two-thirds, of a field had to be highly erodible land for those producers who wished to plant trees on land entered into the program.

The CRP is already one of the largest tree-planting programs in history. More than 1.5 million acres—6.2 percent of the total acreage bid—will be planted to trees. Although we're still short of the nationwide target of 12.5 percent trees, the amount of tree planting in the Southwest is far exceeding our expectations.

What effect has CRP had on wildlife so far? We expect to see some major increases in wildlife, especially upland game birds such as pheasant and quail where there has been a large amount of land in the reserve. Part of the reason may be some mild winters. But we know that CRP has created more wildlife habitat by providing special cost-share assistance for developing food plots, cover and shallow water areas for wildlife. Several state fish and wildlife agencies have played an outstanding partnership role by coming up with their own supplementary programs to increase the incentive to develop wildlife habitat. A combination of other erosion-control practices that receive cost share assistance in the program also provides such wildlife benefits as planting grass, trees and windbreaks.

The *conservation compliance* provision requires landowners to have a conservation plan developed and approved by their local conservation district for highly erodible cropland by December 31, 1989, if those farmers wish to remain eligible for USDA program benefits. Their conservation plan must be fully implemented by December 31, 1994. There has been some pressure to move the deadline for developing a conservation plan to 1992. Let me assure you that we are staying on target for 1990.

The goal of conservation compliance is to reduce soil erosion on the nation's 118 million acres of highly erodible cropland to acceptable levels. About half of the nation's farmers are affected. The Soil Conservation Service (SCS) estimates that about 800,000 plans will need to be developed in the next 20 months. The goal is to have 65 percent of the plans developed by the end of December 1988, and the remainder by the following year. As of January 1, 1988, SCS field staff has made 554,000 highly erodible land determinations on nearly 60 million acres. There has been 176,000 conservation plans developed on about 20 million acres. Nearly 84,000 conservation systems have been applied on 8 million acres.

Sodbuster is the other conservation provision affecting highly erodible land. Under sodbuster, landowners must implement a conservation plan immediately on any highly erodible land in grass or trees converted after December 1985 to crop production or they will lose farm program benefits. There are about 250 million acres of highly erodible land with potential for being converted to cropland. Sodbusted land that is converted from native vegetation to cropland must be be farmed to attain or approximate the soil loss tolerance level, or "T." The sodbuster provision hopefully will help encourage farmers to keep these lands out of annual crop production.

Swampbuster is the wetlands equivalent to the sodbuster provision. Basically, swampbuster says that if you convert bonafide wetlands after December 23, 1985, you lose eligibility for USDA program benefits if you plant a row crop on the converted wetlands. Of the 76 million acres of wetlands in the United States, about 5 million—or 6.6 percent—have medium or high potential for conversion to cropland.

Nearly every county in the nation has some wetlands. Wetlands have important environmental values—as wildlife habitat, for flood control, for trapping nutrients and other pollutants, for recharging aquifers, and for providing recreational opportunities.

Farmers who wish to sign up for USDA commodity program benefits must certify that they are not growing annual crops on wetlands converted after December 23, 1985. If they are not sure if the land they plan to crop is a wetland or a converted wetland, SCS will make that determination. Of the determinations made to date, 46,000 farms turned up with wetlands and 3,800 farms with converted wetlands.

The final rules for swampbuster, published in February 1988, were closely coordinated with the U.S Fish and Wildlife Service. All USDA agencies involved in implementing the swampbuster provision have developed procedures to be followed by their employees. Training has been provided to SCS field employees on how to make wetland determinations based on the presence of hydric soils and hydrophytic vegetation.

We do not wish to impose any undue hardship or burden on our agricultural producers. Swampbuster is designed to preserve our remaining wetlands, not to take existing cropland out of production. It does not withhold USDA program benefits from farmers who simply wish *to maintain existing drainage systems.*

Benefits of the Provisions

We've seen a great leap forward for natural resource conservation in the past year. The final rules for the conservation provisions were issued in September 1987, after extensive consideration of public input. We need to give them a chance to work. They will not put farmers out of business if the farmers make a sincere effort to conserve their soils or maintain bonafide wetlands.

You as professional resource managers, can help:

- *First*, by encouraging the landowners with whom you work to contact their local Soil Conservation Service office as soon as possible to find out if they have highly erodible land or wetlands.
- *Second*, by encouraging landowners with highly erodible land to get a conservation plan developed as soon as possible.
- *Third*, by dispelling some of the myths and fears surrounding the process.
- *Fourth*, by being reasonable in working with farmers, SCS and ASCS.

We want to help farmers develop conservation systems that are economically feasible. That means meeting soil erosion-reduction goals based on local conditions and local standards set forth in field office technical guides. Some landowners are betting that if they wait, the rules will change. That's a pretty big gamble—especially considering the strong support that Congress received for this legislation from farm and nonfarm groups. We in USDA will do our best to help anyone who wants a plan by the deadline.

What do we have to gain? Together, conservation compliance and CRP will reduce soil erosion on all cropland by half. Currently, soil productivity is reduced 2.5 percent from sheet and rill erosion and by about 1.2 percent from wind erosion every year. This translates into an *average annual loss* in productivity alone of $150 million annually over the next 100 years. Conservation compliance, along with CRP, should reduce this loss by $90 million annually.

The benefits of the conservation provisions are much more wide-ranging than just maintenance of soil productivity. About 400 million tons of sediment will be prevented from reaching our waterways each year when the conservation provisions are fully implemented. Associated off-site benefits for water quality, sediment reduction and flood reduction control approach $1 billion annually. These estimates do not take into account the benefits associated with reducing wind erosion—a major benefit in the Great Plains.

All of these benefits mean good news for wildlife and for wildlife managers. As a result of the conservation provisions, there will be more habitat for wildlife and cleaner water for waterfowl and aquatic life.

Turning briefly to multiyear set-aside on farm program land, including conservation-use acres and acreage-reduction program, ASCS is making a good-faith effort at the state and county level to encourage landowners and operators to put set-aside acres into permanent cover for at least three years. This would have tremendous benefits for improving wildlife habitat—to say nothing about reducing soil loss on these set-aside acres that are sometimes clean-tilled. Naturally, county and state weed-control laws would be observed. But that could be done by clipping after the nesting season.

This is an exciting time with exciting challenges for resource managers. In our zeal to meet these challenges, however, let's not forget that *most* of our farmers are doing the best they can—often under difficult economic circumstances. We have the highest standard of living and the most productive agriculture on the face of the earth. American farmers deserve a lot of credit. Let's work together to maintain that standard of living—and our natural resource base—for their grandchildren and for ours.

Implementing Conservation Provisions of the Water Resources Development Act

The Honorable John S. Doyle, Jr.
Deputy Assistant Secretary of the Army (Civil Works)
Washington, D.C.

It is a pleasure for me to represent Secretary of the Army Marsh, and Assistant Secretary Page in this national forum of resource managers and conservationists. I am billed to address the implementation of Public Law 99–662, and certainly plan to do so.

To begin with, however, I'd like to share with you some observations. During my last year and a half in the Office of the Assistant Secretary, and in my former capacity on the Hill, I've had a unique opportunity to observe the Corps of Engineers. And for a long time, it has bothered me that, on environmental issues, the Corps is often put in a "black hat" posture. Quite often, the Corps is maneuvered into that posture and portrayed in that light by those who profit by such portrayal. That's extremely unfair. It implies that the Corps has an institutional bias against environmental values. It implies that the Corps is environmentally irresponsible.

My experience indicates that the exact opposite is true. The Corps does so many positive things for the environment, yet gets little credit.

Many view the Corps of Engineers as a developmental organization that is antithetical to environmental concerns. It's not fair to make that connection, and we need to work to correct that problem.

While we're far from being there yet, our trend line is in the right direction. Most notably, cost-sharing is helping us a great deal; it puts us in the position of doing projects that are environmentally and economically sound.

Larger developmental projects inevitably have led us into controversy with the environmental community. With smaller, scaled-down projects, we have fewer conflicts with that community.

Another upward trend is that the Corps is realizing that there are sensible, cost-effective engineering solutions to environmental problems. We are working to identify and pursue more of these opportunities. Another positive trend is that the Environmental Protection Agency (EPA) is increasingly recognizing that we can help that agency in its environmental construction programs. I'm referring specifically to Superfund.

If this country is to clean up our environmental mistakes of the past—toxic and hazardous waste sites, etc.—all resources have to be applied. The Corps is being called on to play a bigger role in Superfund.

In the past several months, I have seen indications that the image of the Corps of Engineers, in relation to the environment, is changing.

Let me share a couple examples that illustrate the message *is* beginning to get out—the Corps cares for the environment.

A couple of weeks ago, I made a presentation on the Army Civil Works budget before the Natural Resources Council of America (NRCA). I mention this as significant because, first of all, this was the first time the Corps of Engineers has been invited to participate in that forum.

Second, the response I received was openly receptive. As you are aware, the environmental community actively supported the Water Resources Development Act of 1986. The participants at that briefing to NRCA, which is comprised mainly of members of the environmental community, expressed overall satisfaction with the way the Corps has been implementing the provisions of that Act.

Another example revolves around the Central Arizona Flood Control Project. This past summer, the Arizona congressional delegation, OMB and the environmental community met to iron out their differences. The Corps was not a player; we were only advised later that it had occurred. During the meeting, however, the environmental community demanded Corps of Engineers participation in the project. To me, that means the Corps is perceived by them as environmentally sensitive.

I'd like to give you some indicators that I think are helping to demonstrate the environmental responsibility of the Corps.

Our FY 1989 budget, which was sent to the Congress last month, continues the President's commitment to support responsible national water resources development. It is, we believe, a well-balanced, fiscally responsible budget.

Our request totals $3,317 billion. That represents a slight increase over the FY 1988 budget request and appropriation, yet is consistent with the constraints imposed under the 1988 bipartisan budget agreement. This is a significant investment level. It includes funding of 157 construction projects and 6 new construction starts in FY 1989.

As a result of the Water Resources Development Act of 1986 and its cost-sharing reforms, our budget has fared well in the budget wars of late. Overall, the Army Civil Works program has been increased from 1986 to 1987 by about 13 percent. And even after the Gramm-Rudman budget summit, the 1988 appropriation is about 4 percent above FY 87. The FY 89 budget request is within the 102-percent cap of the bipartisan agreement.

The key to sustaining our investment level is the increased non-federal share of project costs and financing of that share during construction.

The beneficiary-pay concept is the heart of our program, and it's working well. Approximately 14 percent of our FY 1989 program will be financed by other than general treasury funds. Two years ago, that was only 2 percent.

The President's 1989 budget request for new construction general funds is 40 percent greater than the FY 1986 appropriation. Moreover, because of non-federal cost-sharing, each dollar of the FY 1988 requested amount will support about $1.14 of new water project development.

This is another indicator of the success of the beneficiary-pay concept. Of 57 new starts funded prior to FY 1988 that require local cooperation agreements, 47 have been negotiated and signed, and the other 10 continue to move forward. Also, we've already signed LCAs on three of the FY 88 new starts.

Local sponsors—our partners—are demonstrating that they are willing to pay an increased share to construct projects that reflect sound engineering, economic and environmental standards.

Now let me turn to some specific natural resources programs supported in the FY 1989 budget request.

Our first major interagency activity is the Chesapeake Bay Model, which we are pursuing in conjunction with EPA. In August 1987, the Army and EPA executed a Memorandum of Understanding to develop a numerical 3-D hydrodynamic and water quality model as part of our effort to protect and restore the Bay.

Our FY 89 budget request will be used to complete assembly and verification of the model. The operational hydrodynamic model will allow resource managers to test alternative strategies. It will also provide the ability to predict impacts from Army and other Department of Defense activities on the Bay.

Our next major interagency program is for fisheries habitat. The Army entered into an agreement with the National Oceanic and Atmospheric Administration to restore and create fisheries habitat. The program is administered and executed through the field offices of the Corps and the National Marine Fisheries Service (NMFS).

We've selected 4 sites from 45 nominated for pilot study. The Corps and NMFS, assisted by interested state agencies, are documenting and evaluating the effectiveness of these pilot studies.

Our criteria in considering an alternative involving creation of fish habitat are that the technique applied is no more costly than would be our normal construction or maintenance practice, and that the work is within existing Corps and NMFS authorities.

The purpose of our pilot studies is to document fully and evaluate activities involved in restoring fisheries habitat. However, the pilot study framework is very limited, and the opportunities are great. Therefore, we've been encouraging our field commanders to cooperate with NMFS regions in pursuing habitat-restoration opportunities as they arise. And they have done so.

Ken Roberts of NMFS will address this successful cooperative effort in much more detail in a separate presentation at this Conference.

The next subject I'd like to cover is individual Corps environmental projects funded in the FY 89 budget request. It is important to note that the FY 1989 budget request is the first to be prepared in the wake of PL 99–662. More than $16 billion in projects are authorized in the Act. In actual dollars, that exceeds what had been authorized for the Army Civil Works program in all previous authorizations. Obviously, we can not pursue all these projects at once. And very likely, some will never be built. However, I want to assure you that the environmental provisions of PL 99–662 are being given due consideration in the budget process. And while first priority is given to the Corps traditional missions of navigation and flood control, a number of environmental projects are emerging from the process. In most cases, these are mitigation projects. Among them are Clearwater Fish Hatchery, Missouri National Recreation River, Atchafalaya Basin Floodway, Big South Fork, Cooper Lake and channels, and Mississippi Delta Region.

I'd like to point out a couple things about the latter project. First, it has quantifiable economic benefits—enhanced oyster production. Second, more significantly, the local sponsor—the State of Louisiana—has volunteered to cost-share 25 percent of the project.

While the Corps of Engineers is thought of principally in terms of engineering and construction, it also has an extensive natural resources management program. The Corps administers the second largest, federal, outdoor recreation program. More than 460 Corps water resource development projects, scattered throughout 42 states, host 500 million recreation-days of use annually. While our 11.9 million acres of land and water comprise only 1 percent of the total federal recreation land base, our projects accommodate about 27 percent of the annual recreation-days of use on federal lands. Visitors are drawn by our 4,000 developed recreation areas, which generally are within 50 miles of major metropolitan areas.

Our people in the field—about 1,550 rangers, 840 of whom are full time—have a good conservation record. We see our mission as managing these resources to ensure their continued availability to present and future generations. In pursuing that mission, we encourage support from other agencies, and publicly promote good land stewardship on all project lands.

Another Corps mission that has an extensive, positive effect on the environment is our regulatory program. As a budgetary line item, our regulatory program is relatively small—some $55 million. However, its size belies its importance to the public, the environment and the economy of the United States.

Decisions made by the Corps on permit applications literally affect billions of dollars of private construction work every year. The overall objective of the Corps' 404 regulatory program is to provide the public with a program that offers applicants a fair, balanced and prompt response, while maintaining environmental safeguards. And I am pleased with the efficiency of the program.

In this fiscal year's continuing authority resolution, Congress, for the first time, chose to break out our regulatory program as a separate budget line item. That's a good news/bad news story. The good news is that it gives the program the visibility that it deserves. The bad news is that it takes away the flexibility we enjoyed when the program was under the Operation and Maintenance general account. We can no longer reprogram money to meet unanticipated peaks in our regulatory workload.

The bad news gets worse. While the President requested $60 million to fund the program, Congress appropriated only $55 million. By so doing, Congress has, in effect, determined the scope of our regulatory program. That $55 million represents a $2 million decrease from our budgets for the last two years. Consequently, we are going to have to prioritize and limit our universe. And we're going to have to let some things go undone.

I want to wrap up with a couple final points about the effect of the Water Resources Development Act of 1986 on the Army Civil Works Program and the environment. One area often overlooked is that PL 99–662 deauthorized some 300 specific projects. It also provided for periodic reporting by the Corps of projects eligible for future deauthorization. We've complied with that requirement and reported 363 projects and 555 studies eligible for deauthorization. This effort ensures that a lot of projects that were environmentally and economically marginal will not be built, and it keeps our program modern.

I touched earlier on the environmental fallout from PL 99–662 on the down-sizing of projects as a result of the new cost-sharing provisions. These are some of the more dramatic cases. But across the country, we are seeing that when local sponsors are faced with paying an increased share, and paying that share during construction, they ask themselves not only what do we want, but what can we afford.

A final item I want to mention is our current legislative proposal. We want to get away from omnibus bills and back on a biennial cycle. The program is easier to manage in smaller bites and avoids the high costs associated with implementing a big bill. So, with this year's budget we have submitted a "minibus" bill.

It would authorize four new starts, modify some existing project authorizations to comply with Water Resources Development Act cost levels, and makes some technical corrections to provisions of the Act. Included in the proposal are provisions that would expand our authority to collect fees for the use of project recreation lands. If enacted, the increase in revenue would go to meet the ever-increasing needs of our recreation program. A second major provision would enable the Secretary of the Army to transfer funds to other agencies, both federal and nonfederal, to carry out intensified wildlife management on areas under the jurisdiction of the cooperating agency. This intensified wildlife management would mitigate fish and wildlife impacts attributable to Corps projects. This is another example of the kind of thinking that enables us to build the infrastructure the nation needs. It also makes sense from an environmental perspective.

I want to conclude by asking for your help. We need additional ideas from you on how we can do what we do better. Our mission is to develop the nation's water resources in a sound manner and to protect the environment. We value your contribution to our program in finding the proper balance between environmental and developmental values. Your support was certainly instrumental in presenting us the new charter we have in PL 99–662. I solicit your support in preserving its reforms that are producing projects that reflect good engineering, good economics and a sensitivity to our environment.

A New Management Thrust in NOAA

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Bill Evans asked that I personally convey his regrets that he could not attend this Conference. While I can't give you the exact words he would have used in presenting this topic, I can tell you what I think he might have said and what those of us say who share his vision for the future of conservation and management of living marine resources.

The "Why" of a New Management Thrust

The first question is—what is this new management thrust that Dr. Evans has set in motion within NOAA? We call it the ecosystem approach to management of fisheries and protected resources. The interesting thing is that, if you tell people you're going to be managing in that manner, as if it were something really exciting, they're apt to ask if you just completed your first ecology course! You see it's obviously not a new idea. Scientists (government, including our own, private and university) have been working within that context and preaching that message for years. However that was not so evident when Bill Evans walked through the doors of the National Marine Fisheries Service. He was reminded of a few facts: most of the U.S. traditional fisheries are heavily exploited; over the past 20–30 years, there has been a dramatic increase in the number of fishermen and in their efficiency; fisheries have moved from small capacity, low-hp boats to larger capacity, high speed and less fuel-efficient engines. Such a trend pushed us into a fatal downhill slide toward inefficiency. In the fisheries context, the cost of "bigger is better" outweighs the gain, and we exceeded sustainable economic harvests. (As someone so eloquently put it, we've found the 20th century analog to the dinosaurs—the tuna superseiner, the high seas trawler, etc.) The problem is, we've lost the balance between technological efficiency and resource resilience.

Dr. Evans found himself with a declining resource base and the realization that, given conventional management practices, the growth era in fisheries had come and gone. He also found that, generally speaking, our present management practices focus on the traditional single-species approach. These practices assume that we can have a sustained yield for each species—whatever its biological characteristics and whatever its interspecies dependencies—as long as we have the proper regulation to control harvest. The problem with this thinking is that it fails to recognize that stock behavior and natural history parameters are largely dependent on environmental variations that are not described in these traditional models. When fishery managers first recognized a problem with declining resources, the immediate assumption was that overfishing was to blame. However this was not necessarily the case. Data will show that stocks fluctuate and change over decades in the absence of a commercial fishery. These fluctuations are affected by environmental processes—perturbations, habitat degradation and loss, and pollution, as well as fishing activities.

After assessing the situation, the decision was made to shift away from the more traditional approach to management. After all, we do not harvest species in isolation, and if you doubt that, just talk to someone about the by-catch issue. Since we don't harvest in isolation why should we expect to manage in isolation. The manager needs to have some understanding of interspecies relationships and natural variations in stock abundance. The only way he/she can do this is to have a well-structured, integrated research program that generates information on the biological, oceanographic, economic, social and political processes affecting living marine resources. So, in fact, we are indeed talking about Ecology 101—a holistic approach to resource management. Interestingly enough, the timing is right for this approach. A holistic approach is feasible now because of the technological advances of the past few years. We've seen conceptual advances in systems modeling and advances in computer technology that allow us to sit at our desks and manipulate and analyze large data bases. These advances, in addition to the increasing demand for more and more sophisticated information, make it timely for us to move away from the traditional approaches to resource management.

The "What" of a New Management Thrust

The objective of our NOAA initiative is to orient our living marine resource research and management program toward a multispecies/ecosystem approach, in order to provide a predictive capability while still providing information necessary for day-to-day management decisions. The "ecosystem" program will be built on the existing core NMFS program base, which presently supports single-species focused management. Routine fishery monitoring and research activities within the proposed core NOAA fisheries program will continue to provide the minimum level of information necessary to meet immediate management needs. However, the core program will be adjusted so that its data products are complementary to the research proposed in this ecosystem program initiative.

The "How" of a New Management Thrust

The question becomes—how do we go about making this shift? One begins as with any complex problem—break it down into manageable parts and then put it back together again. In this case, our manageable parts are seven regional ecosystems. One of the large marine ecosystem gurus said " . . . a region is essentially an intellectual concept." Well our intellectual concept focuses on the North Atlantic shelf, the South Atlantic and Gulf of Mexico shelf, the Atlantic Oceanic, the Pacific Current, the Pacific Oceanic, the Bering Sea, and the Gulf of Alaska, and finally Antarctica. These areas all contain either resources under U.S. jurisdiction or resources of particular interest to the U.S. They are zoogeographic areas characterized by similar oceanographic and biological features. They're not closed systems with boundaries *per se*. In fact, the boundaries will shift horizontally and vertically in response to short- and long-term natural and human-induced perturbations. Of course, they are also affected by environmental events outside their boundaries, such as climatic shifts. Dr. Evans refers to these regions as the cogs in our ecosystem clockwork.

One of the most exciting aspects of this initiative is that it has forced us to look at the work closely with other NOAA components. It became quickly apparent that the data and expertise required by this effort were not all going to be found within NMFS. Throughout NOAA, we have identified pockets of applicable research and expertise.

An integral part of this initiative, which should be of particular interest to you, is the strength of our focus on habitat. For years, we have seen habitat considerations band-aided onto our fishery management-planning process. Intellectually, both the Councils and our staff were clearly aware of the relationship between productive fisheries and habitat, but our single-species approach to management didn't encourage its integration into the decision-making process. Recently, this has begun to change, primarily for two reasons. Back in 1986, the Magnuson Fishery Conservation and Management Act was amended to include provisons requiring consideration of habitat as an integral part of the planning and management process. Now, with the broader ecosystem, multispecies approach, this should be easier to accomplish. Dr. Evans is fond of saying that, if we do not shift away from the single-species approach, the fishery management folks won't have any species to worry about because they'll all be managed out of my office. You see, I manage the endangered species program. Now that might be a slight exaggeration but it certainly gets the point across. In any case, we're all aware that the well-being of living marine resources and the commercial and recreational fishing industries depend on healthy and productive marine and estuarine habitats. We know that it is inconsistent to conduct long-term programs of fisheries management without also planning for the maintenance of high quality habitats.

Good things will come out of this ecosystem initiative regarding habitat. For example, one of our primary habitat program objectives is to advise other agencies on the cumulative, long-term effects of their actions and to provide them a sound basis for action. Another management focus deals with restoration of habitats. Even with the most effective protection and conservation programs, inevitable losses of fish and wildlife habitat will accompany human activities and development. Unless we learn to replace these inevitable losses as they occur, I'm afraid we will never offset the accompanying losses in fishery productivity. The state of the art is not far advanced. Often, restoration success is not readily predictable and benefits are difficult to quantify. Our immediate role as fish and wildlife professionals is twofold. First, we should demonstrate the potential and cost benefits possible under existing technology. Second, we should concentrate on translating research into successful restoration techniques. Following such a course, it will be possible to assess the potential of restoration and to translate this knowledge in technology development, public policy programs—the end product—a reduction in net loss of habitat.

I would like to make a final point. For many years, it was just the national and international scientific community that kept focusing on the ecosystem approach to management of the oceans as the rational approach. Today, however, that is no longer true. The exciting point is that we now are beginning to hear the same message from international managers and even politicians. The Law of the Sea Treaty gave nations the right to manage and control fisheries within their 200-mile limit. Even nations not accepting the treaty—such as the U.S.—accepted this. This, then offered incredible opportunities and, in some cases, the necessity of broader ecosystem management. In countries like the U.S., the size of our 200-mile limit and our relative isolation offers us the chance to manage large marine ecosystems and still be within our own boundaries. We then also have the opportunity to work with our neighbors to manage those areas where the systems are not solely within our waters or theirs. For smaller nations with adjacent neighbors, and certainly for many of the island nations, they have no choice but to work cooperatively to manage marine areas effectively. In those cases, there are no coherent ecosystems totally within their waters.

In an ideal world, perhaps one could argue that there would be an international law to mandate global ecosystem management. Unfortunately, the world is not ideal, and this is not a likely scenario—at least not within our lifetimes. However, a generally accepted thesis seems to be that international law is evolving toward recognition of the ocean as a commons, and toward consideration of the total and interrelated scope of problems. To focus on individual problems such as ocean dumping, plastics, etc., in isolation is no different than focusing fishery management on a single-species approach. It's true that we've not yet reached the point where we find anything out there but moral support for the concept of total ecosystem management. Even that's a beginning. The general feeling is that it will take a few successes to move that support a little further along. Interestingly enough, fisheries is seen as an area of potential success, both within one nation's EEZ and between governments. First, however, we must succeed at home. I think if you watch NOAA over the next few years, you'll see some exciting things happen.

I believe it takes a great deal of courage for an agency to make a decision essentially to shift away an approach to management that has been a way of doing business for the life of the organization. A famous German author (Goethe) once said, "whatever you do, or dream you can, begin it. Boldness has genius, power and magic." In our case, hope it also has a little luck and a lot of support from people like you.

National Forests: New Strategies for America's Great Outdoors

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Let me start by saying that I believe that fish and wildlife on the national forests are very important and deserve more of our attention. How we manage national forests has a lot to do with the future of fish and wildlife in the United States.

I think we are doing a pretty good job at it, but the USDA Forest Service can and must do better. We're making progress in working with the state fish and wildlife agencies. Together, we've had some great success stories, such as the restoration of deer, elk, pronghorn, wild turkeys, salmon and eastern forest birds.

We're making progress despite diverting a lot of time and energy into arguments, debates, appeals, lawsuits and other controversies. There is a lot of pulling and tugging on the Forest Service. This is because the national forests are so precious and so valuable for supplying so many things that the American people demand.

We're in a high conflict situation, which requires a high energy level for the Forest Service just to do the basic job—and that isn't good enough. We spend a lot of time just slugging things out on an issue-by-issue basis.

The arguments and debates are an overall indicator of the underlying conflicts and disagreements among the American people over how these precious national forests ought to be managed. The tight federal budget tends to exaggerate the conflict because we are not only debating the value-laden disagreements over the management of the forest, but also relative priorities among programs and among regions out of the country.

Fortunately, while the arguments and debates over the future management of the national forests go on, there is another Forest Service out there working with thousands of people making *real progress* on the ground every day.

As you all know, we have been developing plans for managing national forests for the next 10–15 years. As part of this planning effort, we have conducted the most comprehensive public involvement ever attempted by a federal agency. The American people have spoken out, and sent a loud and clear message to the Forest Service: "Fish and wildlife and outdoor recreation are really important to us" and "We want more and better opportunities to enjoy the national forests." Our forest plans reflect a higher priority for these programs. Never before have we done a better job in planning for the care of fish and wildlife on the national forests. Furthermore, we're moving out to implement those plans.

There are some exciting things going on in the national forests. As a result, I believe, the Forest Service is doing a better job than ever before for wildlife and fish. But that's still not good enough. For example, our fishery initiative, "Rise to the Future: Fish Your National Forests," is really rolling, with good results to show for it on the ground. A lot of fish and wildlife organizations are lending a helping hand. Together we're making progress.

The Importance of the Forest Service to Fish and Wildlife

The national forests are, as I have said, extremely important to the future of fish and wildlife in this country. National forests and national grasslands make up about 8.5 percent of the land and water area of the United States. That represents an area 10 percent larger than the state of Texas. The national forests and national grasslands have 128,000 miles of waterways, more than 2 million acres of lakes, about 50 percent of the nation's big game animals, 50 percent of cold-water fisheries, 50 percent of anadromous fish, and 153 threatened and endangered species (about 30 percent of the listed species in this country). For some species—such as the grizzly bear, red cockaded woodpecker and a few others—their future largely depends on the Forest Service.

With so much at stake, and to capitalize on the strong public interest and support in fish and wildlife, I believe, a "partnership approach" is not only the best way, but with today's budget climate, it's the only practical way to go.

Fish and wildlife management on the national forests has long been a cooperative venture with state fish and wildlife agencies, but now we have a third full-time partner—the fish and wildlife organizations outside of government and, really anyone else who is willing to lend a helping hand.

National Agreements

We have signed several national agreements with organizations that want to help out. Last year, we signed an agreement with the Rocky Mountain Elk Foundation. Under this agreement, the Foundation, which was founded in 1984 and now has more than 30,000 members, provides money and volunteers to help improve elk habitat on the national forests, where more than 80 percent of the nation's elk live at least part of the year. The Foundation has provided the Forest Service with $133,000 to make sure we continue elk as a prime example of successful wildlife conservation.

Last June, we signed an agreement with The Ruffed Grouse Society to improve habitat on national forests. One success story is the designation of two new management areas on the Chequamegon National Forest in Wisconsin to be managed intensively for ruffed grouse.

In December, we signed an agreement with Trout Unlimited, which commits both partners to improving the fishery on national forests through specific habitat-improvement projects. Under this agreement, local Trout Unlimited chapters and Forest Service district rangers are really doing some great things for fisheries on the national forests.

We recently signed an agreement with the Izaak Walton League of America to organize volunteer Riparian Enhancement Teams to correct some riparian problems of national forests.

Since 1984, we have had an agreement with Ducks Unlimited, Inc. and the U.S. Fish and Wildlife Service aimed at improving the 12 million acres of prime waterfowl habitat on the national forests. This work is helping to implement the North American Waterfowl Management Plan.

In 1986, we signed an agreement with the National Wild Turkey Federation to increase population of wild turkeys on the national forests. And, again, we've already had some real success stories in improving thousands of acres of wild turkey habitat in the East, South and Southeast. The National Wild Turkey Federation has invested $50,000 to date on the national forests under this agreement, with plans for another $200,000 over the next few years.

As you can see, the era of partnerships in habitat improvement is here and *it's working*. We're not *just* signing agreements and we're not *just* talking about it. We have impressive results on the ground, with thousands of habitat-improvement projects being accomplished each year.

Challenge Cost-Share Projects

The Challenge Cost-Share program in fish and wildlife habitat, which began in Fiscal Year 1986, is a major tool we're using to strengthen partnerships. In Fiscal Years 1986 and 1987, the Forest Service had $2.5 million to use to match nonfederal contributions. The response was overwhelming!

Our partners and customers matched it and demanded more. The matching funds from our partners and customers were more than $4.1 million. That's $1.65 contributed for each Federal dollar. Under this program, 340 conservation organizations, private companies and local agencies become our partners in fish and wildlife habitat improvement projects.

Now, I want to give credit where credit is due. This new concept of Challenge Cost-Share programs—aimed at capitalizing on the strong public interest and support for fish and wildlife to do high priority habitat-improvement work on the national forests without the federal government having to shoulder the total financial burden—was conceived and developed by Lonnie Williamson of the Wildlife Management Institute. I recently presented an award to Lonnie at our January Regional Foresters and Director's meeting in Washington, D.C., for the outstanding work he has done in plowing new ground in this area.

The Forest Service knows a good thing when we see it. We've really captitalized on Lonnie's idea and are pushing the Challenge Cost-Share program as far as we can take it.

I want to compliment the Wildlife Management Institute further for practicing what it preaches. It has financed a brochure, "Join Us In A Partnership for Fish and Wildlife Management on the National Forests." The brochure explains the opportunities on national forests and how an interested individual or organization could go about becoming a partner with the Forest Service to do something great for fish and wildlife.

In Fiscal Year 1988, we have $2 million in Challenge Cost-Share money. We anticipate matching that $2 million with about 3 million in funds from our partners. The President's Fiscal Year 1989 budget proposes $5 million in Challenge Cost-Share money—a 250-percent increase over Fiscal Year 88. Deputy Secretary Peter Myers and I were able to convince the Office of Management and Budget and other Administration officials that we can get matching funds. We made that commitment on the behalf of both the Forest Service and the fish and wildlife community, and we don't like breaking commitments.

The Fiscal Year 1990 budget is just around the corner, and our success will rest, as it should, on our track record. So, we need your help!

Partnerships in Recreation

I am so proud of our partnerships with the various fish and wildlife groups that we're successfully moving the ''partnership approach'' over to outdoor recreation as well. The Forest Service is the Number One supplier of outdoor recreation in the United States. National forests supply 43 percent of the outdoor recreation on federal land. That is more than twice the recreational use on national parks. Enough people enjoy outdoor recreation on the national forests to equal having *every* American spending a 12-hour day every year enjoying the great outdoors on the national forests.

The national forests have 80 percent of the wilderness in the lower 48 states. They have 50 percent of the wild and scenic rivers in the lower 48 states. They have more than 100,000 miles of hiking trails and 6,000 campgrounds and picnic areas. Yet, we have so many unturned stones of opportunity in National Forests. We have not yet reached our potential.

So, patterned after our success with fish and wildlife, we've developed a new outdoor recreation strategy based on a partnership approach with state and local government, private sector and outdoor recreation groups.

The Fiscal year 1988 budget includes $500,000 for a pilot Challenge Cost-Share concept in recreation. As in fish and wildlife, the response was overwhelming!

This half-million dollars has already been matched by partners contributing more than $900,000 for 30 cooperative recreation projects. But, more than that, we had proposals on the table for $4 million worth of recreation projects. Of those proposals, we only had matching funds for 35 percent. Based on that experience, the President's 1989 budget includes $3 million for Challenge Cost-Share projects in recreation management—a six-fold increase. Again, Peter Myers and I made some commitments based on our beliefs that (1) the matching funds are out there and (2) the recreation community will rise to the occasion as the fish and wildlife community has done. We don't believe we will have any trouble attracting the matching funds for this $3 million program.

Conclusion

Just where is the limit?

We don't know, but we intend to just keep pushing the Challenge Cost-Share program to find out just how committed the American people are about fish and wildlife and outdoor recreation. In the meantime, this program is not only getting a lot of good fish and wildlife habitat work done on the national forests, but it also is improving communication and working relationships with the people and, in general, building even more support for fish and wildlife.

Our new strategy is to get people involved with more than words. Our new strategy is to respond to criticism by asking our critics, ''What are you willing to do to help out?'' That new strategy also includes a major effort to break down the bureaucratic ways of the Forest Service that get in the way of field people working things out with the local people. We want to make it easy, not difficult, for important work to get done on the ground for the benefit of fish and wildlife.

The Wildlife Management Institute and state fish and wildlife agencies have been great partners to the Forest Service over the years. We've had a lot of successes, and we've had some failures as well. Together, we've set an outstanding example for federal and state cooperation.

Now, we have many other fish and wildlife groups who are willing to lend a helping hand, and they are finding the Forest Service a ready and willing partner prodding them to do more than they expected to do. Together with our many new partners, we can give fish and wildlife a better place on the national forests. We are making progress!

We've got the philosophy of Satchel Paige, who said, "Don't look back, because someone might be gaining on you." We're moving out on the national forests. With the outstanding group of biologists working for the Forest Service and with help from our partners, we're going to make even greater progress in the future!

Progress in Implementing the North American Waterfowl Management Plan

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North American Waterfowl Management Plan Committee
Canadian Wildlife Service
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Harvey K. Nelson
Cochairman
North American Waterfowl Management Plan Committee
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The North American Waterfowl Management Plan was signed on May 14, 1986, by Minister of Environment Tom McMillan for Canada and Secretary of the Interior Donald Hodel for the U.S. The Plan is a basic policy document with which all people, public and private, who are interested in waterfowl can identify. It establishes recognition by the U.S. and Canada that the North American waterfowl resource is of significant international importance and its conservation must be pursued through cooperative planning and coordinated management.

The Plan has a 15-year horizon, to the year 2000, with review and updating at 5-year intervals. It does not replace the Flyaway Council System or related federal/provincial cooperative management systems now in place, nor does it alter processes used in each country to establish cooperative management programs and regulations governing the harvest of waterfowl. Existing agency budget processes will provide funding for related development, management and research requirements.

Objectives

The Plan sets waterfowl population objectives for ducks of 62 million breeders and a fall flight of 100 million birds—a level common to the decade of the 1970s. Objectives for geese and swans are also presented in the Plan.

Objectives for dabbling ducks include 8.7 million breeding mallards, 6.3 million breeding pintails and a wintering population index of 385,000 black ducks in the Atlantic and Mississippi flyways. Objectives for some diving ducks are 760,000 breeding redheads and 578,000 breeding canvasbacks. For geese the objective is a post-hunting season level of 6 million birds for all populations combined but not including resident giant Canada geese, which probably number 1 million continentally. Achieving this level of waterfowl populations would enable 2.2 million hunters in the U.S. and Canada to harvest 20 million ducks annually. It would also provide benefits to millions of people interested in waterfowl and other wetland species for purposes other than hunting.

To achieve these objectives the Plan identifies the most important waterfowl breeding, staging and wintering areas in the two countries and calls for their conservation and management.

Specific habitat objectives for the U.S. are to protect and improve an additional 1.1 million acres of production habitat in the northcentral states, 686,000 acres in the Lower Mississippi Valley and Gulf Coast, 80,000 acres in the Central Valley of California, 50,000 acres along the Atlantic Coast and 10,000 acres in the Lower Great Lakes-St. Lawrence River Basin. These are *minimal* priority acreages that may be increased as project planning progresses.

Objectives for Canada are to protect and improve 3.6 million acres in the Prairie Provinces, 60,000 acres in the Lower Great Lakes-St. Lawrence Basin and 10,000 acres in the Atlantic Coastal Region.

The cost of this ambitious habitat protection and enhancement program is estimated at $1.5 billion, of which $1 billion is designated for habitat protection and improvement in Canada. The Plan established a funding ratio of 25 percent from Canadian sources and 75 percent from United States sources. Considerable support will be required from the private sector. The Plan is quite specific in that the two federal governments are not committed to providing all the funds required. We must continue to seek other major funding sources.

Plan Administration

Implementation of the Plan is administered by a 12-member North American Waterfowl Management Plan Committee, composed of 6 members from Canada and 6 from the United States. Input from the private sector, states and provinces is through steering committees established by the respective joint venture organizations, and by the Plan Committee. Chairmanship of the committee alternates between the two countries each year. Plan implementation is guided by Canadian and U.S. Executive Directors and their staffs.

In Canada, the Director is James Patterson, Canadian Wildlife Service, located at headquarters in Hull, Quebec. In the U.S., the Executive Director is Harvey K. Nelson, former Regional Director for the U.S. Fish and Wildlife Service's North Central Region. The U.S. Office is located in the Twin Cities, Minnesota.

Joint Ventures

One of the concepts of the Plan is to implement cooperative actions through joint ventures, in so far as possible. A joint venture brings together a coalition of federal, state, provincial and private sector forces in a concerted effort to protect and enhance waterfowl habitats and populations through specific projects in specific geographic regions by a variety of methods.

Habitat joint ventures may involve protection and enhancement using current and new techniques. Some examples include the traditional acquisition by fee title, perpetual easement and shorter term easements, and protection by specific lease arrangements. There have been some innovative new arrangements whereby habitat protection and development funds are piggy-backed on other existing programs, i.e., Food Security Act of 1985, to enhance waterfowl benefits further. New programs that encourage changes in land-use practices on private lands to increase wildlife benefits can make substantial contributions. It is important to bear in mind that this is an effort to protect and enhance all important waterfowl habitats in a given project area by whatever means are available and acceptable. In addition to acquisition and development, such protection might include zoning and altered mitigation practices to reduce habitat loss.

Of the 34 important habitat areas listed for the U.S. and Canada, 6 in the U.S. are high priority. Joint ventures for these are now underway in the Prairie Pothole Region, Lower Mississippi Valley, Gulf Coast, Central Valley of California, Atlantic Coast and Lower Great Lakes-St. Lawrence Basin.

In Canada, the Prairie Habitat, Arctic Geese and Black Duck joint ventures are underway. The Canadian Prairie Habitat Joint Venture, the first major initiative, will receive shared funding from the U.S. for the Quill Lakes project in Saskatchewan. Four million dollars have been committed to this effort by a matching grant arrangement involving 12 states, Ducks Unlimited, Inc., and the National Fish and Wildlife Foundation. This will be matched by Canadian interests for a total of $8 million. The Canadian Wildlife Service, the Province of Saskatchewan, Habitat Canada, Ducks Unlimited (Canada), and other public and private organizations are involved in contributing to the Quill Lakes project.

Species joint ventures are intended to evaluate specific population problems in the habitats they occupy. Under the Black Duck Joint Venture, the population status of this species is being analyzed across its breeding and wintering ranges in the U.S. and Canada. Factors limiting population size will be determined and appropriate management strategies developed. Similar action is being taken under the Arctic Geese Joint Venture, concerning geese nesting in the Canadian Arctic.

In the U.S., project coordinators have now been named for the six initial habitat joint ventures. Under the guidance of Fish and Wildlife Service regional directors, directors of state conservation agencies involved, the U.S. Office for Implementation of the North American Waterfowl Management Plan, other federal agencies and participating private organizations, the individual joint venture organizations are evolving.

Ancillary Programs

Seeking to preserve wetlands and adjacent uplands for wildlife habitat, land managers have frequently come into direct conflict with certain agricultural programs and practices, some of which have been the main force in wetland destruction. In both the United States and Canada, government programs strive to help maintain farm income through regulation of commodity production and marketing. Application of these regulations influence the way in which millions of acres of farmland are managed. Until recently, little coordination existed between soil, water and wildlife conservation programs and agricultural commodity programs, often resulting in lost opportunities for conservation. Recent changes in agricultural policy have resulted in a new era of coordination of goals for commodity programs and conservation.

Waterfowl managers in both the United States and Canada need to be knowledgeable about agricultural programs and their impacts on waterfowl habitat. They need to become more involved in the planning and decision-making process so as to maximize benefits to the agricultural community and waterfowl populations.

Through the North American Waterfowl Management Plan, waterfowl managers in both Canada and the United States are encouraged to become involved in the development and administration of agricultural policies and programs that are also compatible with good management of waterfowl habitat.

The Plan's strategies for action to increase waterfowl population levels will include increased cooperation between waterfowl managers, wildlife agency administrators and farm program administrators at all levels to achieve mutual program goals. There needs to be increased emphasis on extension education efforts to assure that waterfowl habitats and populations will benefit from provisions of new agricultural programs.

In the U.S., benefits to waterfowl from the various conservation programs in the Food Security Act of 1985 are already apparent. Program titles such as Sodbuster, Swampbuster, Conservation Reserve and Debt Restructuring under the Farmer's Home Administration all can benefit waterfowl to various degrees. Additional waterfowl benefits, such as wetland restoration and establishment of quality nesting cover for extended periods, can be incorporated into some of these programs by wildlife agencies under cooperative arrangements. Innovative managers have new opportunities and new tools under the Act to use in implementation of the North American Waterfowl Management Plan.

During recent months, there has been increasing interest in Plan participation by a number of federal agencies such as the Forest Service, Bureau of Land Management, National Park Service, Bureau of Reclamation and the Corps of Engineers. Some of the other agencies under the U.S. Department of Agriculture, such as the Soil Conservation Service, Agricultural Stabilization and Conservation Service, and the Farmers Home Administration are already involved at the local project level. We will be pursuing discussions with them so as to enable these agencies to apply their support and capabilities to whatever they can do best. This will further enhance our partnership approach.

Future Efforts

One of our greatest needs at the moment is to improve our internal and external communications capabilities. While considerable progress has been made the past three months, we are obtaining additional professional assistance to guide us in moving forward in this area.

Following recent discussions between the federal wildlife agencies of Canada, United States and Mexico, the countries agreed in principle to a series of implementation steps that will be followed during the next 90 days to develop strategies for the conservation and management of migratory birds and their habitats for North America that might lead to development of a coordinated management plan between the three countries. This Plan will be separate from, but supplement the North American Waterfowl Management Plan, and will give special emphasis to conservation and management of wetland and wintering sites for migratory birds in Mexico.

A Memorandum of Understanding to this effect was signed in Mexico City on March 16, 1988, by Graciela de la Garza, Director General, Ecological Conservation of Natural Resources, Secretariat of Urban Development and Ecology of the United States of Mexico; H. Anthony Clarke, Director General, Canadian Wildlife Service, Department of the Environment of Canada; and Frank Dunkle, Director, Fish and Wildlife Service, U.S. Department of the Interior.

While we all become a bit impatient with our progress, indeed, a lot has happened the past year. In fact, things are now changing rapidly, by the week, by the month. Whether by *design* or *coincidence*, the North American Waterfowl Management Plan came into being at the right time. We have a window of opportunity that we must take advantage of now.

The Plan has inspired a new spirit of cooperation and support between federal, provincial and state governments, and the private sector. The partnership concept of joint ventures has been well-received by government agencies, private organizations and individuals interested in the conservation and management of waterfowl and their habitats. Enthusiasm is high in all circles and the momentum is building as joint ventures are being developed and implemented. It is one of the most innovative approaches to cooperative management that has ever occurred in international natural resource conservation. This is the kind of support that is needed to address continental waterfowl problems properly and achieve the objectives of the Plan. We must make this work. As we have said before, we may never have another chance.

4-H Wildlife and Fisheries Recognition Awards, 1987

Introducing Remarks

Frank H. Dunkle, Director, *U.S. Fish and Wildlife Service, Washington, D.C.*

It is my privilege, on behalf of the U.S. Fish and Wildlife Service, to recognize and thank these six outstanding 4-H Wildlife and Fisheries Program Volunteer Leaders. They are truly volunteers, receiving no pay for their contribution of many, many hours of their time to guide and inspire young people.

I am delighted to continue Fish and Wildlife Service sponsorship of this recognition program for the eighth consecutive year, in cooperation with USDA's Cooperative Extension Service.

Peter C. Myers, Deputy Secretary, *U.S. Department of Agriculture, Washington, D.C.*

I am pleased and honored to recognize and publicly thank these six national winners of the 1987 4-H Wildlife and Fisheries Volunteer Leaders National Recognition Awards. These are very special people who believe deeply in the work they do. They represent, for 1987, the best of thousands of 4-H leaders across the country who encourage and lead youngsters along the road to wise stewardship of our nation's natural resources.

Once again, on behalf of the Extension Service and the Department of Agriculture, thanks to the United States Fish and Wildlife Service for its continuing support of this annual recognition program, and to the Cooperative Extension Service's personnel nationwide who develop, coordinate and educate both leaders and youth about wildlife, fisheries and other natural resources, and to those of you at this meeting who support these programs.

Award Recipients

William Clay Brister, *Boyce, Louisiana*

William Clay Brister is a cattle rancher and construction company owner, and has been a 4-H Volunteer Leader for eight years. His involvement with 4-H while a youngster has continued into adulthood. Clay has stated that, "Throughout the year, I assist 4-H in whatever way I can. Summer workshops provide me with still another opportunity to encourage future winners to make the best of all that is available to them." Mr. Brister has involved urban-oriented youth in wildlife and fisheries management projects through scuba diving and other water activities. He has stated most appropriately, "4-H will always be a part of my daily living. It gives us great satisfaction and enjoyment to know that I have helped someone else get a little more out of life."

Well said! Well done! Our best wishes and thanks.

Katherine M. Kurz, *Nokomis, Florida*

Katherine Kurz is a registered nurse and has served in Sarasota County as a 4-H Volunteer Leader for three years. Kathy, her husband Richard and two daughters moved to Sarasota County three years ago and, shortly thereafter, the local 4-H club had a new leader—Mrs. Kurz—and two new 4-Hers, daughters Katie and Kim. Mrs. Kurz has been very active at the county level and assisted with the distribution of 4-H ecology packets for each student in area schools. The list of her accomplishments is lengthy and includes involvement with the Woodsy Owl Program, Florida panther, Florida forests and Manatee conservation efforts. She says her living room has been reclassified as the 4-H publishers clearinghouse.

Congratulations, Mrs. Kurz. We are astonished but delighted you find the time and energies to lead these outstanding 4-H fisheries and wildlife projects in Florida. We are genuinely pleased to present you with this award.

E. May (Pat) Lindquist, *Brookville, Kansas*

Pat Lindquist has been a 4-H Volunteer Leader for 28 years! She is an elementary school teacher and the community leader of a very active 4-H club that is more than 60 years old. Ms. Lindquist's contributions to 4-H and natural resource conservation projects would fill many pages. Her 4-Hers have arranged wildlife exhibits in schools, city libraries and in downtown store windows to make the public more aware of what the club does and to show appreciation for wildlife. She has given innumerable talks to school classes on fishery and wildlife related subjects. She has organized and directed the teaching of wildlife conservation in the 13 city schools.

What a winner! Thank you so very much for all you have accomplished. It is a privilege to present you this award, and we wish you great continued success in the future.

Ken Mertz, *Danville, Pennsylvania*

Ken Mertz, an eighth grade science teacher, has been a 4-H Volunteer Leader for the past 14 years. His 4-H wildlife and fisheries experiences are many and varied, and he enjoys hunting, fishing, hiking and camping. His wife Connie, also is a very able and dedicated 4-H Volunteer Leader, and a recipient of this national award for 1986. Ken has emphasized an appreciation for and wise use of natural resources in all his classes. He and Connie have been responsible for developing and implementing the outdoor educational program for their 4-H camp.

In the future, Ken intends to see that their 4-H wildlife club becomes second to none in Pennsylvania. He has stated, "I am proud to be associated with the 4-H youth program and look forward to giving many more years of my time and energy to this fine organization."

Congratulations, Ken. It is a pleasure to present you this well-deserved award.

Patricia Orr, *Virginia Beach, Virginia*

Patricia Orr, a 4-H Volunteer Leader for nine years, is a high school teacher. She has been deeply involved in the development of the Virginia Beach school system project ICE (Individual Concern for the Environment), and ecology and environmental science curriculums. All her life, observing, studying and photographing nature have been major interests. Since 1982, her students have been enrolled in 4-H school programs including conservation of natural resources, agronomy, entomology, forestry, and wildlife and fisheries conservation. The outstanding activity of her environmental sciences programs involves school 4-H members, as well as many local 4-H club members, participating in the dune grass planting project. The list of activities that involve Mrs. Orr's 4-H club members covers several pages!

Mrs. Orr has pledged to ''continue to participate in Project WILD and 4-H wildlife workshops, and work with the Virginia Beach Schools Environmental Sciences Curriculum.''

Thanks so much, Mrs. Orr, for all your efforts on behalf of all the 4-H youngsters you have guided and inspired. We are very pleased to present you this award.

***Margaret Schmidt**, Novi, Michigan*

Margaret Schmidt, a homemaker and mother of three daughters, Jill, Anna and Sarah, has been a 4-H Volunteer Leader for three years. Her husband Larry is the club's entomology leader. One of a number of projects Mrs. Schmidt's club undertook this year was the development of a nature trail behind a local elementary school. Plans for next year include preparing a wetlands manual, initiating a bluebird project, and working on a variety of conservation projects at the new State 4-H Leader Training Center opening in Novi.

Mrs. Schmidt believes that ''We must teach our children at an early age to be caretakers and treat the land gently. As they grow to be adults, they will then treat our environment with respect and use it wisely.''

Well-said, Mrs. Schmidt. Our sincere thanks for sharing your knowledge, enthusiasm and time for the benefit of our nation's youngsters and natural resources. Congratulations and best wishes for continued success.

Concluding Remarks

Peter C. Myers, Deputy Secretary, *U.S. Department of Agriculture*

Ladies and gentlemen, the value of the kind of work these six 4-H Volunteer Leaders do cannot be measured in customary ways. However, their positive impact on our nation's natural resources, by helping our youth learn to appreciate and understand the benefits of wise stewardship of natural resources, will surely be substantial for many, many years. These are the best of thousands of adult 4-H Youth Leaders in 1987—no wonder the 4-H wildlife and fisheries program is so successful and growing. These people do not just talk about conservation, they invest their time, energy and enthusiasm in positive, learning-by-doing activities—volunteering for dividends in the future. We applaud them all.

Special Session 1. *Innovations and Incentives for Integrated Management of Woodlands*

Chair
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Cochair
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Role of the Wildlife Manager in Nonindustrial Private Forest Management

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This paper addresses the role that wildlife managers can and needs to play in helping to manage nonindustrial private forests. I hope to prove, when it comes to forest management of nonindustrial private ownerships, that the wildlife manager can play two very important roles. First, the wildlife manager is needed to provide more training and information on wildlife management techniques, practices and habitat requirements for foresters and consultants. Second, the wildlife manager is often needed as a full working partner with the forester. More on this later. First, I think we need to understand the magnitude and extent of these nonindustrial private ownerships.

The United States has 482 million acres of timberland.[2] More than 277 million of these acres—58 percent—are owned by private owners who do not own or operate wood-using plants (USDA-FS 1982). Thus, the term nonindustrial private ownerships. Nationally, these ownerships account for three-fourths of the nation's softwood harvest and nearly all of its hardwood harvest. According to a recent assessment of projected future demand for timber, the nation must become increasingly dependent on these ownerships if it is to have adequate supplies of timber at reasonable prices (USDA-FS 1982). However, few of these owners hold forest land for the production of timber.

[1]Currently stationed at North Central Forest Experiment Station, St. Paul, MN.

[2]Forest land producing or capable of producing crops of industrial wood (more than 20 cubic feet per acre per year) and not withdrawn for timber utilization. Formerly known as commercial forest land.

The forestry profession has spent a considerable amount of time agonizing over the best ways to encourage active management of these lands. Much has been written and many conferences have been held dealing with this problem. Most of this effort has been centered on timber production as an additional source of income to the owner and to a vaguely stated plea that it is somehow the patriotic duty of these owners to produce timber. Yet, as I said, most are not interested in producing timber. However, it is interesting to note that most of these owners will cut timber when it is mature and if the price is right. When this cutting does take place, little thought is given to more than cashing in on nature's bounty.

Who are these nonindustrial private owners? Despite the fact that farmer-owned forest land is often talked about, the term in fact, is often used almost as a synonym for nonindustrial private forests—farmers account for only 6.7 percent of the nonindustrial private owners (Figure 1) (Birch et al. 1982). Most are white-collar workers. Then, numerically, come retired people, followed by blue-collar workers. Nonindustrial private forest owners tend to be older than the general population, with the greatest concentration in the 45–65-age group (Figure 2). But, the over-65 group also accounts for a big share. These owners also tend to be relatively well-educated. Fifty-one percent have at least a high school diploma (Figure 3). The amount of forest land they own varies considerably. However, the overwhelming majority own fewer than 50 acres (Figure 4)—anything from a magnum houselot to a "back 40."

In the East, nonindustrial private forests constitute an even more significant portion of forest ownership than in the national picture. Roughly east of the 100th meridian,

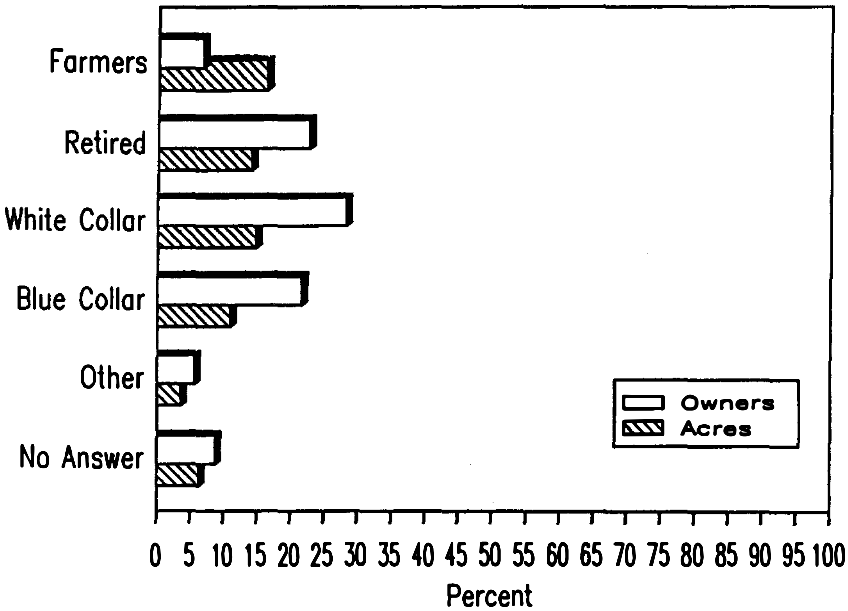

Figure 1. Distribution of individual ownerships, by owner's occupation, 1978 (Birch et al. 1982).

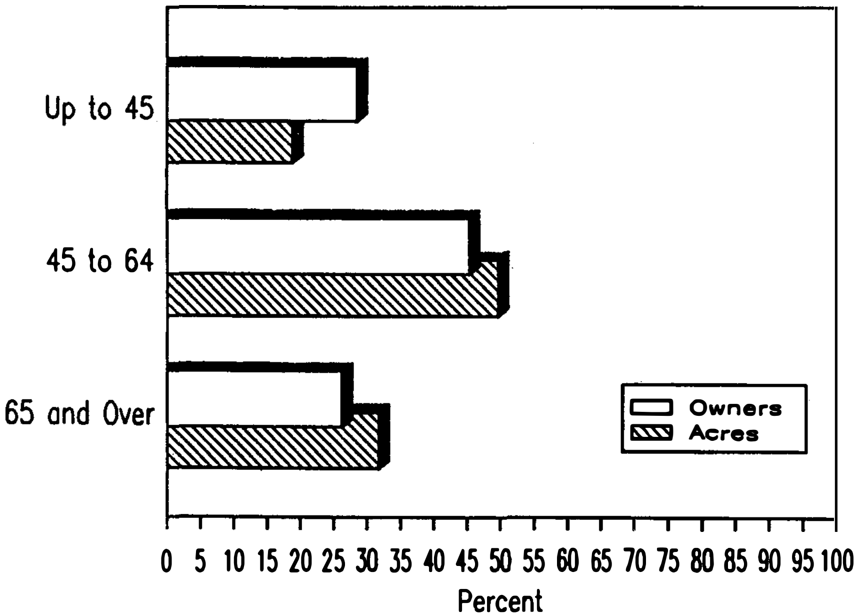

Figure 2. Distribution of individual ownerships, by owner's age, 1978 (Birch et al. 1982).

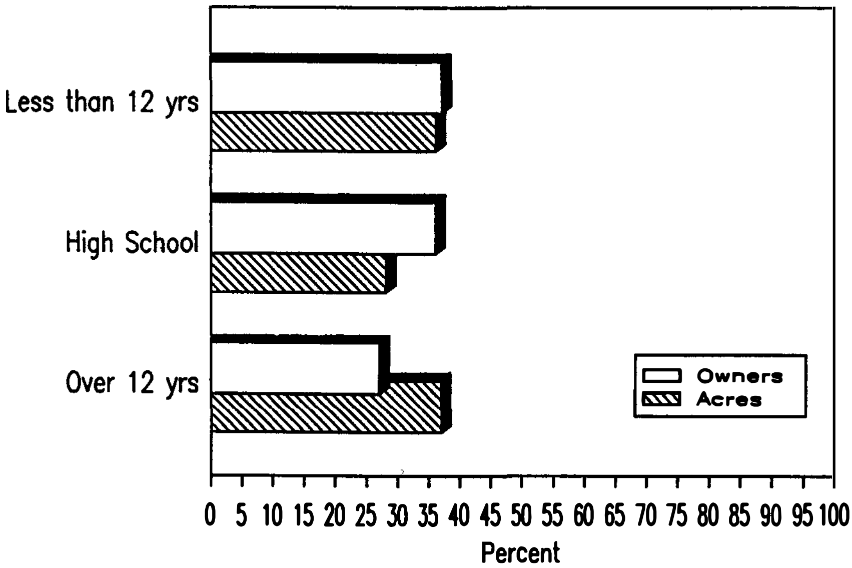

Figure 3. Distribution of individual ownerships, by owner's level of education (Birch et al. 1982).

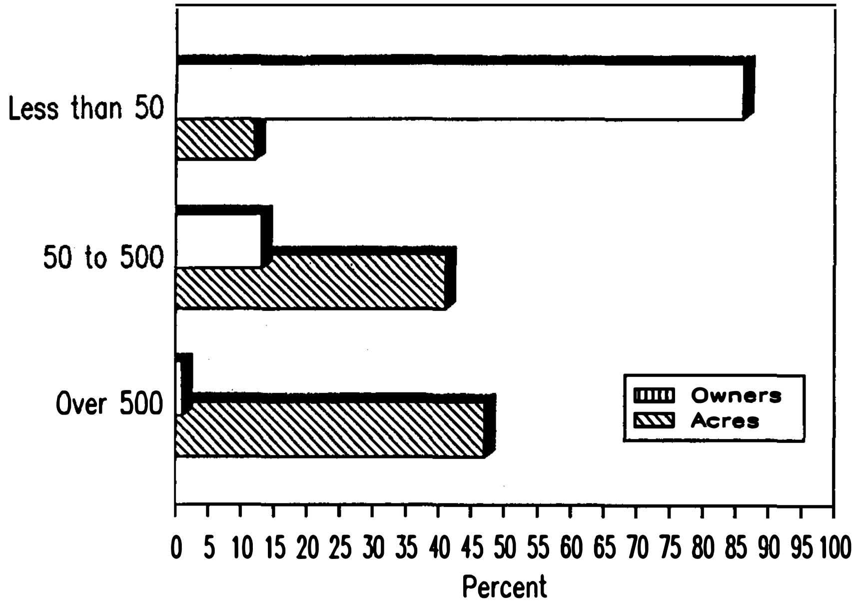

Figure 4. Distribution of individual ownerships, by size, 1978 (Birch et al. 1982).

nonindustrial private ownerships account for nearly 219 million acres. This is about 70 percent of all the timerbland in the region. In many eastern states, the total share is much larger. In Connecticut and Rhode Island, for example, 92 percent is in nonindustrial private ownership (Kingsley 1976). Typically, the states with a very high share are the older, more-settled states with very little land in industrial or public ownerships.

I will rely primarily on information from studies conducted in the area covered by the U.S. Forest Service's Northeastern Forest Experiment Station (Figure 5), for several reasons. These studies were undertaken in conjunction with statewide forest inventories. This allows for the comparison of owner demographics with data on the resources. There are states for which owner canvasses have been conducted over two inventory cycles. This gives us some idea of trends. Also, I conducted several of these studies. I do not want to give the impression that the Northeast is the only area of the country with good ownership data. There have been a number of excellent studies done in the southern, southeastern and northcentral states. In fact, the literature is quite extensive. For those who might wish to pursue the subject further, the Small Woodlot Forestry R&D Program at North Carolina State University has published an extensive bibliography. To get a copy or more information, contact North Carolina State and ask for Research Note Number 46.[3]

Why do people own forest land? As indicated earlier, few hold forest land for timber production. Since we are in Kentucky and it is very typical of most eastern

[3]Carpenter, Eugene M.; Holley, Lester D., Private nonindustrial forests—the first 100 years—an annotated bibliography, Res. Note Ser. No. 46, Raleigh, N.C., Small Woodlot Program, N.C. State: 1986, 270 p.

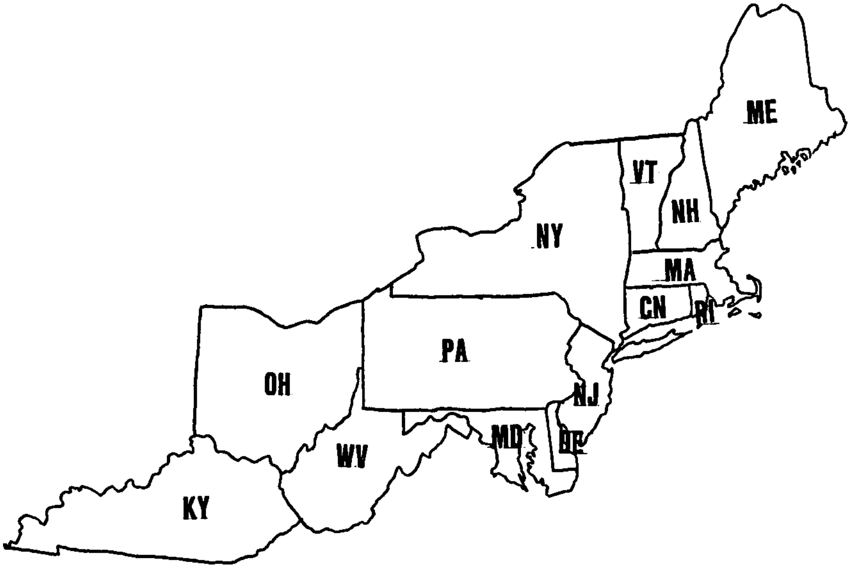

Figure 5. The northeastern states.

states, I will use Kentucky as an example. In Kentucky, only 2 percent of the owners reported that they hold forest land for timber production (Birch and Powell 1978). These owners hold only 5 percent of all the private timberland in the state, including industrial ownerships. The percentages would be even smaller if we could segregate the industrial ownerships. Almost 60 percent of the respondents gave what I consider vague reasons for owning forest land—it is part of a farm or residence, or it is for farm or domestic use, i.e., a source of firewood, fence posts, etc. Another 9 percent reported that they held forest land for recreational use or esthetic enjoyment. In some other states, this percentage is higher. In New Hampshire and Vermont, for instance, 21 percent said they held forest land for recreational enjoyment. I have felt for sometime that these responses do not tell the whole story. It is just too easy to say "I own it because it's there"—which is essentially what the respondent is saying when he or she says the forest is part of the residence or farm or that it is for farm or domestic use. So, in 1982, we undertook a study to try to "get into the minds" of some owners (Brock et al. 1985). We conducted group interviews with retired owners in West Virginia. The results proved very interesting.

Above everything else, it became clear that many of these older owners had a strong sense of stewardship for the land. The attitude of many is best summed up by the interviewee who said ". . . when a fella buys a place, he should leave it in better shape, when he's towed across that pond, than it was when he bought it." For these interviews, it became clear that many of these owners consider wildlife, recreation and esthetic enjoyment important reasons for holding forest land. In our earlier mail canvass of West Virginia owners, we found that 22 percent of the owners gave these reasons and that they hold 18 percent of the private forest land in the state (Birch and Kingsley 1978).

Many of the retired owners who rated wildlife as important apparently derive a high level of satisfaction from hunting and allowing others to hunt on their land. Others derive pleasure from observing wildlife and from the beauty of their land. Their own words reveal their feelings best:

> ". . . I like to squirrel hunt and grouse hunt and deer hunt. It would be one reason I would want to keep it. Although I haven't killed a squirrel this year, not for three or four years, but still I might."
>
> ". . . it [timber] might be marketable, some of it. But, it makes a good place to hunt and, say, recreation-wise."
>
> "I bought mine basically for hunting purposes when I retired."
>
> "I like to hunt and my sons like to hunt. I have two sons and two grandsons."
>
> ". . . I'm keeping it for my children . . .. My boy loves to hunt."
>
> ". . . mainly I bought it because I liked it and I wanted it and it's good hunting territory for deer and that type of thing. Of course to me, it's very valuable, I mean it's something I figure on."

All of these owners showed a strong interest in hunting on their land. Others expressed a more loosely defined enjoyment of wildlife and esthetic values.

> ". . . that would be one good reason, for wildlife to have a place to live."
>
> "I like to own timber myself, because if you don't have timber, you will not have any wildlife."
>
> "If I want to build something, I go down there and cut me a tree, but mostly it's for wildlife."
>
> ". . .watch the deer come out of there and coons, all that, and of course, we cut a little bit of firewood off of it."

These owners expressed a very definite interest in wildlife, either consumptively or passively. Others in these group interviews, while not as expressive, harbored similar feelings. It is clear that wildlife is an important ownership benefit for many owners. For this reason, wildlife concerns need to be an integral part of any management or harvesting plans on many nonindustrial private ownerships. Unfortunately, foresters all too often give little or no consideration to wildlife. Management plans are frequently developed with the primary or even sole objective of maximizing the financial return from timber production, and they are often designed to regenerate the most productive timber stand without regard to the impact on wildlife populations or habitat.

In our interview study in West Virginia, we asked owners who had received forestry assistance if they felt it was helpful (Brock et al. 1985). Most of their comments, I am pleased to report, were positive. But a few were not. The comment of one owner illustrates the myopic timber-first view of at least one forester. The owner said: "I have mine marked. He sprayed yellow paint on the tress to come out. There isn't too much hickory in the woods. I have about 50 acres and they put yellow paint on them hickory. I said, '. . . [expletive deleted] man, them are healthy trees, what are the squirrels going to eat?' So I scraped the paint off of them. I wouldn't let them cut them. I just don't agree with everything they put paint on to cut."

In a similar vein, I have some forester colleagues who have declared war on grapevines in the woods. After they have railed about how grapevines smother young trees and reduce quality, I like to say, "I don't see anything wrong with grapevines. The grouse like 'em." I sometimes get some very unpleasant looks. Likewise, I do not see anything wrong with some patches of aspen or hemlock thickets. The grouse eat the aspen catkins and buds, and the hemlock provides good heavy weather cover. For that matter a little gypsy moth is not all bad either. That is a heresy to a forester. But, think about it. The insects provide plenty of protein for young birds, the tree mortality creates opportunities for cavity nesters and it opens the stands up to make way for seedlings and saplings that provide good cover and browse.

While many owners profess an interest in wildlife, few do anything to improve wildlife habitat on the land. When we ask owners who have not harvested timber from their land why they have not, they frequently tell us that the value of the land for hunting or wildlife would be destroyed. In Kentucky, we estimate that the owners of nearly 132,000 acres would give this as their primary reason for not harvesting timber (Birch and Powell 1978). As resource managers, we realize that this is not usually the case. In fact, properly designed cuts can be a boon to wildlife. Small clearcuts produce a surge of vegetation as they regenerate. The grasses, forbs, seedlings and sprouts represent high protein food sources and berry bushes become abundant (USDA Forest Service 1970). Edges of clearcuts become prime nesting areas for many wildlife species.

The key to increasing most wildlife populations on small private ownerships is to provide habitat diversity. A well thought out timber management plan can be the means to that diversity. Cuts can be designed to provide a mix of stand sizes and timber types. Poletimber stands provide loafing areas, while sawtimber stands provide mast. Logging roads and landings can be seeded to grasses and legumes to provide nesting and sunning areas. Conifer patches can be planted to provide escape cover during bad weather. Long, narrow or irregular clearcuts can be used to maximize edge. And, the best part of this is that, while timber management is improving the wildlife habitat, it is also providing the landowner with an economic return.

To be sure, some foresters will rightly argue that because of this special consideration given the wildlife, the landowner will not realize as great a financial return as he might otherwise. But, we are talking about landowners who hold forest land primarily for the enjoyment of wildlife. Most would apply no management at all if the only objective was to maximize the economic return from timber. Thus, we see an opportunity for both the wildlife manager and the forester. The forester's objective is to encourage timber management on nonindustrial private forest land. The wildlife manager's objective is to improve wildlife habitat. Most importantly, the owner wants to enjoy wildlife on his land. For this reason, I feel it is encumbent upon the forester to develop a good rapport with wildlifers. In fact, in those situations where the owner's wildlife objectives are paramount, the wildlife manager may take the lead in developing the management plan for the property. In any situation, the wildlife manager needs to be consulted and play an active part in the development of the plan.

Unfortunately, few of the foresters who provide services to nonindustrial private owners place much emphasis on wildlife management. In 1936, Ira Gabrielson wrote: "The average forester is well trained in his profession when he leaves school. He knows thoroughly the technical side of surveying, timber cruising, trail building, and a multitude of other activities which made up the routine of his profession, but comparatively few of them clearly conceive of a forest as an interrelated community of living organisms." Although today's forestry school graduate is likely to receive more wildlife management training than those of Gabrielson's day, the forester typically lacks incentives to place much emphasis on wildlife management. There are just too many other concerns that demand his attention.

We have come a long way since 1936; the body of knowledge in forestry has ballooned. Today, the forester not only needs to know surveying and cruising, he or she also needs to understand computer modeling and remote sensing. I'm sure the same is true of wildlife management. There is just too much to learn and understand to expect one discipline to do it all. Together, however, the forester and the wildlife manager can bring about the management of that "interrelated community of living organisms" we call a forest. And, a substantial number of nonindustrial private owners can be producing timber and enjoying wildlife at the same time.

In the Northeast, there are an estimated 259,000 owners with more than 8 million acres of forest land who claim they own it primarily for recreation. If wildlife is important to only half of these owners, there is no question that a huge opportunity exists to encourage some integrated timber/wildlife management on nonindustrial private forest lands.

So the "stump jumpers" need to be mindful that the "dickie-bird watchers" can be of considerable assistance to them in dealing with a large segment of the nonindustrial private forest land owners. And the wildlifers need to remember that the chainsaw is one of the best wildlife management tools ever invented.

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Evaluation and Critique of Government Programs in Woodland Resource Management

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Introduction

The privately held woodlands of North America have long been recognized for their importance to national timber supply goals, habitat for wildlife and for the related socioeconomic values to local, state and regional economies.

The first government programs involving these woodlands date back to the early 1900s with such legislation as the Clarke-McNary Act, the Norris-Doxey Act, and the Smith-Lever Act. Early emphasis was on fire control, followed by efforts to enhance management and reforestation on private lands by farmers through education and technical assistance. The dust bowl era of the 1930s added emphasis to the need for public conservation efforts involving private woodlands. Government efforts for private forest lands peaked in the 1950s and 1960s with the Cooperative Forest Management Act, the Soil Bank Program, Forestry Incentives Program (FIP), and the Agricultural Conservation Program (ACP).

For the most part, government woodland resource management programs continued at a relatively steady level until the early 1970s. The most notable accomplishments over the years have been the development of very effective state forest fire-control programs, the evolution of fire as a management tool, sporadic successes in reforestation (e.g., the Soil Bank Program), and a general enhancement of public education and technical assistance programs and a variety of federal and state financial assistance programs for forest owners.

Government programs involving education and technical assistance for farmers to improve management practices were given a boost in 1978 with the passage of the Rural Forestry Assistance Act and the Renewable Resources Extension Act. However, because of inflation, shifts in federal funding priorities and overall federal budget problems of the last decade, these programs have never achieved the authorized funding levels envisioned to enable them to reach, educate and assist owners in private woodland management. In most cases, resources and programs have diminished at the state level as well. This has led to an overall erosion in government education and technical assistance programs to private woodland owners as compared with the early 1970s.

A recent government program that has given a boost to forest and wildlife concerns is the Conservation Reserve Program of the Food Security Act of 1985. It provides direct payments and cost-shares for the setting aside of highly erodible cropland into permanent cover. As of this writing, nearly 1.3 million acres of tree cover have been planted under this program. In addition, 691,000 acres have been enrolled into wildlife-related planting practices, and 3,696 acres enrolled into field windbreaks.

Changing Clientele and Changing Priorities

Private woodlands constitute nearly 60 percent of the U.S. commerical forest land acreage and are held by more than 7.8 million owners. Nearly 75 percent of the acreage is held by approximately 600,000 owners, in parcel sizes of 100 acres or larger. Many studies have been conducted in regard to nonindustrial private forestland owner (NIPFLO) objectives, interests and ownership patterns over the last two decades. While allowing for regional variations, most studies show several important trends. One trend is steady fragmentation of larger ownerships into smaller parcels. Another is decreasing length of ownership tenure. A third trend is a change from farm to white- and blue-collar (nonfarm) ownership. The trend is also towards more absentee owners. Accompanying these changes in ownership patterns and tenure is a shifting of priorities for woodland ownership, from timber production to wildlife and aesthetics.

Implications for Government Woodland Programs

The changes that are occurring in ownership, tenure and owner priorities, combined with decreasing financial resources for government programs, call for new direction for our woodland programs. In the past, where woodlands were primarily owned by farmers, county-based delivery systems were adequate. In many cases, public education and technical assistance efforts were conducted on a first-come-first-served basis. And timber production was the primary focus in the delivery of these programs.

Given the larger number of private owners of forest land, their varying cultural and educational backgrounds, age structure and reasons for woodland ownership, there is need for government agencies to rethink their approaches in reaching and motivating owners to manage their resources.

First of all, we need to know the nature and extent of private woodland resource capabilities right down to the community level. This not only means acreages, but also economic and environmental management potentials for timber, wildlife, water and aesthetics, the current state of management, and a constant monitoring of trends with regards to what is happening, or may soon be happening, to those acreages (i.e., harvesting, development, fragmentation, etc.). The current process of forest survey does not provide sufficient detail to facilitate informed resource decision making, nor does it occur frequently enough to provide adequate data on trends in land use or management status. We need to develop a system of resource monitoring for private woodlands that is on par with those on the National Forest System. Recent advancements in satellite photography and computer systems should go a long way in moving us towards a much improved level of resource assessment on private lands. This will allow much better tracking of shifts of land use and resultant impacts on economic production potentials, wildlife habitat and environmental quality. At the same time, we need all the information we can gather on the demographics of owners, as well as an in-depth knowledge of their reasons for owning woodland.

Rural communities, more than urban, depend more directly on renewable natural resources for their economic vitality. Knowledge of the resource is essential in helping to ensure that private woodlands contribute their full economic and environmental potential to rural areas and to society as a whole in both the short- and long-term.

Information on owners is essential to understand what will motivate people to manage their woodlands for their individual, family or societal goals. Resource and owner data also allow public agencies to target educational, technical, and financial assistance efforts better, so that societal goals involving private woodlands may be attained in concert with those of the owner.

Public agencies will have to develop new strategies for matching knowledge of resources, national, state and local economic and environmental goals and concerns, with owner goals and objectives for holding woodlands. While most technical and financial assistance programs continue to stress predominately timber and fiber production, educational efforts are beginning to place greater emphasis on a more holistic/comprehensive approach that incorporates wildlife, fisheries and recreation into production systems that address the owner/manager objectives. Georgia, Louisiana, Oklahoma and Tennessee have recently developed in-depth information on private woodland ownerships, which is being used in targeting educational and technical assistance efforts along acreage lines (e.g., greatest economic and environmental gains for the greatest good—be it timber, wildlife, recreation or water quality—are realized with larger ownerships). It is also being recognized that a critical juncture in the targeting process is professional assistance at or just before a decision is made to harvest timber. Too many land-use and forest management decisions are still being made on private land by the logger and the landowner without benefit of professional assistance.

Managers of public woodland resource programs are becoming more aware that knowledge of owners and their reasons for ownership are essential in motivating change, and are developing multidisciplinary educational programs and packages targeted at owners. Vermont and Connecticut have cooperatively strengthened their capabilities in reaching private owners and causing them to implement improved forest management through the COVERTS Project, developed jointly with the Ruffed Grouse Society. The project is aimed at stimulating owners to manage their woodlands and manipulate vegetation for grouse, woodcock and other wildlife habitats. It also incorporates a unique volunteer element to reach new woodland owners and encourage them to invest in management of their woodland. Many states have developed in-service training, correspondence courses, and other educational packages that take a more holistic or interdisciplinary approach to woodland owner education and motivation.

Other states are following suit with efforts that combine on-site research demonstrations, correspondence courses and volunteer elements. Not surprisingly, a significant number of the new approaches being taken are by Cooperative Extension Services. Much of the impetus is resulting from expanded efforts that have been made possible by the Renewable Resources Extension Act, which has been strongly supported by the total natural resources community. Being a part of the Land Grant University System, the Extension model is most suitable to initiate change and new thinking. Extension also has a long history of adapting new research and technology into usable how-to methods for improving management. It understands the importance of reaching and stimulating early adopters and innovators (opinion leaders) to influence and cause change in other owners (peers).

The unwritten premise in all of these efforts is that, in order to reach and motivate new landowners, you have to develop a rapport with them and their interests. Only then can you develop their interest in management and facilitate the adoption of practices. For those interested in timber production from these lands, it is safe to say that the product will eventually come to the marketplace in some form or shape, regardless of the initial motivator to management. It may not come to market exactly as one might traditionally envision, but it will come to market. For example, it may be a by-product to achieve other ownership goals, such as wildlife habitat through selective harvest, seed tree or other manipulation of vegetation. The healthy aspect in all of this will be a more holistic management style that encourages the understanding and adoption of wise stewardship, and establishes and provides a multitude of market and nonmarket benefits to the individual, the community and society as a whole. Further, it discourages apathy or only an interest in natural resources when someone knocks on the door and makes an offer on the timber or the land.

Changing Technologies

With the changes that have occurred in woodland ownership, another aspect that needs to be incorporated into government woodland resource management programs is electronic technology. We mentioned earlier the use of satellites and computers in resource inventory work. The same technologies need to be applied in the targeting and delivery of educational, technical and financial assistance efforts. With satellites and uplink/downlink capabilities, educational programs can be beamed to woodland owners across a state, a region or even nationally. No more are we restricted to county meetings involving local woodland owners. That one meeting can be multiplied manyfold with the application and use of technology. Computers can also be used to develop educational modules and packages that are menu-driven to allow owners to identify topics, evaluate alternative management strategies, and select levels of knowledge and training desired. Modules and packages can range from general knowledge to sophisticated investment and land-use management strategies involving simulation games to test understanding of principles and skills. The combination of computers and laser disk technologies will even further expand self-learning opportunities and potentials for owners and the general public as we move into the future.

Cooperation

Government woodland resource programs reside in a multitude of agencies and organizations. This has often resulted in duplicative efforts and conflicting advice, which is confusing to the woodland owner and wasteful of taxpayer dollars. Given the scarcity of public resources today, this duplication can no longer be tolerated. Clearly, all of those involved in public education, technology transfer, and technical and financial assistance need to work more closely together in identifying and addressing key private woodland issues in need of attention at all levels of government, and in coordinating programs and efforts to get the job done. Cooperation will be a key ingredient to future governmental woodland program success. Along with that, all levels are going to have to be more accountable to the public for what is being accomplished. There will also have to be increased involvement of the private sector in educational and technical assistance efforts with private woodland owners.

Summary

Many changes have occurred since the inception of public woodland resource management programs in the early 1900s. Productivity levels from private woodlands are, for the most part, much improved since that time. However, many changes have occurred in ownership patterns and characteristics, including goals and objectives for buying and owning woodlands. Government programs that were designed for the situation that existed in the 1950s and 1960s have to be redesigned and redirected to meet the challenges of today's environment. Better and more frequent data will be needed to track changes in resources and owners. New strategies and technologies will be needed to target, reach and motivate woodland owners so they can: (1) better understand the potential for returns (economic, recreational, and social); (2) learn what practical and effective management strategies are available to help them meet their objectives; and (3) learn how to manage and market to reach those objectives. This will call for increased levels of involvement, cooperation and coordination not only of government, but private efforts as well.

Politics and Policy in Formulating Integrated Forest Management: The 1985 Wisconsin Managed Forest Law

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Introduction

To assist private woodland owners, the Wisconsin Legislature in 1985 enacted the Managed Forest Law (MFL) as a replacement for two earlier laws—the 1927 Forest Crop Law (FCL) and the 1954 Woodland Tax Law (WTL). This new program brings innovations to Wisconsin's private forest management: more landowner options to manage for wildlife, aesthetics and recreation; well-defined criteria for management plans; owner options to open or close land to public access and, on open land, to permit hiking and skiing, in addition to hunting and fishing; increased public information on location of open land; increased landowner educational programs; and a systematic program evaluation.

This paper outlines the history of these programs, the events surrounding enactment of the MFL, and the difficulties of integrating owner values into programs that historically emphasized wood production. The conclusions from this case study may provide useful insights for other states.

Destructive Logging

Well-before the turn of the century, admonitions of scientists and foresters regarding the destruction of the Wisconsin forest went unheeded. Colonization and logging companies left a legacy of short-term unplanned development and ruthless exploitation of both people and natural resources. By the turn of the century, in central and northern Wisconsin, millions of acres were blackened with charred remains of forest fires and lay tax delinquent. Isolated settlers attempting to eke out a living in the "cutover" faced an uncertain and grim future. The land tenure pattern precluded rational management.

Early efforts to deal with the chaos included state forests and parks programs, fire control, tree nurseries, planting and incentives for private forestry. The program was emasculated in a 1915 State Supreme Court decision which held state forestry programs unconstitutional. The fight was described as ". . . a long, sustained, vigorous, and sometimes unfair, sometimes downright dishonest attack upon the forestry plans and any state policy which sought to limit the extent and nature of the use of the lands of northern Wisconsin'' (Carstenson 1958).

In the early 1920s, an agricultural depression exacerbated the crisis and, in 1924, voters approved an amendment to the state constitution ''for acquiring, preserving and developing the forests of the state.'' In 1927, the FCL was enacted to provide property tax relief for lands devoted to forestry. The incentives were insufficient; millions of acres still lay idle and tax delinquent. Thus, in 1929, the law was amended to permit counties to enter lands in the program. Other programs included relocation of isolated settlers, land-use planning and zoning, in lieu of tax payments to local governments, forestry assistance, and acquisition of land for public forests, wildlife refuges and parks. Vast areas were zoned for agriculture, recreation and forestry. Some 5 million acres were acquired for public purposes.

The purpose of the FCL was ''to encourage a policy of protecting from destructive or premature cutting the forest growth in this state, and of reproducing and growing for the future adequate crops through sound forestry practices on lands not more useful for other purposes, so that such lands shall continue to furnish recurring forest crops for commercial use with public hunting and fishing as extra public benefits . . ..'' Forest management plans were optional, and lands were open to public hunting and fishing.

Although the program grew slowly, changes in demand for forest products and rising property taxes eventually made entry attractive. By 1981, 1.3 million acres were enrolled.

Because small, irregular woodlots in agricultural regions did not qualify for FCL, the WTL was enacted in 1954 to provide tax subsidies. Lands had to be more suitable for the growing of timber and other forest products than for other purposes. Forest management plans were required, with approval by the Wisconsin Department of Natural Resources (WDNR). Lands were not open to public hunting and fishing. By 1981, there were 286,000 acres in the WTL program.

Setting the Policy Agenda

Changes to established programs, such as FCL and WTL, are often incremental and carefully measured against existing policies. Conferences, committees and task forces are used to test revisions. This was the case when it came to revising the FCL and WTL. A review of the significant early events that led to the MFL proposal, indicates that nontimber resources did not have strong advocates. As the policy evolved, nontimber resources—wildlife, aesthetics, recreation and watershed management—though not outrightly dismissed, were carried as a residual of timber production. The following events led to the debate on the MFL.

Governor's Committee on State-Owned Lands

Widely different opinions related to forest practices have generally existed in Wisconsin. In 1971, the Governor, a Democrat holding a progressive political ideology, appointed a committee to review timber management practices on state-owned land and to determine if new policies were needed. The committee proposed several, including emphasis on ''big tree silviculture,'' expanded recreation use and multidisciplinary forest planning. In addition, the committee found ''the procedure for formulating Wisconsin's forest land policy inadequate to non-existent'' (Wisconsin Governor's Committee 1974). The committee also emphasized that having appropriate data and a forum for interested parties was needed to formulate good public policy.

Governor's Conference on Forest Productivity

The Wisconsin Governor's Conference on Forest Productivity was held in 1980. The Governor was a Republican holding a politically conservative ideology. Although several speakers commented on the need for balanced resource management, the overall theme emphasized intensive timber practices and educational programs to persuade owners to maximize wood production. Among the 10 workshops conducted, 2 related to private nonindustrial forests (PNIFs) and integrated resource management. The tax policy group addressed concerns related to FCL and WTL, including consolidating the laws, lower acreage limits, eliminating public access, severance tax modifications, and the issue of the highest and best land-use provision of FCL. The multiple-use group was concerned with the increasing role of special interests and their adverse impacts on integrated management.

Governor's Council on Forest Productivity

Out of the 1981 Governor's Conference came the establishment of a Governor's Council on Forest Productivity, which was to study and advise the Governor on opportunities to meet the growing demand for wood fiber, with the expectation that forest resource shortages may exist in Wisconsin by the year 2000. In its subsequent report, the council strongly suggested that timber resources were the dominant resources and were to be given the highest priority (nontimber resources were given minimal consideration, if recognized at all) (Wisconsin Governor's Council 1982). For example, the cover letter stated, ''While our report *focuses on wood productivity* we would be remiss to overlook the value and importance of Wisconsin's forest relative to esthetics, quality fish and wildlife habitat, recreation and vital soil and water resources'' (emphasis added).

The executive summary stated, ''Although the *production of wood and fiber remains a primary purpose* of forest management, other values are recognized'' (emphasis added). The report, however, failed to suggest how these ''other values'' were to be recognized.

Three of the seven task force reports, addressed to the council, raised issues relative to PNIFs and the FCL and WTL programs. The PNIF task force included issues of public hunting and fishing, severance taxes, minimum acreages, and new incentives. The task force on training and education reported that only about 5 percent of the PNIFs lands were being intensively managed for multiple use, including wood, and that landowners do not understand practices of multiple-use forestry.

The task force on FCL and WTL recognized that the long-term goal of increased wood productivity would require a strong contribution from the PNIFs, and stated that the major obstacle was that ''other'' landowner objectives compete with and may effectively preclude maximization of forest productivity. In a carefully worded statement, the task force suggested that modifications of the FCL and WTL might constitute the most effective vehicle for influencing forest activity. While recognizing that ''other'' forest values were important, it questioned whether change in the forest tax laws could have a significant impact on forest productivity or protecting the forestland base. Nine recommendations were made and most were incorporated in early drafts of the MFL. An important recommendation related to landowner plans included a proposal that *required management practices to enhance other values* (emphasis added) of the forest, such as fish, wildlife and water quality.

The committee's executive summary highlighted key recommendations and greatly limited the task force recommendation on required management practices to read "management plans required for all new entries to the program." The strong multiple-resource recommendation was lost to the single-purpose objective of wood production. Obviously, the Governor's council did not want to mandate, let alone encourage, management for nontimber resources. Later, the issue of integrated or multiple-resource management would surface with the "Stewardship" proposal.

Forest Inventory and Strategic Plan

A hierarchy of planning was required to meet the objectives of the 1974 and amended 1976 Forest Range Renewable Resources Planning Act and the 1978 Cooperative Forestry Assistance Act. To address these needs, the WDNR's Bureau of Forestry prepared two plans.

The first plan published was "Wisconsin Forests: An Assessment" (WDNR 1980), which described the status of current resources, major ownership categories, supporting programs and activities related to forested lands. The assessment also included information on the FCL and WTL programs. It was estimated that Wisconsin had 14.5 million acres of commercial forestland, and that 68 percent of this land was privately owned. As of January 1, 1979, there were approximately 1,160,000 acres in FCL and 226,000 acres in WTL. Forest industries own 8 percent of all the commercial forestland (1,150,000 acres) in the state—the bulk of this land is owned by less than a dozen corporations who had enrolled approximately 68 percent of their acreage in FCL. A more recent assessment states that, as of January 1984, there were approximately 1,400,000 acres in the program, with about 75 percent industry lands, and that about 90 percent of all forest industry's ownership is in FCL. By contrast, private nonindustrial owner's were reported to have only 6½ percent of their ownership in FCL and WTL (WDNR 1985).

Industry lands are managed primarily for wood fiber production and most are open to the public for hunting and fishing. Their objectives would be consistent with the FCL program. Given high industry participation in FCL, there was no problem in making minor changes to bring more PNIFs under timber management requirements.

The report addressed management of private lands and noted that owners, for justifiable reasons, prohibit use or are unwilling to engage in multiple-use management through timber practices. The Bureau of Forestry concluded that these affects are most adverse to recreation, game and nongame wildlife, environmentally sensitive areas, and lands with high esthetic value. Under private forest opportunities, it stated ". . . PNIF owners often hold forest land for purposes other than timber production, a point that foresters must be cognizant of when promoting the managed forest . . . timber in this sense can be a by-product of outdoor recreation, wildlife production or aesthetics" (WDNR 1983:39).

Proponents of integrated resource management were concerned that the two studies by the Bureau of Forestry and the reports of the Governor's Conference and Governor's Council could be interpreted several different ways. Generally, there was some mention of resource management in addition to timber. However, forest resources such as wildlife, recreation, aesthetics and watershed management were never given a prominent position for policy implementation. At best, these resources were provided low levels of mitigation in the development and implementation of the timber strategy. Landowner needs, other than public access, did not seem to influence proposed policies. Rather, the landowners were to be "educated" to understand that multiple use provides not only optimum timber benefits, but would benefit nontimber resources. The Bureau of Forestry attempted to address these nontimber resources by referencing existing agency plans or by stating that it would be mindful of nontimber resources.

At this point, an attorney in the Public Intervenor's office (an agency in the State Justice Department, with responsibilities to represent broad public environmental interests) objected to the plan being adopted as policy by the WDNR Board because of its' single-purpose emphasis. A compromise was reached between the Bureau and the Intervenor, and the WDNR Board (1984) passed a resolution that ". . . acknowledges the plan is an important first step . . . [and they] endorse[d] the interdisciplinary forest planning process [and] acknowledged the plan as an important first step in the planning process, recognized the need to include 'multiple use goals and policies' in the context of producing wood fiber and endorse interdisciplinary forest resource planning process and direct[ed] it to be continued and expanded . . . ." Therefore, while the report was recognized through Board resolution, it did not constitute WDNR policy.

Policy Development

MFL Proposal

In June 1983, and as a result of the Governor's committee actions, a technical committee from the Bureau of Forestry, presented to the Assembly Committee on Forest Productivity and Rural Development a first draft MFL. The Bureau used recommendations from the earlier reports to improve administration and changes to attract more landowners into incentive programs.

Significantly, the Bureau followed the FCL purposes section with the emphasis on growing timber, rather than integrated resource objectives. Forestry was defined as commonly accepted timber cutting and cultural methods for propagation and improvement of various timber types. This proposal did not have the advice and support of other DNR bureaus, or the agency policy board. Overall, the more significant highlights were: combining FCL and WTL into one new program; public access was optional, with landowners who provided access given a tax incentive; a management plan was required; and local units of government could object to the petition only when eligibility was in question.

Forestland Stewardship and Development Act

The draft MFL was routed to the Public Intervenor who requested that we, along with an interested graduate student, review it. We were familiar with forest policy, owned forestland and were proponents of integrated management.

We concluded that the draft MFL, as a revision of the FCL and WTL programs, did not address: (1) current and future public policy needs; (2) concerns expressed by landowners; and (3) the needs of wildlife, aesthetics, recreational and watershed management. Two courses of action seemed appropriate. Either the draft needed selected "cut-and-paste" revisions or a new bill needed to be drafted. We discussed these concerns and options with the cochair of the Assembly Committee, who made two decisions. First, he requested that we develop a proposal as an alternative to the draft MFL; second, he asked the graduate student to serve as staff to his Committee.

In September 1983, we presented our alternative and titled it "Forest Stewardship and Development Act" (Jordahl and Tlusty 1983). It was a completely new bill, which emphasized options for landowners and diverse public benefits as follows:

- A broad purposes section for integrated management with a landowner option to select primary and secondary management emphasis.
- County planning—eligible forestlands would be inventoried in each county and incorporated with farmland preservation planning (see Figure 1, Step 1).
- Minimum statewide resource protection standards would be developed by an interdisciplinary team and modified through administrative rules; included were scenery, wildlife, fisheries, dispersed recreation and watershed protection.
- Inventories would be conducted for timber production sites and significant forest resources, including wildlife, scenery, recreation and watershed values (see Figure 1, Step 2).
- Increased landowner options (See Figure 1, Step 3).
- Required management plans that included approval by a certified silviculturist and review by several different resource specialists.
- Distinction in public access—small parcel landowners would have more options, and dispersed recreation was a separate option from the public hunting option.

The "stewardship" proposal was presented to the Assembly Committee along with a comparison of the two proposals. The Forestry Bureau criticized the "stew-

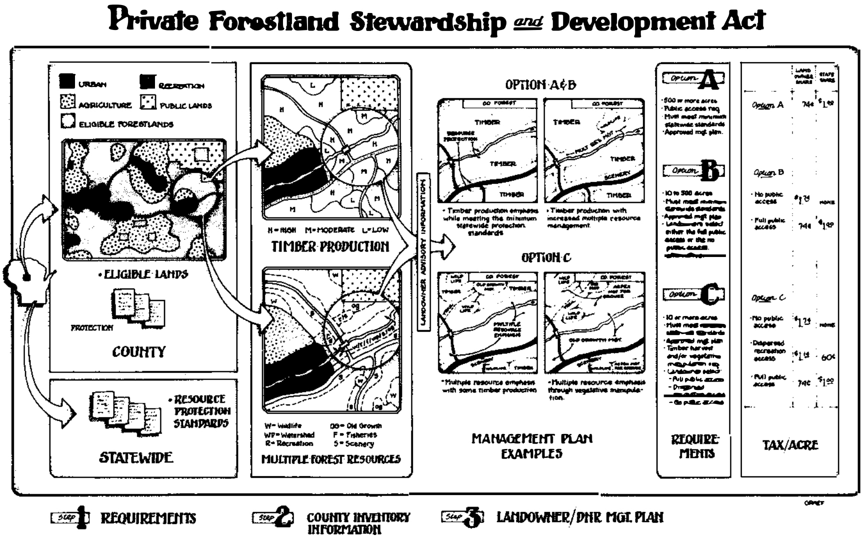

Figure 1. Major integrated resource policy components of the Private Forestland Stewardship and Development Act, presented to the Wisconsin Assembly Committee on Forest Productivity and Rural Development, September 1983.

ardship'' proposal, but noted that it contained many innovative concepts. Because of the conflict, the Committee requested both proposals be put in draft bills that would be reviewed at later public hearings. In 1982, a new Governor (Democrat) had been elected, with a broad view of government intervention in natural resource management. He reconstituted the Council on Forest Productivity and appointed a university professor, who formerly was state planning director, to chair the Council. The Council, with new appointments, supported multiple resource management concepts at key points in the policy process.

Legal, Constitutional and Political Issues

The policy differences between the two groups became legal and constitutional as well as political—industry versus public interest groups issues. Because there were no definitive court decisions on the matter, the Assembly Committee sought a legal opinion. The staff attorney to the Wisconsin Legislative Council, in a carefully worded option, reached three significant conclusions. The first conclusion, based on the language in the constitution, indicated that lands could be classified as forests for tax purposes, leaving the purposes of such lands to the discretion of the Legislature. Second, multiple use of forests is constitutional. And third, lands to be entered in a new program could be taxed at different rates, depending on their availability for public access (Wisconsin Legislative Council 1984). The opinion cleared the way to argue for an integrated resource program.

MFL/Stewardship Hearing

In early January 1984, an ad hoc meeting of several WDNR Board members was held to review the proposals. The meeting was also attended by elected officials, members of the Governor's Council, several organizations and the press. A statewide newspaper title captured the many different views—''First Squalls Felt in Storm Over Forest Tax'' (*Milwaukee Sentinel* 1984). In addition to differences over the proposals, the Wisconsin Wildlife Federation wanted all lands in the program open to hunting and fishing. They claimed both proposals closed too much land and would lead to a European style of hunting, where only the rich could afford the opportunity.

Both bills were reviewed by the Assembly Committee later that month. The MFL was not appreciably changed from earlier proposals and relied on support from the Bureau of Forestry, forest industries, Wisconsin Woodland Owners Association (WWOA), and the earlier reports of the Governor's Conference and Council.

The opening statement of the cochair at the public hearing recognized the conflicting issues. He told the story of the army messenger sent out to scout enemy positions ''Great news, sir! We can attack on all sides—we're surrounded!'' He made it clear, however, that issues would not be resolved for short-term gain, special interest demands or legislative politics—''we are pro-Wisconsin in terms of quality of life for all'' (Wisconsin Assembly Committee 1983).

There were now six major differences between the two proposals: (1) purposes section; (2) landowners options for open/closed land; (3) harvest tax; (4) management plan requirements; (5) landowner dispersed recreation option; and (6) relating the program to the farmland preservation model.

The stewardship proposal, although modified, retained the essential components of multiple use and landowner options (Jordahl and Tlusty 1984a). The major challenge was to convince the committee that it was good public policy and would benefit a large group of landowners. We believed our role to be both advocates for integrated management, while at the same time assisting the Committee in understanding program differences. Position papers and visual illustrations of alternatives were especially useful (figures 1, 2, 3). In addition, the results from (1) WWOA membership applications review (approximately 1,100) were used to show owners diverse resource interests, (2) the relationship of the stewardship proposal to the many reports and recommendations of the WDNR, and (3) most importantly, multiple-use options were highlighted to illustrate how they related to landowner needs.

The Committee decided to use both bills to develop a new proposal. Although it did not specifically state the manner of integrating the proposals, the Committee wanted it titled MFL, with parcels of 80 acres or more open to the public. Also, it was evident that a broader purposes section was expected. The task of redrafting was assigned to the Committee staff, who was the former graduate student who assisted in drafting the initial Stewardship proposal.

Assembly Bill 1126—Managed Forest Act

The staff person to the Committee reviewed the testimony of the January hearing and worked with cochairs to draft a compromise MFL bill (Wisconsin Assembly Committee 1984). In March, prior to introduction, staff discussed sections of the bill with the Bureau of Forestry, forest industry representatives, Wisconsin Wildlife Federation lobby and proponents of the stewardship concept. Although a consensus did not develop, the Assembly Committee cochairs wanted a single bill for further discussion. Hearings were not held during the remainder of 1983–84 Legislative session, which officially killed the bill. However, to set the stage for the 1984–85 session, public hearings were held in May 1984.

Forest Stewardship Act

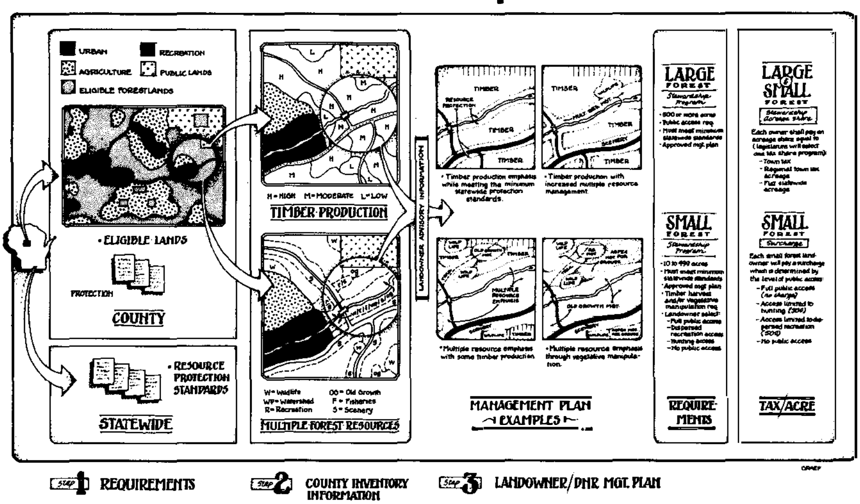

Figure 2. The Forest Stewardship Act—revision of the Private Forestland Stewardship and Development Act, presented to the Wisconsin Assembly Committee on Forest Productivity and Rural Development, January 1984.

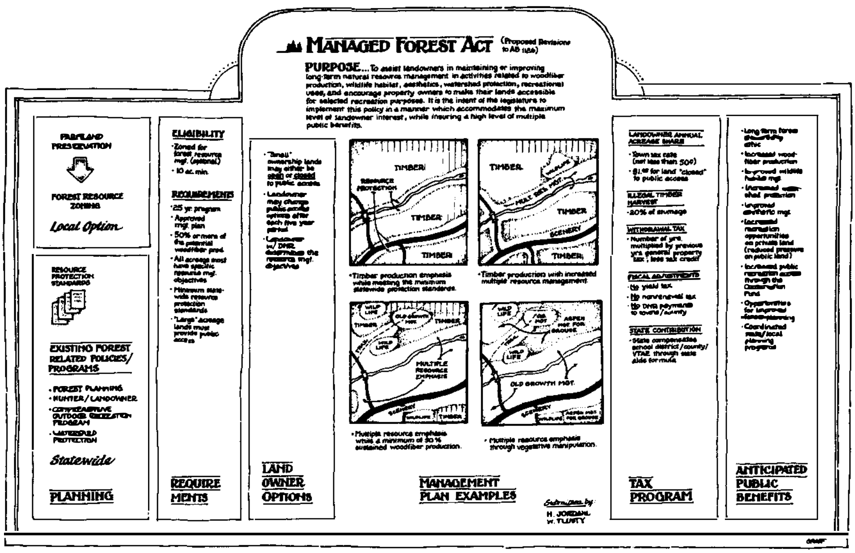

Figure 3. Proposed revisions to the Managed Forest Act (AB 1126) presented to the Wisconsin Assembly Committee on Forest Productivity and Rural Development, June 1984.

These hearings highlighted the controversy rather than developing a consensus. A statewide newspaper titled it "New Forestry Plan is Running Aground" (*Milwaukee Journal* 1984). An editorial in a regional newspaper, however, commented on the need for change in the 57-year-old law, as it "was showing signs of age and needed attention" (*Rhinelander Daily News* 1984). It also was contended that, because both industry and environmentalist were equally unhappy, it must be essentially a good and balanced bill.

Three sections of the bill were the most controversial. First, lands of more than 80 acres were required to have public access, while those less than 80 acres were open or closed at the options of the landowner. Second, the management plan required landowner objectives and a review by experts from five disciplines—forestry, wildlife, aesthetics, recreation and watershed. Third, the purposes section referred to timber production for commercial use through sound forestry practices which *may* integrate with wildlife habitat management, aesthetic considerations, watershed stabilization and recreational uses. The word "may" became an issue. It was too close to mandating integrated management for some and too limiting for others. The Bureau of Forestry, forest industries and the Wisconsin Wildlife Federation were against some sections of the bill. Proponents of integrated management also were against the bill and provided testimony on 12 specific sections in need of revision (see Figure 3 for some of the revisions). In addition, we posed 11 questions for further study (Jordahl and Tlusty 1984b). The Committee asked for a prioritization of issues needing revision. Our priority issues included the following: (1) an explicit purpose section; (2) an option to close lands to public access on lands up to 320 acres; (3) not less than 50 percent of lands mandated for wood fiber (this would permit a landowner to use up to 50 percent for nontimber emphasis); (4) planning at the county level; and (5) minimum statewide resource-protection standards.

The cochairs reviewed the testimony and decided two issues needed further resolution—public access and forest management. An ad hoc committee was established to work on the issues during the summer of 1984.

Ad Hoc Committee

We were on the committee, along with representatives of the Wisconsin Paper Council, Wisconsin Wildlife Federation, WWOA, Sierra Club and WDNR Bureau of Forestry. The staff to the Assembly Committee was chair. Three meetings were held between June and October, and the draft bill was revised five times.

Public access issue. After considerable debate and strong arguments from the Wisconsin Wildlife Federation for keeping all lands open (or not more than 40 acres to be closed) an agreement was reached. It allowed landowners to close up to 80 contiguous acres by paying an additional $1.00 per acre per year. It also required, as proposed in the Stewardship proposal, that public access include, hunting, fishing, sightseeing and cross-country skiing. The new public uses of sightseeing and cross-country skiing were never an issue with the Committee.

Forest management issue. Forest industry representatives criticized the purposes section as being too broad and felt the "productivity" intent had been lost from the FCL and early MFL proposals. Integrated management advocates argued it was too narrow and did not allow sufficient nontimber resource management, and that the intent was not clear and would permit vastly different interpretations. However, on several topics, there was agreement. First, the program was not intended to be for nonforested lands. Therefore, 80 percent or more of the parcel had to be capable of producing 20 cubic feet per acre per year of wood fiber. This controlled the amount of nonproductive timber lands entered in the program—such as wetlands, bogs, and sand dunes and rock outcrops.

Second, all were in agreement that lands in the program had to produce some wood fiber. While it was agreed that 20 percent of the land did not have to produce wood, it was not clear what multiple resource options, if any, were available to landowners on the remaining 80 percent of the land. Ad hoc committee members could not agree on an explicit statement in the "purposes section" to clarify program intent. To "integrate" forest crop production with non-timber resources was unacceptable to industry because the word "integrate" appeared to mandate multiple use. The forest industry representatives, WDNR foresters and foresters representing the WWOA wanted timber practices on 80 percent or more of the land. They claimed that with "good forestry practices" there would necessarily follow "good multiple-use" outputs. We urged specific language to the effect that on "at least 50 percent of the land wood fiber would be produced."

A third area of agreement was that landowners could choose to optimize wood production on all their land. Although industry agreed, they suggested separate legislation would be more appropriate for those landowners who wanted broad multiple-use resource management.

Resolution

To resolve the purposes section issue, materials were presented to illustrate a variety of multiple resource practices, from permanent openings to old-growth management (Tlusty and Jordahl 1984). In addition, the management plan examples in figures 1–3 were used to illustrate acceptable options for the 80-percent productive lands. During the committee meetings, there was agreement that the examples were acceptable management practices under MFL. However, during the development of administrative rules, industry and the Bureau of Forestry changed their position.

Consensus on the purposes section could not be reached, and the Assembly Committee cochair and staff elected to include the following language in the bill, ". . . through sound forestry practices which *may* integrate . . .." The bill was to be included in an omnibus Governor's budget proposal to the Legislature. The Governor's staff was subsequently lobbied by an influential member of the Governor's Productivity Council, and a former Governor, and then-chairman of The Wilderness Society. They were successful in changing the intent of the bill by having "may" removed. The purposes section then read, ". . . which integrate wildlife habitat, aesthetic, watershed and recreational considerations . . ." (State of Wisconsin 1985a). The change was controversial. The Wisconsin Paper Council wanted the word "may" reinserted; otherwise, emphasis on wood production would be difficult. It also argued that consensus had been reached by the ad hoc committee.

The Governor's staff needed to resolve the issue and consulted the former Assembly Committee staff and requested his assistance in drafting a version different than earlier drafts. His new version was not totally acceptable to any of the participants. It was adopted, however, and the purposes section states ". . . recognizing the objectives of individual property owners, compatible recreational uses, watershed protection, development of wildlife . . ." (State of Wisconsin 1985b). Aesthetics was dropped inadvertently from the purposes section, but continued to be included under acceptable management plan activities. The bill was adopted as part of the Governor's budget bill and signed into law in July 1985. The policy development of two issues and some of the program highlights have also been reported in a paper on integrated resource management (Stoddard 1988).

Administrative Rule Making

Throughout the policy process, it was not clear who spoke for private owners. WDNR staff used anecdotal evidence developed by field foresters to advocate their position. The WWOA had association foresters present at hearings and meetings. We used studies from other states as evidence to argue for landowner discretion and resource integration. Agreement was never reached on the question of woodland owner interest for resources such as wildlife, aesthetics and recreation, and whether owners thought the purposes of a new MFL should provide integrated resource options.

To fill this void, the first comprehensive survey of private, nonindustrial forestland owners in Wisconsin was initiated in late 1984 and early 1985 (Roberts et al. 1986). Although the survey was too late to influence debate on the bill, the findings were useful in the process of developing administrative rules to implement the program. The same issues debated in the legislation resurfaced in development of the rules.

Findings of significance to our position on the policy debate were as follows (estimates):

- 218,000 ownership units; 9,082,000 acres (average size—42 acres);
- 80 percent indicated wildlife and scenery as important reasons for owning land;
- reasons for not participating in MFL and WTL included lack of information, public access requirement, long-term contracts, not eligible and incompatible with their objectives.
- a large majority supported broadening the purposes of the WTL and FCL to emphasize wildlife, scenery and recreation as well as wood production.
- responses on limiting public access by payment of an additional fee were mixed—47 percent disagreed, while 41 percent agreed.

In May 1985, WDNR issued the proposed administrative rules for pubic hearings. The Public Intervenor's office requested a review of the proposed rules. Those arguing for integrated management identified five areas of disagreement with the draft rules: (1) how the 80-percent rule was to be interpreted; (2) landowner's option to change public access; (3) leasing lands in the program for hunting; (4) definition of sound forestry; and (5) management plan and nontimber practices.

Although it was agreed landowners could manage for multiple use, there was no agreement on which nontimber practices were acceptable on the 80-percent productive timber land. The WDNR proposed a maximum reduction of 10 percent of the annual growth for nontimber purposes. We argued for resource management practices that produced not less than 20 cubic feet per acre per year of growth. The WDNR argued a 10-percent reduction would be enough to satisfy landowner interests in den trees, seed trees, shelterbelts and scenery, and that the legislative intent supported their position. The Intervenor countered that the new bill was intended to emphasize "multiple use" and the 10-percent proposal was unduly restrictive.

The issues were again debated at the hearings. Along with the Intervenor, we presented testimony supporting integrated management. Following the hearings, the Intervenor requested a meeting with WDNR staff to discuss the issue further. The new director of the Bureau of Forestry, who had not been involved in the issues, brought new insights into the integrated management question and indicated his desire to develop rules reflecting other interests in WDNR and the interests of groups outside the WDNR supporting integrated management. Changes in the draft rule were more supportive of integrated management.

The amended rule permitted the following on lands meeting the 80-percent requirement: openings and vegetation not producing forest products could total no more than 10 percent of the 80 percent; other practices related to forest resources could be approved if they did not significantly alter the value of merchantable stands or preclude the growing of future forest crops. Examples included modifying timber rotations, allocating clearcut limits to the entire tract, permitting irregular cutting boundaries, leaving small uncut tree islands, modifying species composition, modifying residual basal area and substituting partial cuts for clearcuts.

The amended rules were a positive step towards integrated management and were recommended to the WDNR Board for approval. All the rules were adopted with the exception of the leasing question. Landowners enrolled in MFL may not close their lands and lease for hunting or cross-country skiing. This, the Board considered as "developed recreation" and unacceptable under MFL rules (WDNR 1986a).

Collaborative Programs

The MFL also required the WDNR and UW-Extension to cooperate on public information and education programs. First, it required that they "publish and distribute information describing the MFL program . . . and forestry and resource management practices that are acceptable . . . ." The first fact sheet explaining the program has been completed (Tlusty and Rodgers 1987), and others are being prepared.

The law also required that WDNR and UW-Extension ". . . shall study and evaluate the first five years of . . . the managed forest land program to determine whether it has achieved the purposes specified [and to] . . . report their findings . . . [to] each house of the legislature." The study group, now underway, includes the WDNR bureaus of Forestry and Wildlife, and University of Wisconsin faculty from the disciplines of planning, landscape architecture, wildlife ecology, forestry, agricultural economics and watershed management. For the first time, a reporting system also will be used to determine landowner objectives and practices to benefit wildlife and aesthetics.

Program Participation

Current enrollment data for the first two years are very preliminary and should be used with caution. In 1986, the first year, approximately 1,600 owners entered 114,000 acres—65,000 open to public access and 49,000 closed. In 1987, approximately 1,500 owners entered 95,000 acres—53,000 open to public access and 42,000 closed.

In the five years previous to MFL, an average of about 100,000 acres was entered annually under the FCL and WTL programs. Early expectations were for a 50,000-acre increase through MFL. This has not occurred. However, it is too early to predict trends. Several events may explain why entered acreages have not been higher. The totals for five previous years may be atypical in that inflated land values and increased property taxes caused many owners to enter lands. In addition, owners elected to enroll in the established programs of FCL and WTL for 25 or 50 years because they were uncertain about new program options. Other reasons could include lack of educational information and the unsettling issue of Native American treaty rights in northern Wisconsin, which might affect lands in the program. Limiting public access to 80 acres is a concern of some landowners. In the first year, owners applications were submitted for 138,000 acres. Some owners later withdrew lands when they were informed of the 80-acre public access limit. On the other hand, the ratio of open to closed public access lands is about the reverse of what was predicted—more lands are open than closed to pubic access.

Conclusion

There were a number of factors that influenced the acceptable level of policy development for integrated forest management. First, forestry had been an agenda item for two Governors—one a Republican, the other a Democrat. Although their personal interest was at best peripheral, it did provide legitimization and momentum for those who viewed change as desirable and a reasonable expectation.

Second, public policy—once established by law, administrative rules and practice within a bureaucracy—is difficult to change. In this instance, more than 50 years of practices that emphasized wood production were being modified.

Third, there was a legal basis to argue for integrated management. The language in the constitution was broad enough to authorize integrated management. A legal opinion supported the concept. Moreover, in Wisconsin and elsewhere, forestry laws, policies and programs were being broadened to encourage integrated management. Furthermore, the Society of American Foresters definition of forestry supported the concept.

Fourth, proponents of integrated management had a place at the table where issues were debated. The cochairs of the Assembly Committee, both of whom were supportive, requested a proposal that emphasized multiple values as an alternative to one emphasizing wood production. When a consensus did not exist, in lieu of selecting either option, an ad hoc committee was formed, and proponents of integrated management were given equal status in bargaining compromises. The Assembly staff member and Committee cochair was persevering, sympathetic and permitted full debate on the issues.

Fifth, despite several attempts to constrain us, our positions at the University permitted us to make suggestions, develop ideas and debate issues without fear of sanctions. The only constraints were the political and economic realities of the time. In fact, the University made a special effort to support our participation in the debates, which was in keeping with the "Wisconsin Idea" of faculty involvement in public policy issues.

Sixth, although conservation/environment client group support was not aggressive, the proponents were able to argue persuasively that a broad base of public support existed. Conservation lobbyists made strong statements in support of integrated management at the hearings, and participated from time to time in meetings where compromises were forged. The presence of the Public Intervenor and his active participation at contentious points was an important base of support.

Seventh, when trust or mutually compatible goals do not exist, the policy process becomes longer and more difficult, and advocates strive to insert or delete statutory language that would be more appropriate in administrative rules, handbooks or field decisions.

Eighth, there was passive internal support in the WDNR for the concept. Although foresters represented the agency and emphasized wood production, they recognized that, when integrated forest management agreements were reached, the agency would support the concepts. And, although the department's policy board did not play a significant role in the process, its support was a given once decisions were made. Its approval of the administrative rule, which substantially broadened the basis for integrated management, supports this observation.

Ninth, there was evidence from studies in other states that indicated strong preference for integrated management among small woodland owners. A subsequent study in Wisconsin, completed after the law was passed but before the administrative rule was adopted, documented significant owner preferences for wildlife, aesthetics and recreation. Thus, the arguments for integrated management had a strong basis in facts and lent credence to the proponents' arguments. However, it is important to note that a research base documenting landowner interests in other states did not ensure recognition of that interest in formulating Wisconsin policy. A vigorous advocacy role was required.

Tenth, the MFL was another incremental step in the process of evolving public policy that emphasizes integrated management. There are significant innovations in the law to effect changes on the land. However, the more dramatic changes in policy suggested in the stewardship proposal were not debated because they either were too complex or too much of a radical departure from past policy. These innovations included the following: (1) a process of land-use planning at the county level to identify forest regions of high value for wood production, wildlife, scenery, etc., where incentive programs would be targeted; (2 statewide resource protection standards for major forest resources; (3) field-level interdisciplinary review and approval of owner management plans, including approval by certified silviculturists; (4) analysis of means other than property tax relief to induce owners to participate; (5) in lieu of a statewide formula, compensation to local taxing districts for taxes foregone based on their actual tax loss; (6) variation in landowner's payments by regions of the state, reflecting differences in land values; and (7) giving landowners' increased public access options, based on incentives and sanctions, to close their land to the public, to open it for nonhunting recreation (skiing, hiking, etc.) or to open it for both nonhunting activities and hunting.

Eleventh, a forum for continuing the studies, discussions and debates on the program with its many facets was institutionalized by establishing a joint WDNR/UW-Extension committee to report to the Legislature in 1992. Representatives on the committee reflect broad integrated management interests and, thus, will not be constrained by short-run objectives or temporal political and economic circumstances. Subsequent legislative debates on amendments to the program, hopefully will be based on a wide range of options and alternatives that will assure full consideration of integrated management goals.

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A Strategy to Improve the Adoption of Forest Management Practices, Especially for Wildlife, on Private Nonindustrial Woodlands

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Most forest resource professionals in the United States would agree that the key to improving the long-term productivity of our forests for timber hinges on our ability to motivate millions of private woodland owners to manage their lands. Yet, increased fiber production is not a priority of most of the 7.8 million nonindustrial private forests (NIPF) owners who hold approximately 58 percent of the timber lands in the U.S. Public opinion polls taken among woodland owner populations in recent years have shown that many prefer to manage their forests for wildlife. Coupled with this situation is a startlingly common misconception that the best course of action for meeting the habitat needs of wildlife species is to leave the forest undisturbed (Alexander 1984, L.A. DeCoster personal communication: 1985).

It is not surprising that industry's need for wood is perceived as being at odds with the desires of private owners to preserve the forest for wildlife. Disturbances caused by timber extraction are often unsightly and apt to be prejudged by the uninitiated as detrimental. The real dilemma in this seemingly irreconcilable set of circumstances is that as forest managers we may be over emphasizing timber production at the expense of lost opportunities to manage for wildlife. By shifting the emphasis of our public and private forest management assistance programs to improvement of wildlife habitat, not only are we able to attract more owners to participate in forest management activities, timber productivity in the long-term should increase as well.

Another, perhaps more critical aspect to the dilemma of how to increase management on NIPF lands has to do with our methods of assisting owners. A wealth of technical assistance, education and cost-sharing incentive programs are available to woodland owners, yet only a relative few avail themselves of these publicly supported services. An examination of this situation from the perspective of communication research indicates that, although the programs offered to landowners provide a technical and service-oriented approach to the problem, they lack interpersonal communication network processes that affect motivation and influence adoption of management practices. This, coupled with the fact that management for improved wildlife habitat—most often species-richness—is consistently identified as a top priority of woodland owners, suggests a need to re-examine the way we, as forest resource professionals, attempt to convince woodland owners of the need for and benefits of forest management. It also suggests a need to redefine the term forest management to encompass a process that optimizes owner-defined woodland benefits in addition to timber.

The Coverts Project, now in its fourth year, is a cooperative effort involving the Extension Services in Vermont and Connecticut. Funded through a grant from the Ruffed Grouse Society, the project has as its goal to improve and increase management of private woodlands by demonstrating ways that timber and wildlife habitat prescriptions can complement one another. The project advocates a more holistic, goal-oriented approach to forest management that highlights both game and nongame habitat improvement opportunities. This approach, we believe, will convince more private woodland owners to manage their lands than will programs that solely emphasize timber production. Furthermore, highly motivated woodland owners identified as community "opinion leaders," who believe as we do in a broader definition of management, are much more effective at influencing their neighbors to adopt management than are forestry and wildlife professionals. In a sense, the messengers become the message in the Coverts Project.

The philosophy of the project and rationale for our approach have been the subjects of earlier articles (McEvoy et al. 1984, 1985, McEvoy 1985, 1987, Stewart and McEvoy 1986, Broderick and McEvoy 1986).

We contend that many woodland owners have ignored our forest management messages in the past because they have not been properly motivated to do otherwise. They lack an experiential basis from which to judge compatibility of forest management with their own beliefs and concerns. As a result, they are quite possibly ambivalent or even oblivious to our efforts to attract them to forest management. Since it is not uncommon for people to be forced to make decisions on the basis of information for which they have no basis of experience, exploring forest management options can be a lot like buying a new car or choosing a restaurant. Communication science has shown that people will rely to an enormous extent on the representations of others whom they know and trust. Although the analogy between choosing a restaurant and deciding on a course of forest management may appear thin, they are in fact similar in that the decision process is virtually the same.

Rodgers (1983), after many years of studying the process by which people adopt new ideas, has proposed a model of the way innovations or new ideas diffuse through a community. Based on our experiences, the model seems to fit the null-management syndrome we described earlier. There are five distinct stages in Rodgers' adoption-sequence model: (1) awareness; (2) interest; (3) evaluation; (4) trial; and (5) adoption or rejection. Our public service and education programs in forestry, coupled with a strengthening private sector, have been fairly successful at all stages, save one. We can create awareness, generate interest and help woodland owners try practices on their lands, but it is virtually impossible for professionals to help owners evaluate management within the context of their own beliefs. The evaluation stage is a powerful filter which, so far, has excluded a majority of private woodland owners from considering forest management. Rodgers tells us that the catalysts, or "gatekeepers" in the adoption-diffusion process are peers—friends and neighbors—who, by sharing their experiences with a "new idea," enable an owner to evaluate a decision to try something new. The theory has proved true for well-defined groups such as physicians and farmers. Our experiences in New England indicate that the same is true for woodland owners, even though they represent a diverse and heterogeneous group of people. Interestingly, as was pointed out by one of our volunteers in Vermont, the desire to provide better habitat for wildlife is the force that brings his neighboring woodland owners together.

A key to our success is being able to select woodland owner volunteers who believe in a more holistic approach to management and who also show characteristics of leadership—someone to whom others in the community look, especially regarding forestry. Coverts Project volunteers are usually resident woodland owners who have had management experiences in the past. They must demonstrate a commitment to the ideals of the project, and wildlife must be a fairly high priority. Candidates are nominated by forestry and wildlife professionals on the basis of these criteria, or sought from the ranks of local conservation commission officials, tree farmers and other groups whose members are likely to be opinion leaders in the natural resource area. Each nominee is then asked to complete a rather lengthy six-page application. The application was designed to help us choose opinion leaders and to ascertain why a candidate wants to be involved in the project. Since people who volunteer are notorious for overextending themselves, we also wanted to be sure a candidate had time for the project. Each was told in advance of completing the application that the project would involve participation in a three-day workshop in the fall, and up to an average of two hours per week thereafter for a period of 12 months. Our experience has been that the actual hour commitment for most volunteers is less. However, many have discovered that, after 12 months of working with their neighbors, they are just getting started.

Each group of volunteers has been small. Connecticut usually selects about 30 each year, while Vermont has had groups ranging from 16 to 24 people.

Once a candidate's application is reviewed in the spring and the selections are completed in early summer, the new corps of volunteers are assigned readings that span a number of different disciplines, but especially forest and wildlife ecology and management. Most of their reading is assigned from *Working With Your Woodlands* (Beattie et al. 1983). We also supply copies of *Leadership Effectiveness Training* (Gordon 1977), although no readings are assigned.

Our workshops are held over the course of a Friday, Saturday and Sunday. Although the specific agendas differ between states, each curriculum covers four main concepts: (1) forest and wildlife ecology; (2) management planning and forest use; (3) communication and leadership skills; and (4) important current forest and wildlife management issues and policies. Demonstration sites, established early in the project, are used as outdoor classrooms to show complementary timber and wildlife management practices. The three-day sessions are an intense experience, which most participants have found to be totally engaging.

An essential part of the workshop in recent years has been an opportunity for new volunteers to interact with some of the veterans. For the same reasons that peer communication is so effective in the community, listening to fellow Coverts Project volunteers describe their experiences with the project has a profound effect on the new group. More than a few have commented that a presentation by one of the veteran volunteers had a greater effect on their thinking about the project than any other aspect of the workshop.

More than 130 woodland owners in the two states have completed the training, which has been offered six times (three times in each state) over the past four years. Although we have not yet completed any formal evaluations of the project, we have gathered some impact data and can share other observations.

Our application process appears to guide us toward a correct decision about a candidate more than 50 percent of the time. This is substantial because leadership is not defined by a set of personal characteristics as much as it is by the situation in which the person is found (Howell et al. 1979). About half of the candidates we select go on to become very active volunteers, about a third are somewhat active and the balance seem to disappear after the workshop. We are not sure why the application process fails to identify seemingly unsuccessful volunteers, but we have been extremely pleased with all of the others. Their activities have surpassed our expectations to the extent that they more than make up for the inaction of the others.

In 1985–86, 13 of 24 volunteers in Vermont who responded to a year-end accomplishment evaluation said they contributed an average of 163 hours each to the project. They also reported that, collectively, they had personally contacted more than 2,000 woodland owners in their communities. Media contacts included 23 newspaper articles and seven radio and television appearances. Thirty tours and workshops were sponsored by these 13 respondents, and they reported that 78 of those contacted in person sought out professional assistance. Of those, 50 followed through by implementing management practices on a total of more than 6,000 acres of forest land. The volunteers themselves reported completing management practices on nearly 800 acres.

Factoring these figures to the entire corps of volunteers would be unreasonable and misleading, and probably unnecessary. The accomplishments of these 13 volunteers exceed, by a wide margin, the accomplishments that could be expected from a single Extension Service professional, and at a fraction of the cost.

In Vermont, the most successful approaches so far have involved volunteers working with their immediate neighbors. As an example, a Coverts Project volunteer in the southern part of the state has developed an informal association with 30 neighbors in his valley, all of whom have agreed to adhere to a collective management plan that features habitat improvement for a variety of game and nongame species. It is significant to note that it is the habitat improvement potential that attacts these people, not the prospects of income from timber sales. With a single volunteer's tract of 250 acres as a nucleus, that volunteer and his neighbors are implementing management, principally for wildlife but also for timber where the potential exists as well, on more than 1,200 acres of forests and fields.

There have been a number of spinoffs of the project too, some of which are portentous of change in forest industry's approach to management. For three years in a row, Vermont's Outstanding Tree Farmer has been selected from among the ranks of Converts Project volunteers. One, Harry Chandler, went on to win the New England competition and national title in 1986. In the same year, Connecticut's Oustanding Tree Farmer was also a Coverts Project volunteer. The American Forest Council—the public relations arm of the country's wood-using industries—which sponsors the Tree Farm program, has substantially broadened its definition of good forest management. Why? Because, as we had indicated earlier, industry's opinion polls in recent years have shown that improved wildlife habitat ranks as highly or higher than timber in most owner's minds. And, of course, the way to get them to manage their timber is by emphasizing the potential to improve wildlife habitat.

Our experience with the Coverts Project in Connecticut and Vermont—two states in New England for which one could think of more contrasts than similarities—leads us to believe that the concepts of the project, both with respect to our approach to forest management and to the validity of employing volunteers, would be applicable to other states. More than a few agencies and organizations from a number of different states around the country have expressed interest. Usually, they are surprised to learn that about the only thing they need to import are ideas. Virtually all of the materials and expertise to begin a similar project already exist in most states.

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California's Integrated Hardwood Range Management Program

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Introduction

During the past decade, Californians have become increasingly concerned about decline in the distribution and abundance of California's oak woodlands (Walt et al. 1985). Several native oaks (*Quercus* spp.) have not regenerated well for the past 100 years (Muick and Bartolome 1986, Steinhart 1978, Griffin 1971, 1976), and removal of oak trees for wood products, intensive agriculture, and urbanization and road building has increased dramatically (Bolsinger 1987). In response to this set of circumstances, the University of California (UC) began in 1983 to work cooperatively with the California Department of Forestry and Fire Protection (CDF) and the California Department of Fish and Game (CDF&G) to gather hardwood information and develop a research and education program aimed at managing, enhancing and protecting the state's hardwood resource (Walt et al. 1988). California's Integrated Hardwood Range Management Program was funded with an annual budget of $1 million approved by the State Legislature beginning in 1986–87 and to extend for at least the next 10 years (Walt et al. 1988). About half of this money was earmarked for research and half for educational activities.

The Resource

Distribution and Abundance

Hardwoods occur over one-fifth (21 million acres: 8.5 million ha) of California (Bolsinger 1987). Of this, about 7.4 million acres (3 million ha) are lands dominated by oak trees and are not capable of producing economical quantities of wood (20 ft^3/acre/year: 4.6 m^3/ha/year). They are referred to as oak woodlands, oak rangelands or hardwood range, and are mostly privately owned and used primarily for livestock production. Oak rangelands border California's Central Valley and extend south along the coast to the Mexican border (Figure 1). They occur in 52 of the 58 California counties; 21 counties have more than 100,000 acres (40,500 ha), and 3 have in excess of 400,000 acres (161,900 ha) of hardwood rangeland (Mayer et al. 1986).

Blue oak (*Quercus douglasii*), alone and associated with digger pine (*Pinus sabiniana*), predominates on the more xeric sites and coast live oak (*Q. agrifolia*), interior live oak (*Q. wislizenii*), and valley oak (*Q. lobata*) occur on more mesic

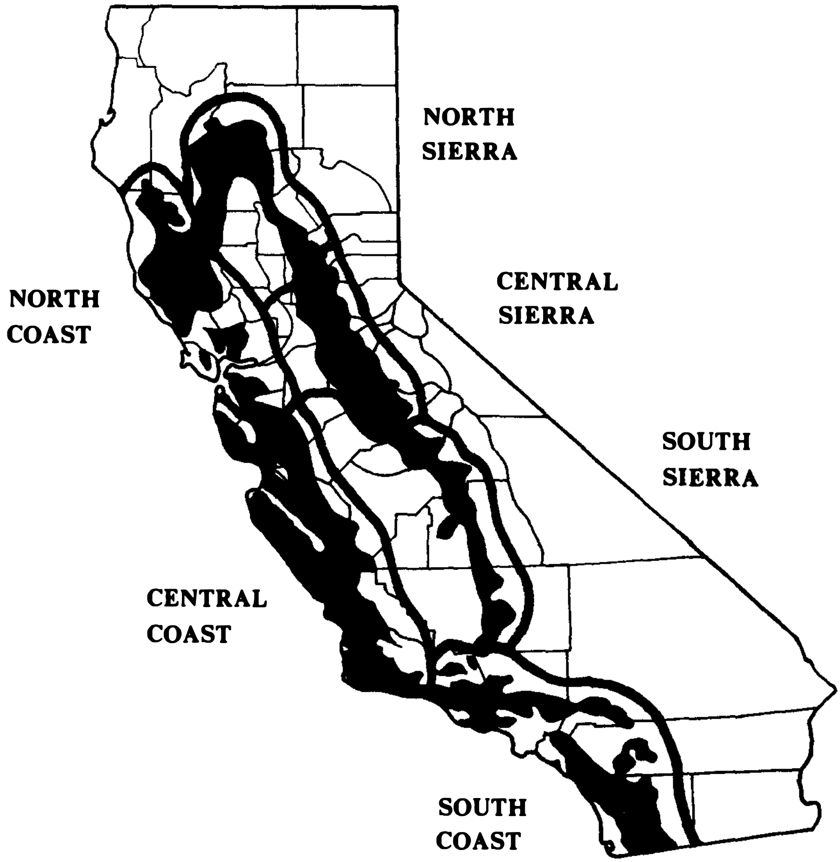

Figure 1. Composite distribution of blue oak, coast live oak, interior live oak, valley oak and Engelmann oak (Griffin and Critchfield 1976) that comprise California's hardwood range. The hardwood range is demarcated by the six UCCE Area Natural Resource Specialist regions of work.

sites (Griffin 1988). Engelmann oak (*Q. engelmannii*) is restricted to the south third of the state. These species comprise only 22% of the total hardwood volume in California, but more than 50% of the hardwood volume on oak woodlands (Bolsinger 1987).

Values of Oak Rangelands

Oak rangelands provide habitat for more kinds of wildlife than any other major habitat type in the state. More than 300 vertebrate species use this rich habitat for food, reproduction, and thermal or escape cover (Ohmann and Mayer 1987, Barrett 1980, Verner and Boss 1980) (Table 1), and the list is growing as more information is gathered. During part of the year, oak mast comprises about half or more of the diet of the state's most important game animals—mule deer (*Odocoileus hemionus*) (Potter and Johnston 1980), wild pigs (*Sus scrofa*) (Barrett 1978) and wild turkeys (*Meleagris gallopavo*) (Smith and Browning 1967).

Table 1. Major vegetation types in California and the number of wildlife species that use each for reproduction (from Ohmann and Mayer 1987).

Vegetation type and wildlife species group	Total number of species
Hardwood	
Herpetofauna	58
Birds	168
Mammals	105
Total	331
Conifer	
Herpetofauna	55
Birds	148
Mammals	108
Total	311
Shrub	
Herpetofauna	62
Birds	85
Mammals	102
Total	249
Desert	
Herpetofauna	58
Birds	98
Mammals	74
Total	230
Wetland	
Herpetofauna	27
Birds	89
Mammals	53
Total	169
Grassland	
Herpetofauna	32
Birds	56
Mammals	77
Total	165

Together with associated grasslands, oak rangelands produce more than two-thirds of the state's total range forage for livestock (Forest and Range Resources Assessment Program 1979). The annual market value for cattle and calves in California averages nearly $1 billion and almost $50 million for sheep and lambs (Halverson 1987). Historically, oak trees for wood products have been neglected because of the more easily processed conifer species. But utility rates began to rise in the mid-1970s and, today, California's native oaks are highly valued for firewood (Doak and Stewart 1986), with prices at more than $200 per cord common in the metropolitan areas.

Oak trees also increase property values. Lands with trees have a real-estate value about 25 percent greater than lands without trees (Diamond et al. 1987). Replacement values of oaks in the suburban landscape can be as high as $18,000 per tree. In addition to their beauty, oak trees symbolize rural values and traditions. One landowner put it this way, "I want to conserve oak trees because they make my land look more like a ranch than a farm." In short, hardwood rangelands provide food, fiber, open space and a way of life for many Californians.

The Problem

Biological Concerns

During the past decade Californians have become increasingly concerned about losing oak rangelands and the values they provide. Three native California "white oaks" (subgenus *Lepidobalanus*—blue oak, valley oak and Engelmann oak) are not regenerating sufficiently in many areas to maintain current stand structures (Muick and Bartolome 1986, Steinhart 1978, Griffin 1971, 1976). McClaran (1986) characterized large stands of blue oak in the northern and southern Sierra Nevada Mountains in California. The stands were dominated by seedlings and old trees. Middle-aged trees, which typically dominate self-sustaining hardwood stands, were nearly absent. This skewed age structure indicates that little recruitment has occurred during the past century. These findings are of special concern since California's white oaks grow slowly compared with other California oaks and with their eastern U.S. counterparts.

Social and Economic Concerns

Poor regeneration has been coupled with increased removal of oak trees. During 1945–73, oak woodlands decreased by nearly 1 million acres (404,900 ha) (Bolsinger 1987), due primarily to clearing for rangeland improvement which took place in 42 of the state's 58 counties (Mayer et al. 1986). During the past 15 years, the major cause of clearing has changed from range and forest management to urbanization and road building; 199,000 acres (80,600 ha) have been converted (Bolsinger 1987). During this time, use of native hardwoods for biomass fuel (Pillsbury et al. 1983) and firewood (Pillsbury and Williamson 1980) has also increased substantially.

These oak issues and concerns were brought into California's political arena by three separate incidents (Walt et al. 1985): (1) Monterey and Santa Clara counties were concerned that scenic and watershed qualities would be damaged by hardwood harvesting; (2) a timber-harvest permit was requested to clearcut 1,000 acres (405 ha) of black oak (*Quercus kelloggii*) in critical deer habitat in the Western Sierra; and (3) concerned environmentalists pressed the California State Board of Forestry (BOF) to look critically at the potential adverse impacts on the hardwood resource of proposed biomass-fueled power plants.

One solution to the hardwood "problem" brought forward was simply to classify oak on rangelands as commercial tree species under the State's 1973 Z' Berg-Nejedly Forest Practice Act. This would extend the BOF's jurisdiction over commercial wood harvesting and stocking on conifer lands (located primarily in the northern half of the state) to oak rangelands. Private property rights sentiments, however, are strong in California (Walt 1987) and regulation of hardwood harvesting on rangelands would be very expensive to monitor and enforce. There was much opposition coming mainly from ranchers and other landowners to use of regulations to solve the hardwood problem.

The Program

Background

Within this socioeconomic atmosphere, H. R. Walt, Chairman, BOF, was instrumental in the emergence of a cooperative approach to the hardwood problem between the CDF, CDF&G and UC. In 1983, the BOF commissioned a Hardwood Task Force (HTF) to examine the entire hardwood controversy and recommend solutions. Of the 19 issues identified in the report (Pillsbury et al. 1983) that affect hardwoods on rangelands, 17 pointed to research and education programs as possible solutions. The HTF Report concluded that some form of regulation may be necessary to protect the hardwood resource, but it also called for putting together extant information, seeking new knowledge on oak woodlands, and assisting land managers and the public in using that information.

Responding to increasing public attention to oak woodland issues, the HTF's findings and the $1 million acquired from the California State General Fund, UC substantially increased its focus on hardwood range research and education (Table 2). In 1986, the Integrated Hardwood Range Management Program (IHRMP)—a long-term program of education and research aimed at managing, enhancing and protecting California's hardwood resource—was put in place. Based on cultural and land-use differences, and logistical concerns, the hardwood rangeland was divided into six regions, each comprised of six to nine counties (Figure 1). A UC Cooperative Ex-

Table 2. Significant activities and events, involving the University of California (UC), and the California Department of Forestry and Fire Protection (CDF), in the development of the Integrated Hardwood Range Management Program (IHRMP) (September 1983 to February 1988).

Date	Activity or Event
September 1983	University of California Cooperative Extension (UCCE) Hardwood Workgroup is formed in response to the need to address the training and research needs of UCCE Farm Advisors and their clientele.
September 1984	UCCE Hardwood Workgroup sponsors three in-service training sessions to inform UCCE Farm Advisors about opportunities for multiple-use management of oak rangeland.
March 1985	UCCE funded a statewide sociological study of oak-woodland owners to get a better understanding of owner's attitudes and practices concerning oak management.
March 1985	UC Wildland Resources Center drafted a proposal, titled *An Integrated Hardwood Range Management Program* (Report No. 6), in response to a request from the State Board of Forestry. The proposal outlined an aggressive educational and research program to be delivered over a 10-year period.
March 1985	Director of the UCCE announced the formation of a new program thrust in Cooperative Extension's Natural Resources Program aimed at education and research leadership in hardwood range.

(Continued)

Table 2. (*continued*)

Date	Activity or Event
July 1985	UCCE's 1986–87 budget is proposed to include augmentation of $650,000 for oak-woodland research and extension.
October 1985	UC appointed an Interim Hardwood Range Program Manager to establish visibility and momentum for the proposed program.
December 1985	UCCE's manual, titled *Preliminary Guidelines for Managing California's Hardwood Rangelands*, is published.
December 1985	UC President publicly supported cooperative funding of programs as exemplified by the proposed IHRMP.
January 1986	California Governor's budget for 1986–87 includes UC's augmentation of $650,000 for a coordinated IHRMP to be funded with an additional $350,000 from the CDF.
February 1986	UCCE published the first edition of the newsletter *Oaks 'n Folks* to be a quarterly update on multiple-use management of hardwood rangeland.
July 1986	UCCE Search Committee recommends candidates to be named as Area Specialists for the IHRMP. Formal offers are made in August 1986.
October 1986	UC and CDF jointly funded 18 research studies on biological and socioeconomic hardwood-range issues and concerns.
November 1986	A three-day jointly sponsored symposium on multiple-use management of California's hardwood resources was attended by 500 researchers, policy makers, managers and landowners. More than 70 technical papers were presented.
November 1986	UC presented testimony to the State Board of Forestry (BOF) on its plans for carrying out the IHRMP.
February 1987	The BOF concluded that it was premature to regulate hardwoods and went on record in support of implementing the nonregulatory IHRMP.
March 1987	Surveyed readers of the *Preliminary Guidelines for Managing California's Hardwood Rangelands* manual indicated it was successful in reaching its educational objectives.
July 1987	A statewide study of the ability of blue oak to sprout was initiated at five locations.
September 1987	A newly developed brochure that explains the IHRMP was distributed, and four audio-visual programs were created that explain use of the *Preliminary Guidelines for Managing California's Hardwood Rangelands* manual and several oak-woodland issues and concerns.
November 1987	A management guide, titled *Living Among the Oaks*, was published, and preparations underway to survey 10,000 small-parcel owners sent this brochure in seven California counties.
January 1988	A database was developed of owners of small parcels (3–40 acres) in nine California counties having substantial acreages of oak rangeland.
February 1988	CDF funded six research studies on biological and land-use issues affecting California oaks.
January 1987 to February 1988	Numerous educational activities with targeted clientele were conducted, including field meetings, tours, workshops, paper and poster presentations, surveys, training sessions, and publication of newspaper, periodical, and journal articles, and the IHRMP *Oaks 'n Folks* newsletter.
January 1987 to February 1988	UC Extension personnel continued or initiated many research studies on several of the biological and land-use problems affecting the oaks.

tension (UCCE) Natural Resource Specialist was appointed to work closely with UCCE Farm Advisors in each region. The four major goals of the IHRMP were to: (1) develop feasible (and profitable) alternative management strategies for oak woodlands; (2) improve oak regeneration; (3) maintain wildlife habitat diversity in oak woodland; and (4) show the consequences of oak rangeland conversions.

Examples of IHRMP Activities for Extending Knowledge

1. Field demonstration sites are being installed throughout the state. These sites will be used to show that oaks are a valuable resource that can be managed for profit from wood, wildlife and livestock, in addition to their purely aesthetic value.
2. A manual titled *Preliminary Guidelines for Managing California's Hardwood Rangelands* (Passof et al. 1985), which provides multiple-use management guidelines for oak woodlands, was developed for the IHRMP. Based on the premise that wood, wildlife and water will become more valuable in time, the theme of the manual is "Preserve Your Management Options." On any oak woodland in California, the landowner can use the manual as a self-help guide to calculate the economic potential of wood, wildlife and livestock resources. For achieving these potentials, the manual also offers management recommendations, such as tree thinning, wildlife-enhancement and forage-enhancement techniques. This manual has also been put into video and slide-show formats.
3. The IHRMP is working to create awareness among oak woodland owners and the hunting public of the benefits of game ranching. Hunters pay access fees. These monies provide an economic incentive for the landowner to improve the land for wildlife. One such program in California is the Private Lands Wildlife Management Program, administered by the CDF&G. This program currently encompasses 54 areas totalling over 703,000 acres (284,600 ha) in 17 California counties (Mansfield 1987). Game ranching provides an alternative management strategy for landowners to earn money from oak rangelands—and maintain healthy, productive stands of oak trees.
4. Small-parcel or ranchette owners are becoming more common occupants of California's oak woodlands. The IHRMP developed a brochure, titled *Living Among the Oaks—A Management Guide for Landowners* (Johnson and Austin 1987), that illustrates best-management practices to protect and enhance the oak resource on small parcels.
5. The IHRMP encourages the use of underutilized hardwoods such as tanbark oak (*Lithocarpus densiflora*) or introduced species such as Eucalyptus (*Eucalyptus* spp.) for firewood. Using these kinds of trees eases the pressure on native hardwoods.
6. By working closely with environmental and community organizations, the IHRMP is striving to focus public attention on oak-planting activities. A goal is to develop planting programs in cooperation with 4-H groups and community and environmental organizations.

Examples of IHRMP Research Activities

The UC and CDF are partners in a competitive grants program. Issues for research are identified by a Policy Advisory Committee. Grants are open to the two state university systems in California, consultants and state agencies. Research focuses on: (1) the status of oak-tree regeneration and solutions to this problem; (2) helping oak-woodland owners manage their land and trees for profit as well as for wildlife needs—and the natural beauty of the landscape; and (3) the function of local governments in using and conserving the oak-woodland resource under their jurisdiction (Table 3).

Table 3. Titles of 18 research projects jointly funded by the University of California and the California Department of Forestry and Fire Protection (CDF) in October 1986 and six others funded by CDF in February 1988 in support of the Integrated Hardwood Range Management Program.

Date funded	Research project and title
October 1986	1. Ecology and regeneration of hardwood rangelands: the influence of water, herbivory, and competition on stability, productivity and management options.
	2. Natural regeneration of hardwood range species in California.
	3. Oak woodland regeneration project.
	4. Effect of fire on seedlings and saplings of coast live oak and Engelmann oak.
	5. Ecophysical responses of oak seedlings during establishment: influence of water stress, nutrient stress, and mycorrhizae on survival, growth and establishment of oak seedlings.
	6. Genetic variability of three California oak species: implications for regeneration of hardwood range.
	7. Oak regeneration assessment.
	8. Wildlife habitat relationships in oak woodlands of California.
	9. An investigation of the breeding habitat of cavity-nesting birds in a hardwood-range habitat.
	10. Analysis of local control of hardwood use and protection.
	11. Inventory and analysis of the federal and state statutory environment for hardwood-rangeland ownerships.
	12. Alternative management strategies for hardwood range.
	13. Price structures at big game hunting clubs in California.
	14. Development of a ranch model of California's hardwood rangeland.
	15. California livestock industry economic model.
	16. Overstory canopy effects on forage production, quality and utilization, and soil characteristics on hardwood rangelands.
	17. Ecological site descriptors for hardwood range.
	18. Assessment of California hardwood lands.
February 1988	1. Selected techniques for restocking hardwood rangelands in California with native oaks.
	2. Wildlife habitat relationships in oak woodlands of California.
	3. Regionalizing the Wildlife Habitat Relationships data base to facilitate validation efforts.
	4. Data base for evaluating and monitoring impacts of diseases and arthropods on California rangeland oaks.
	5. Hardwood rangeland soil and water quality.
	6. Vegetation change on hardwood rangelands.

The Future

Walt et al. (1985) posed three questions crucial to the continued existence of large expanses of oak woodland in California and the success of California's IHRMP: (1) Can answers be found to the biological problems facing the oaks? (2) Can this information be extended to landowners and other concerned citizens? (3) Will landowners respond by changing management practices without the need for regulations?

Similar questions about the usefulness of an Extension and research program were raised in the early 1980s about a problem in managing agricultural pests. Here, public input was needed for regulatory decisions on agricultural pesticides and for integrated management strategies for agricultural pests. In response, the UC developed the Integrated Pest Management (IPM) project, which has proven to be successful over the past five years (Canup 1987). Many aspects of the IHRMP are modeled after the IPM program.

Evaluation is a necessary and integral component of the IHRMP. For example, a questionnaire was sent to a sample of readers and users of the *Preliminary Guidelines for Managing California's Hardwood Rangelands* (Passof et al. 1985), to evaluate the manual's effectiveness in causing change in management practices. Published results of the study (Easton 1987) indicate that the manual presented the information in a clear, easy-to-use fashion, and held much potential to effect changes in hardwood management practices. Similarly, the publication *Living Among the Oaks—A Management Guide for Landowners* (Johnson and Austin 1987) will be mailed this year to 10,000 small-parcel owners. An enclosed questionnaire will solicit recipients' opinions on oaks, as well as an evaluation of the publication for its usefulness as a management guide.

The IHRMP is an example of the type of program that is most likely to be funded in the future. In these times of static or declining dollars, most new programmatic funds will be earmarked for problem- and clientele-specific initiatives. The success or failure of the new IHRMP will set a precedent for UC involvement in these initiatives. We are being watched closely.

California's IHRMP may be a good example for other states. Solutions to the problems affecting California's oaks are being sought because: (1) Californians voiced their concern about their oaks; (2) agencies responded with a coordinated effort; and (3) the California State Legislature did something—it picked up on the problem with funding for a long-term program of education and research. The California State Legislature appropriated moneys in support of the IHRMP so that research and education could be used in lieu of regulations to solve the complex biological and land-use problems affecting the oaks. To the extent that this approach can be demonstrated successful, this program and future ones like it will be funded.

Summary

California's native oaks are a multivalued resource that predominate over 7.4 million acres (3 million ha) of mostly privately owned oak rangeland. Poor regeneration and increased removal of oaks threaten their distribution and abundance. Solutions to these problems are complicated by inadequate information and the need for the development and extension of alternative management strategies. Strong property-rights sentiments and enforcement costs render regulations an unacceptable solution. UC, together with CDF, developed the IHRMP—an education and research program committed to improving oak regeneration and offering landowners economically sound alternative management strategies. The IHRMP is currently in operation and its success, and that of future programs like it, rests on whether it can be demonstrated that this innovative approach to a resource-management challenge can change attitudes and resource-management practices, without the need for regulations.

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Changes in New England Forests and Forest Owners: Implications for Wildlife Habitat Resources and Management

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Introduction

In 1986, we reported on the opportunities and constraints for wildlife habitat management on private forest lands of the northeastern United States (Brooks and Birch 1986). We concluded that, although the number of individual private forest ownerships were large and the average individual forest holding was relatively small, there were nevertheless excellent opportunities for forest habitat management. Favorable owner attitudes towards wildlife resources, and the concurrent silvicultural maturity of the forest, would allow for commercially viable forest management, making wildlife habitat management economically feasible.

For our 1986 publication, we used reports detailing the characteristics of forest lands and forest owners of the Northeast. These reports are the published results of federally mandated forest surveys conducted by the Forest Inventory and Analysis (FIA) research unit of the USDA Forest Service Northeastern Forest Experiment Station.

The forest resource surveys have been conducted in the Northeast on a periodic basis since the late 1940s. The New England forest owner survey was initiated concurrent with the forest resource survey of southern new England in 1972. It has been conducted simultaneously with the forest survey and has become an integral and valued part of the survey since that time. The most recent New England resurvey resulted in the first resurvey of forest owners in the Northeast. Our objectives in this paper are to interpret the results of the last two New England forest surveys as they relate to wildlife habitat, and to identify possible changes in that resource, and the characteristics of forest owners that may influence management options.

Methods

We summarized information from reports of the last two resurveys of five New England states (New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut), completed in 1972–73 at the prior survey and again in 1982–84 at the current survey. The FIA publications are listed in the Appendix. At this time, Maine's forest owners have been surveyed only once, hence, Maine data are not included in this paper.

The sampling procedure for the resurvey of New England's forests incorporated a random subsample of field plots from prior surveys, with current survey field plots selected from a large population of regularly located interpreted points on aerial photographs (Barnard 1978). Field data were analyzed and a series of tabular information was published as USDA Forest Service Resource Bulletins by state.

Forest owner resurveys use the same sample plots as did the forest resource survey. A questionnaire was sent to the owner of each of the sampled field plots. Several follow-up efforts, including a personal visit where necessary, ensured an adequate response rate. As with the forest resource data, the owner data were analyzed and published as USDA Forest Service Resource Bulletins.

The current survey shows that forests cover 73 percent of the land area of the five states considered here, and forest acreage is slightly less than 15 million acres. Total forest acreage has changed little from the prior surveys.

The survey reports detailed information on that portion of the total forest acreage defined as timberland, or that forest land producing or capable of producing more than 20 cubic feet of wood per year and not administratively withdrawn from timber utilization. Timberland acreage constitutes 96 percent of all forest acreage in New England—a constant proportion over the past two surveys. Changes in timberland resources between the two surveys have been not in major acreage gains or losses, but rather, in forest structure that may have altered the character of habitat and its potential to provide quality habitat for a variety of faunal species.

Maturation is the most obvious trend in the forests of New England. Stand-size—a classification of forest land based on the predominant tree size class—is a rough indicator of age. Stand-size of New England forests has become dominated by the largest size class, sawtimber-sized stands (Figure 1). These are stands with a plurality of sawtimber-sized trees, trees larger than 9.0 inches (conifers) or 11.0 inches (deciduous) diameter at breast height (dbh). Only a decade age, the forests were more structurally diverse; that is, sawtimber-sized stands were equal in area with the next smallest size class, poletimber-sized stands. Sapling- and seedling-sized stands are becoming regionally scarce, constituting only 8 percent of the timberland area in New England at the current survey.

As the trees grow larger and forests age, structural changes occur that affect habitat potential. Larger trees generally have larger crowns. For common mast-producing species, such as the oaks (*Quercus* sp.), hickories (*Carya* sp.) and American beech (*Fagus grandifolia*), a larger crown yields a larger potential mast crop (Tubbs et al. 1987). Larger trees also provide a greater potential for primary and secondary cavity nesters that are limited by minimum tree diameters, such as the pileated woodpecker (*Dryocopus pileatus*) (Tubbs et al. 1987).

A disadvantage of the increasing stand-size of the forest is the suppression effect it has on the understory plant community. Our survey of understory woody-stemmed species indicates that twice as many sapling, seedling and shrub stems are found per acre in sapling/seedling-sized stands (14,378 stems/acre) than in sawtimber-sized stands (7,240 stems/acre). These plants serve as cover, forage, and/or nest sites for many wildlife species. As the forest matures to a sawtimber condition, the failure to replace maturing stand with younger stands, or without periodic thinning of the overstory, will result in a regional decline in understory plant production.

Probably the most detrimental consequence of the change in forest stand-size distribution is the increasing lack of spatial diversity in New England forest cover.

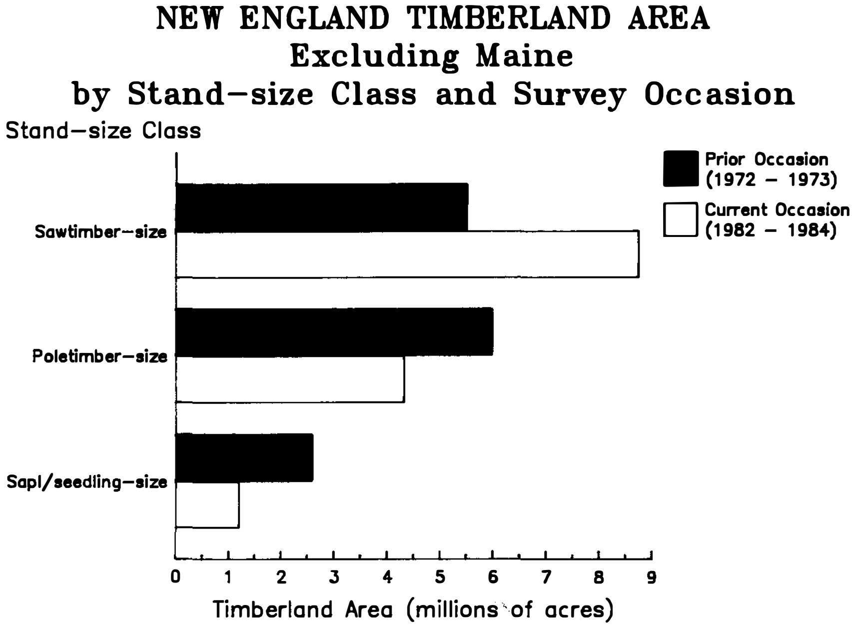

Figure 1. Distribution of timberland area by stand-size class and survey occasion for five New England states.

The failure to replace young stands maturing into the poletimber-size class and larger is resulting in a loss of an important cover type. DeGraaf and Rudis (1986) listed numerous species that use or require early successional forests. We can expect, without these habitats, to observe fewer American woodcock (*Scolopax minor*), chestnut-sided warblers (*Dendroica pensylvanica*) and other species that require similar habitat.

The change in forest structure over the past decade is also illustrated by the increase in acreage in fully stocked and overstocked stands. Stocking is a measure of the occupancy of land by trees relative to a standard optimum for forest growth. Stands should be less than fully stocked for the maximum growth of both trees and the understory plant community. Fully stocked and overstocked stands result in stagnant tree growth, increased tree mortality and a poorly stocked understory.

Figure 2 illustrates the distribution of New England timberland acreage by stocking class. Two assessment standards are shown. The change between survey is documented by stocking of growing-stock trees—trees with minimal or no defect. At the current survey, growing-stock is compared to all-live trees to illustrate the actual condition of the forest.

The predominance of fully stocked to overstocked stands at the current survey is clearly evident. This condition is even more evident when considering all-live tree stocking. When forests are in this stocking condition, all forest vegetation is severly suppressed (Spurr and Barnes 1980). Tree crowns are restricted and mast potential

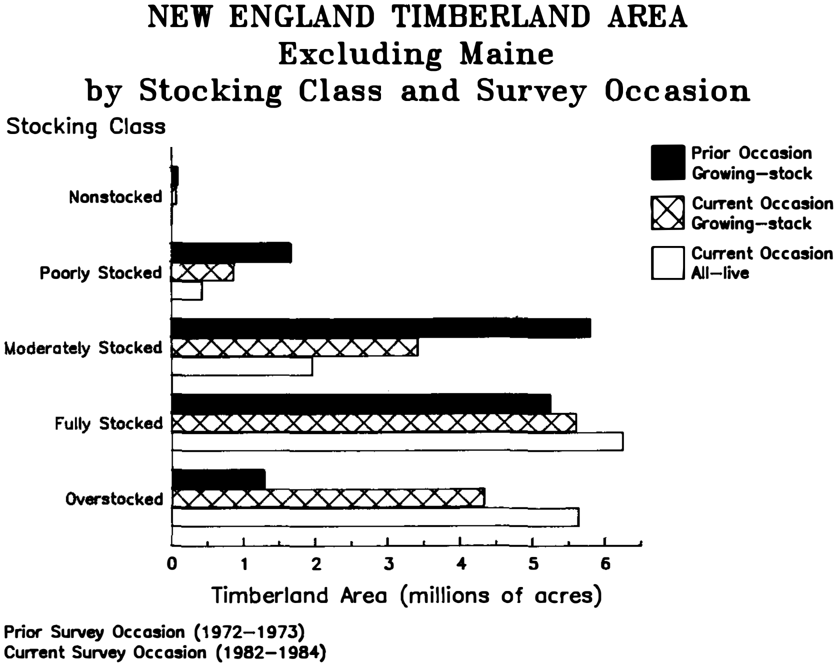

Figure 2. Distribution of timberland area by stocking class and survey occasion for five New England States.

is reduced. The overstory is fully occupied, allowing little sunlight to reach the forest floor, suppressing understory and midstory plant productivity. This results in less forage, understory mast and cover.

A positive aspect of overstocking is that suppression is one of the most common precursors of tree mortality (Spurr and Barnes 1980), resulting in a potential increase in tree cavities. Dead trees are the tree class most commonly found with observable cavities. In the New England states, FIA estimates that 21 percent of all standing dead trees have a readily observable cavity. This compares with only 6 percent of all-live trees. Sixteen percent of rough or rotten cull trees have an observable cavity.

We are unable to estimate the change in the numbers of standing dead trees between the surveys as we did not sample dead trees at the prior survey. However, growth and yield mortality rates, reported as cubic-foot volume, have increased approximately 190 percent from the prior to the current survey. Such a large increase strongly suggests an increase in the numbers of dead trees between surveys. The numbers of cull trees seems to have declined between surveys, from 496 million to 444 million. This perceived change is not certain, as cull-evaluation criteria have been redefined between surveys. Additionally, the growth of many trees from poletimber- to sawlog-size changes the cull-evaluation criteria.

In conclusion, we have found that the situation in New England's forest is similar to that in Ohio (Brooks 1986) and elsewhere in the Northeast (Brooks and Birch 1986). The forests are steadily maturing as one would expect. Without more frequent regeneration harvests, regular selection harvest entries, or periodic thinnings to capture forest growth, New England forests are becoming extensive areas of a single stand-size class. While productive for wildlife favoring these conditions, it is far less productive for species of earlier seral stages (Capen et al. 1979). Species requiring a rich and vertically diverse forest flora, and species requiring mixed conditions of forest, brushlands and fields, will suffer.

We recommend the promotion and application of forest cutting to enhance cover type diversity and to change the wildlife habitat structure now found in New England forests. However, the wildlife managers of this region have little direct jurisdiction over the forest land resource base that is owned predominantly by private individuals.

The Private Forest Owner

General forest ownership patterns have changed little over the past decade between surveys. Public ownership has accounted for roughly 12 percent of the timberland acreage at both surveys. These are predominantly national forests or state forests, with county or municipal forests totalling much less acreage. Forest management on federal and state lands is frequently a major objective of ownership, and wildlife habitat considerations often are institutionalized within management policy, e.g., National Forest Management Act (16 U.S.C. 1600 (note)). County and municipal forest lands are managed less frequently, usually because of a failure to recognize the opportunities for and potential rewards of forest management (Archey and Mawson 1985).

Forest land in private ownership in the five New England states is essentially nonindustrial. Forest industry lands constitute about 10 percent of the total timberland acreage, down from 13 percent at the prior survey, and are found principally in northern New Hampshire and Vermont. Other corporate forest lands are roughly 6 percent of timberland acreage and widely distributed throughout the region. "Other private holdings" include a collection of clubs, camps an partnerships that collectively own 8 percent of the private timberland. The remaining 9.6 million acres of timberland, or 2 of every 3 acres, are held by private individuals as either part of their farm, homestead or other private holding. These acres are owned by 476,000 individuals.

Privately owned timberland acreage is relatively unchanged from the prior survey. The number of private forest owners has increased by approximately 160,000 owners. These changes are equivalent to a decrease in average ownership size between surveys from 28 to 20 acres of timberland. The number of owners in the smaller size-classes has increased from the prior survey as has the number of forest acres owned (Table 1). While the majority of all forest owners own less than 10 acres, the majority of privately held forest acreage is in ownerships larger than 100 acres. This pattern is the same as found at the prior survey occasion (Table 1).

The implications of these changing individual forest ownership patterns are significant. The increase in numbers alone makes the communication of habitat management opportunities more difficult. The use of mass media communication, especially the electronic media, is essential. The more complicating trend is the reduction in timberland area per owner. As area declines, forest management becomes less commercially viable. As the forest is subdivided into increasingly smaller parcels, the opportunity for using timber harvest to support habitat management is less feasible.

Table 1. Number (in thousands) of private timberland owners and private timberland area by ownership size class and survey for New England states excluding Maine.

Ownership size class	Owners (numbers) Prior survey	Owners (numbers) Current survey	Area (acres) Prior survey	Area (acres) Current survey
1–9 acres	195.0	344.2	583.8	792.1
10–19 acres	44.4	52.7	551.3	721.5
20–49 acres	51.9	56.4	1,502.2	1,705.1
50–99 acres	29.0	28.5	1,903.1	1,901.5
100–199 acres	18.7	18.4	2,288.5	2,344.6
200–499 acres	8.1	7.6	2,167.1	2,102.5
500+ acres	1.8	2.1	3,528.9	2,955.3
Total	348.9	510.0	12,524.9	12,522.7

Consequently, managers promoting habitat management on small, private forest ownerships must resort to combining abutting ownerships into minimally viable management areas and promoting innovative programs to attract large numbers of small-acreage owners (Barske 1972, Decker et al. 1979, Morrill and DeGraaf 1981, Sandt 1983, Stoddard 1988).

The predominance of private timberland area in large-acreage ownerships supports effective habitat management. By working with only a few individuals or industries, a habitat manager can influence habitat quality on large acreages. What is lost when working with owners of large acreages is the development of a supportive public constituency. More individuals can be reached when working with the more numerous owners of small forest parcels.

The social and economic characteristics of individual private timberland owners influence their attitudes towards forest management. Changes in owner characteristics should be considered by habitat management agencies when developing or improving habitat management programs.

In general, the individual private owner is younger, more educated and has a higher income level than that those of only 10 years ago. We have found a large increase in younger owners who individually own smaller acreages. At the prior survey, we found the youngest age class to own an average 15.4 acres of forest land; at the current survey, this had declined to 8.9 acres. The regional pattern describes a rapidly growing population of young families moving into rural subdivisions of forest land.

The median education class of individual timberland owners has increased between surveys, from those with high school experience or diploma to those with undergraduate college experience or a degree. Those individuals with some graduate college experience or an advanced degree are the second-largest education category. Income levels of individual forest owners reflect the rise in education level and past wage inflation trends. The predominate income category is now over \$30,000, whereas only 10 years ago it was in the \$10,000–30,000 income class.

It is quite clear that New England forest owners are better educated and have larger family income than was the case at the previous survey. This implies that wildlife management agency programs can be more sophisticated in composition, appropriate to the advanced educational level of the forest owners. The programs can appeal to values and rewards in addition to the generation of income. These results are supported by Alexander and Kellert (1984), who found that private individual forest owners are primarily interested in intangible benefits of forest ownership rather than in economic gain.

While the characteristics of the New England forest owner has changed to some extent between surveys, a more dramatic change that influences the opportunities for wildlife habitat management has been the change in attitudes toward and experiences with timber harvesting. If forest habitat management is to have an extensive and significant impact, it will have to be associated with commercial forest management and the harvest of timber for wood products. While private individual owners are not primarily motivated by economic gain to manage their forests, the opportunity for timber harvesting to subsidize habitat improvement will most certainly motivate a larger number of owners to pursue this activity. Additionally, owners may be willing and have the financial resources to undertake noncommercial silvicultural activities in an effort to improve habitat conditions, e.g., precommercial thinnings, regeneration of noncommercial stands.

At the prior survey, 66 percent of the private forest owners stated they never expected to harvest timber. These owners controlled 24 percent of the forest resource. Only 10 years later, 29 percent of the owners answered that they never harvest timber, and they owned only 9 percent of the forest acreage. Conversely, owners stating they intended to harvest within the next 10 years rose from 10 to 45 percent of all private forest owners. The change in forest acreage on which the intended harvest was to occur rose from 40 to 75 percent. Obviously, attitudes have changed and there is a far greater acceptance of the cutting of forest trees. The fuel oil crisis of the mid-1970s and the maturing of the timber resource changed many attitudes. The immediate availability of an inexpensive fuelwood resource overcame many inhibitions concerning harvesting, and owners of large trees now perceive their commercial value and are more likely to allow harvesting.

Those forest owners who presently intend not to harvest are principally those who express a conceptual opposition to the cutting of trees. The first two most commonly given reasons for not wanting to harvest timber are (1) a basic opposition to harvesting and (2) a perception that harvesting will ruin the scenery. While the numbers who do not intend to harvest have declined between surveys, those remaining in that group do so for philosophical reasons. At the prior survey, a lack of intent to harvest was frequently supported by a concern about the appropriateness of timber harvesting on their forest land, given its perceived lack of silvicultural maturity.

Those who had harvested timber from their forest land expressed a variety of justifications for this activity. Harvesting for the owners own use was most frequently stated at the current survey, while a need for money was most frequently given at the prior survey. The second most frequently mentioned justification at both surveys, and one of great concern for the continued vitality of the habitat resource, is harvesting in the process of conversion from forest to some alternative land use.

A final observation regarding timber harvesting that has changed dramatically between surveys is the knowledge forest owners have regarding sources of forestry advice and assistance. At the prior survey, a majority of owners stated they did not know a source for forestry information. While these were mainly owners of small acreages, they nevertheless controlled a significant timberland acreage. Ten years later, a strong plurality of owners now know to use a variety of public agencies as sources of forestry assistance.

These attitudes and knowledge skills of the New England forest owner create a different management situation than presented only 10 years previously. The interests and values of the private forest owner continue to be dominated more by noncommodity rewards such as recreation, than by a desire to produce a merchantable product. Nevertheless, attitudes toward the use of forest harvests have improved, and this management device is readily acceptable. Modifications of traditional harvesting guidelines to enhance forest habitat resources are increasingly available to both the professional and the interested lay person (Brenneman 1984, Decker et al. 1983, Hassinger et al. 1979).

Conclusions

The maturing of the forest toward a uniformity in age composition and structural condition results in reduction in both inter- and intra-forest diversity. Across the entire timberland resource, landscape diversity is reduced by the failure to convert significant forest acreage to younger age classes. Faunal species that rely on early successional forests, as well as species favored by an interspersion of successional conditions, are negatively impacted. Within the forest stand, structural conditions are simplified. Vertical diversity is reduced by the suppression of understory and midstory vegetation. The reduction in potential nesting and foraging habitats most certainly results in an impoverishment of the faunal community.

The solution is to pursue actively a balance of age classes in the new England forest. This should include not only stands allowed to succeed beyond silviculture maturity to "old-growth," but also regenerating early successional stands.

While the condition of New England forest habitat is becoming one of concern, the opportunities for improvement are available. Forest ownership patterns and the attitudes, values and characteristics of forest owners offer a complicated but supportive audience for the acceptance and implementation of habitat management activities.

Acknowledgments

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Leopold's Land Ethic—Still a Worthy Goal[1]

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Introduction

Nearly 120 years ago, Thoreau (1868) expressed his concern for the clearing of trees and underbrush from the land: ". . . if some are prosecuted for abusing children, others deserve to be prosecuted for maltreating the face of nature committed to their care." This appears to have been one of the first expressions of a social concern for the land and nature. Aldo Leopold (1935), in an early expression of a maturing idea, stated: "I plead for positive and substantial public encouragement, economic and moral, for the landowner who conserves the public values—economic or aesthetic—of which he is the custodian."

Leopold (1949:203) further developed and expanded these ideas into his "most enduring contribution" (Flader 1974:270) called the "land ethic": "There is as yet no ethic dealing with man's relation to land and to the animals and plants which grow upon it. . . . The land relation is still strictly economic, entailing privileges but not obligations. . . . Obligations have no meaning without conscience, and the problem we face is the extension of the social conscience from people to land." Further, Leopold stated that "No important change in ethics was ever accomplished without an internal change in our intellectual emphasis, loyalties, affections, and convictions. The proof that conservation has not yet touched these foundations of conduct lies in the fact that philosophy and religion have not yet heard of it. In our attempt to make conservation easy, we have made it trivial."

Numerous authors have published recent tributes to Aldo Leopold and his work (Allen 1987, Callicott 1987a, McCabe 1987a, 1987b, Meine 1987, Swanson 1987a, 1987b, 1987c, 1987d, and Tanner 1987) as part of the 1987 centennial celebration of his birthdate. All of these accounts of Leopold's life and influence reflected the highest respect and admiration for this man. During his lifetime, he represented a unique combination of roles, including scientist, philosopher, forester, wildlifer, professor and writer. The purpose of this paper is to examine current forest land uses in the southern United States, and to evaluate these uses with respect to Leopold's land ethic.

"Land Ethic" Revisited

In-depth analyses of the land ethic have recently been presented by Callicott (1987b), Dasmann (1987) and Shaw (1987). Regarding our progress toward an extension of ethics to the land in this country, Dasmann (1987) was moderately impressed with the progress made to date. Shaw (1987:470) was rather emphatic

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with the opposite viewpoint: "If the land ethic has taken root in the way envisioned by Leopold, its effects are far from evident". Furthermore, Shaw (1987) outlined four shortcomings of the land ethic:

1. too much reliance on social pressure for respectable land use rather than legal restraints;
2. difficulty in applying "social pressure" to large groups of landowners who are abusing the land;
3. too high a proportion of the human population lives separated from the land and is not familiar with land conditions.
4. a major disparity exists between short-term benefits and long-term costs of land-use practices

The latter point was emphasized recently by Herbert L. Stoddard, Jr., who, as a teenager, met Aldo Leopold several times on trips to Wisconsin with his father, H. L. Stoddard, Sr. (described as a "good friend" of Leopold's). Mr. Stoddard, Jr. lives in southern Georgia and manages his plantation with the land ethic in mind. When asked whether or not we are making progress toward implementing the land ethic, Mr. Stoddard responded that we are making little or no progress because most people manage their land for "short-term economic performance" (personal communication).

Forestry/Wildlife Relations

Leopold was trained as a forester and spent much of his time dealing with forestry in both professional (early days as forest supervisor) and practical (planter of trees in Wisconsin) situations. Leopold was believed to be instrumental in a gradual shift away from the conservation of the Gifford Pinchot era and toward an ecological orientation based on field research (Wallace 1988). Leopold's book, *Game Management* (1933), was a major early contribution to the existing literature on forestry/wildlife relations.

Despite the early common origins of the disciplines of forestry and wildlife management, they often have become over the years strange bedfellows. Much of the acrimony between the two disciplines has evolved from different value systems and different objectives regarding resource management and use. Good forest management fostering economic returns on investments does not translate into good wildlife management and vice versa. Handling of controversy has become a major part of forest management in many regions of the country, as evidenced by concerns over clearcutting, timber-production quotas and schedules, harvest of hardwoods, road construction on national forests, and maintenance/protection of habitats for spotted owls (Northwest) and red-cockaded woodpeckers (Southeast). These controversies have typically reflected the value systems of diverse interest groups challenging the economic priorities of landowners. This scenario appears to represent a modern interpretation of Leopold's land ethic; its strict application to the "real world" was controversial (perhaps untenable?) in Leopold's time and remains so today.

Forestry in the South

In the southeastern United States, the pine belt is expected to play a major role in the future production of pulpwood and other forest products; about 96 percent of the pine forests in this region are categorized as "commercial" forests (Lassiter 1985:34). There are a number of ownership categories for forest land, and it is useful to distinguish three of these: (a) private, nonindustrial; (b) private, industrial; and (c) public lands. The private, nonindustrial forests constitute about 70 percent of forested lands in the southeastern U.S. (Lassiter 1985); owners include people who own the land for a variety of reasons (e.g., timber production, hunting leases, land speculation, etc.). Private, industrial forest landowners own about 20 percent of forested lands and have as their primary objective the production of timber and timber products. Public lands (e.g., national forests, military bases, national parks, refuges, etc.) constitute several large tracts in each state (especially Florida), but represent a relatively small proportion (10 percent) of the total forested area. Private sector ownerships, therefore, are expected to contribute substantially to meeting future demands for forest products as well as recreation in the region. Pine plantations are used extensively throughout the region for production of slash pines (*Pinus elliottii*), loblolly pines (*P. taeda*) and several other species of softwoods depending on the site characteristics. It is expected that efforts to increase forest productivity will focus on pine plantations in the South for several more decades.

Intensification probably best describes land-use practices on most lands in the region, with industrial forests providing some of the best examples. Trends toward forest-management intensification (Marion and Harris 1982) generally refer to: (a) a greater proportion of even-age pine plantations as compared to naturally regenerated pine forests; (b) more within-stand stocking control through planting and spacing configurations; (c) greater use of site amendments (e.g., ditching, bedding and fertilization); and (d) increased efforts to suppress competition from understory hardwoods (using prescribed fire and/or herbicides).

In general, the objective has become one of developing an even-age "regulated" pine forest that can be harvested in blocks selected by computer after 23–30 years of growth. This system has probably evolved more from a desire for accountability in forest management than through any planned disregard for other resources on the land. Very few incentives exist in this country for private landowners to provide for social values. Thus, southern pine forestry has had an increasingly utilitarian motive over the last few decades. In this context, it is difficult to see direct applications of Leopold's land ethic on large portions of the southern landscape.

Management of national forests has been and remains controversial despite three major Congressional actions to try to alleviate problems that developed in the 1940s and 1950s with a major emphasis on timber production from the national forests. The Multiple Use and Sustained Yield Act of 1960 mandated that national forests be administered for "outdoor recreation, range, timber, watershed, wildlife and fish purposes" on a "sustained-yield basis." In 1964, the Wilderness Act recognized wilderness as another legitimate part of multiple use, and set aside millions of acres of national forest lands to be "forever wild." Despite these two laws, the U.S. Forest Service continued intensive efforts toward increased timber production on national forest lands.

The National Forest Management Act (NFMA) of 1976 required the Forest Service to prepare Land and Resource Management Plans for individual units of the National Forest System. According to NFMA regulations, each plan must consider all renewable natural resources, assure that land management not inhibit multiple-use productivity, recognize ecological relationships among plants, animals and their environment, and consider all relevant biological, physical, economic and social factors. Thus, NFMA was an attempt by Congress to mandate several elements of a "land ethic" similar to the one described by Leopold for the management of national forest lands.

Despite these efforts at legislation and mandates for managing the national forests nationwide, timber production still appears to be the primary purpose of national forests, with other uses accommodated to the extent that they do not interfere with timber production. Despite NFMA, the Forest Service proposes nationwide to increase logging 72 percent over recent harvest levels, to build more than 580,000 miles of new or reconstructed logging roads during the next 50 years, to incur more than $2 billion of losses in deficit timber sales, and to recommend for wilderness only one-eighth of national forest wildlands being formally reviewed for wilderness designation. It is, therefore, difficult to see where Leopold's land ethic has been incorporated into the development of the Land and Resource Management Plans for the national forests. Public interest groups have been demanding that more consideration be given to nontimber values on national forests, to the extent that Land and Resource Management Plans are being re-examined in many states and some of the final decisions may result from litigation in court.

Landowners in the South (as elsewhere) have generally had a utilitarian attitude toward the land and land-use practices incorporated into daily life. Recent growth in the popularity of leasing forest lands in the South for recreation (especially hunting) indicates another area where utilitarian values rein supreme—most landowners who lease land for hunting take advantage of native game populations but do little long-term favorable habitat management to benefit these wildlife resources directly (Lassiter 1985). There does not seem to be a value system within people that deals with land ethics *per se*. One needs only to review statistics on draining of wetlands and losses of bottomland hardwoods from an original 23 million acres to the current 5 million acres in the region (Harris 1984) to see where priorities have been, and to conclude that Leopold's land ethic has *not* been foremost in these people's minds. Karr (1981:181) also noted "progressive deterioration in land resources because few recognize the 'land ethic' philosophy." In the same vein and much to the dismay of many landowners in the South, poaching of game, illegal rural dumping and vandalism problems continue to plague the rural forested landscape. These problems certainly do not reflect the elements of Leopold's vision of "respect for the land."

Promising Horizons

The picture is not entirely bleak, however, and there are some situations where Leopold's inspired idea may be leading toward cultural reality (see Tanner 1987). A major way in which Leopold's ideas on land ethics may become reality is through the ecological awareness and concern that has marked the 1970s and 1980s. A healthy skepticism has developed toward a wide variety of traditional priorities and policies regarding land use and abuse. The re-examination of U.S. Forest Service Land and Resource Management Plans in many states appears to represent an effort by public interest groups to insist on management of national forests through guidelines resembling Leopold's vision for the land. The terminology being used is beginning to reflect a sensitivity to this issue—"timber" has given way to "forest," and "species diversity" has given way to "biological diversity" (Norse et al. 1986).

Our ability to deal with land abuses normally depends on priorities and funding levels, which have been grossly inadequate in the last several decades. The current, huge federal deficit and general lack of state funds will necessitate a continuing struggle to improve land conditions nationwide. One program—the Conservation Reserve Program (CRP), developed as part of the Farm Bill of 1985—shows some promise for providing landowners with financial incentives and technical assistance to remove highly erodible farmlands from crop production and grazing pressures. Although all options in the CRP have not been fully developed and implemented, reduction of erosion is a commendable goal. As stated by Dasmann (1987:113): "If efforts to conserve biotic diversity are to succeed, nature conservation must become a part of the total land use pattern . . . . Sustainable use and management must have a role. This is a Leopold doctrine. It is needed today more than ever."

Even though these programs may not be directly linked to Leopold's land ethic, the development and incorporation of nongame and endangered species programs at the state and federal levels could be interpreted as steps toward Leopold's goal. Certainly, the existence, awareness and public support of these programs have favored a more complete consideration of wildlife and their habitats, and this is related to the land ethic.

Integrated forest management is occurring on a number of private holdings in the southern United States to accommodate wildlife and other resources providing personal enjoyment. In some of these cases, landowners are not directly dependent on the land for their primary income, and they are not as utilitarian as most forest landowners. Also, some families in the region with large holdings are doing an extraordinary job of land management, and are encouraging their forests to develop under an uneven-age, long-rotation regime. The old southern plantations near the Florida/Georgia border, although typically managed for quail (and sometimes in a very utilitarian manner), probably represent some of the most aesthetically and ecologically interesting forestlands in the South. They also may represent some of the best examples of the spirit of Leopold's land ethic.

In summary, Leopold's land ethic remains as a worthy, visionary goal that deserves more attention and incorporation by a variety of forest landowners and managers nationwide. Progress toward capturing the true breadth and spirit of the land ethic has been slow and is expected to remain so as long as economics and utilitarian values dominate the scene. Further development of ecological awareness and understanding in the general public is expected to move us closer to Leopold's visionary goal by assuring better recognition of and respect for the land. Continued and (in some cases) increased skepticism and positive input regarding public forest land management is expected in future decades and may move us closer to Leopold's vision. Several provisions of the Farm Bill of 1985 provide both financial incentives and technical assistance to promote other, less destructive uses of the land, and this is an important aspect of land ethics. The growth and public support associated with nongame and endangered species programs at state and federal levels provide some support for the idea that we are more concerned than previously about wildlife and wildlife habitats. This is inherent in what Leopold said about the land ethic. Some examples do exist where forest landowners are cognizant of and manage for a variety of forest values and uses. A major challenge remains the innovative development of incentives for many private landowners to manage their lands with an appreciation of and management strategy to favor long-term social values of the land.

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Integrated Timber/Wildlife Management Through Education of PNIF Owners

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Introduction

Private nonindustrial forests (PNIFs) are typically held for many reasons. However, most management efforts are oriented to timber production, while wildlife is considered to be a significant secondary crop that is a natural by-product of the forestland. Virtually all PNIF owners appreciate wildlife on their land for the psychological benefits they reap just from knowing the animals are present. As such, wildlife, for the most part, is considered a consumer good, yielding nonmonetary benefits. But few owners apply management practices specifically to benefit the wildlife, although some timber management practices have important wildlife benefits as well. The potential exits to improve both wildlife habitat and timber productivity on PNIFs through an integrated approach encompassing management for both benefits.

PNIFs, encompassing some 58 percent of the commercial forestland in the U.S. (Birch et al. 1982), have long been considered a ''problem'' by resource managers and policy makers alike. Heterogeneity of holdings and diversity of owner characteristics, motivations and objectives are, of course, the underlying causes. Common ''problems'' usually associated with PNIF ownerships include inefficiency associated with small-size holdings, lack of owner interest (or attitude, objectives and motivations for holding forestland) in management, and lack of knowledge of opportunities and forest management and timber sale procedures. Also, lack of investment capital, need to liquidate stands to raise cash, lack of adequate markets and long investment period with uncertain payback are frequently encountered. Any of these problems indirectly affect any efforts on the parts of owners to enhance wildlife habitat on their lands.

Education of PNIF owners is seen as a means of providing them the necessary background for achieving their individual goals while improving productivity of woodlands to help meet national objectives (Deneke and Fischer 1985). In contrast, wildlife agencies generally have been concerned with PNIF ownerships largely from the viewpoint of minimizing posting and not with a view to promoting habitat improvements.

This paper addresses the relationship between timber production and wildlife habitat management on PNIF lands in terms of owners' education. Through planned approaches to PNIF owners that relate to a given objective they hold for their forestland, management practice application can be encouraged and implemented that will lead to accomplishment of both the timber and wildlife objectives.

Studies in the northern U.S. suggest to us that there is potential for benefit in this situation for both the forestry and wood products community and the wildlife community. That is, planned silvicultural treatments can enhance wildlife habitat on PNIF ownerships. Also, landowner interest in wildlife offers a ''hook'' for gaining their interest in multiple-use management for timber.

PNIF Owner Decisions

The complex management practice adoption decision process of PNIF owners has been conceptualized in the following model (Figure 1) that details the factors influencing an owner's decision (Kurtz et al. 1983). Components of the model are identified with respect to the position each occupies relative to the others in an owner's decision to adopt and implement a given management practice. Educational and technical assistance serve as interventions between an owner's general attitude toward management and his/her perception of specific management opportunities. Such programs are administered through one of the state or federal agencies charged with the responsibility of landowner education or through private consultants or forest products company-sponsored programs.

This model of the owner decision process helps us examine the manner in which owners' decision might be influenced by educational programs. Specifically, we are interested in encouraging wildlife management indirectly through an attempt to attain a timber management objective. We will examine the results of a study of PNIF owners in northcentral Wisconsin (Marty 1983) to ascertain the possibilities of such relationships. This study was undertaken initially to compare types and characteristics of PNIF owners in Wisconsin to owners in the Missouri Ozarks (Fairweather 1979, Lewis 1979, Trokey 1981).

How Wisconsin PNIF Owners Viewed Wildlife

A random sample of PNIF owners in a nine-county area of northcentral Wisconsin yielded three major typologies of owners, based on their common attitudes toward forest management concerns (Marty 1983). Owner motivations and objective formed the bases for positive and negative statements, which were then sorted along an agree-disagree continuum for grouping using the Q-sort technique (Stephenson 1953) to define owner typologies based on the relative positions of the various statements. The three typologies of owners were descriptively titled ''Resource Conservationist,'' ''Forest Recreationist'' and ''Forest Utilitarian.''

Resource Conservationist owners are the most timber production-oriented of the three types with a dominant attitude of resource stewardship. Wildlife is very important to this owner and is in keeping with a concern for the forest environment; its presence provides a great deal of satisfaction. This owner recognizes the influence of forest management on wildlife and manages for (or at least to avoid damage to) wildlife where feasible. Approximately one-fourth of the owners interviewed are of this type, and they control approximately one-third of the commercial forestland.

The Forest Recreationist type of owner has a primary interest in recreational use of the forestland, although it does not preclude concern about resource stewardship, wildlife, timber production or other aspects of forest ownership. Wildlife is a dom-

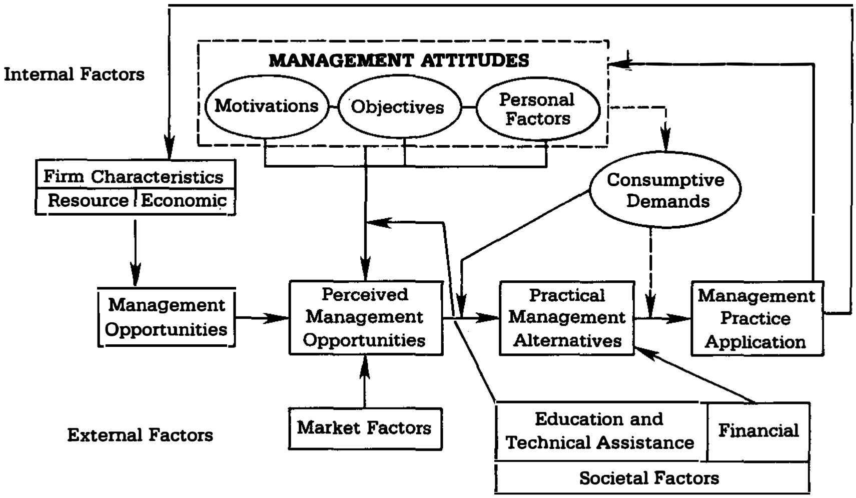

Figure 1. PNIF owner management decision process.

inant concern. These owners derive enjoyment from wildlife's presence and feel it increases land value. The impact of forest management on wildlife populations is recognized, and wildlife management activities are supported. Nearly one-third of the owners interviewed were Forest Recreationist types. They controlled more than 40 percent of the commercial forestland.

The last owner type identified was the Forest Utilitarian. This type has a propensity to utilize all of the products of the forest to meet short-term needs. The Forest Utilitarian also considers wildlife important and derives satisfaction from its presence. Unlike the other two types, however, this type obtains wildlife value through hunting rather than in an intrinsic way. These owners accounted for just over one-third of the owners interviewed, yet they control less than one-fifth of the commercial forestland acreage.

Interest in wildlife was expressed by all landowners. Statements expressing satisfaction with the presence of wildlife on the land and near homes were strongly agreed with by all respondents. Owners recognize that wildlife is an important element in the environment and needs to be managed through proper habitat and forest management techniques. Wildlife was mentioned as the primary management objective by only 3 percent of the PNIF owners interviewed—a sharp contrast to their selection of statements relating to the importance of wildlife. This reflects back on the consumptive good characteristic of wildlife, as mentioned earlier. Furthermore, only members of the Resource Conservationist and Forest Utilitarian types actually made such selections. This is understandable though, since these owner types lived on their land in the greatest proportions (more than one-third of them for all of their lives), and indicated that living on their land influenced management decisions. A more recent, comprehensive survey of PNIF owners in Wisconsin corroborates this finding (Roberts et al. 1986). Wildlife habitat was considered by nearly two-thirds of the owners contacted as being an important reason for owning woodlands. In addition, less than 10 percent of the owners had actually used professional management advice.

A study of why people live in the country explains such relationships to a considerable degree (Lionberger et al. 1979). Types of rural residents have been descriptively titled "Committed Farmers," "Reluctant Residents," "Nature Lovers," "Guests of the Country" and "Agrarian Cornerstones." Nature Lovers, for example, "will want to save the trees, preserve wildlife and protect the environment even at very high costs."

Forest management activities to directly benefit wildlife had been applied to a fairly substantial degree by the sample of owners:

Activity	Resource conservationist	Forest recreationist	Forest utilitarian
Habitat improvement	48%	40%	26%
Leave dead trees standing	18%	26%	8%

At least one-third of the owners had conducted some form of wildlife habitat improvement. The two groups containing the largest proportions of owners who had conducted wildlife habitat improvement were the Resource Conservationist and Forest Recreationist. These two groups had the highest representation of individuals who harvested timber as part of a management plan and had completed timber inventories—obvious indications of interest in timber management.

The Resource Conservationist and Forest Recreationist types of owners were the most active groups in terms of participation in public forestry assistance programs, particularly the Wisconsin Department of Natural Resources. Seventy-five percent of the Resource Conservationist, 32 percent of the Forest Recreationist and 23 percent of the Forest Utilitarian types had experience with this agency. Other than forms of financial assistance, on-farm technical assistance was mentioned most frequently as the most desirable form of public forestry assistance. Yet, a preponderance of all owners indicated that public assistance programs had no influence on their attitude toward forest management.

In summary, PNIF owners, as types of individuals, have broad goals for use of their forestlands and seek information to attain them as the need is perceived. The more personal approach of having a resource professional visit their property is preferred, because the learning experience is more effective through the contact and opportunity offered to discuss management problems on-site. However, by segmenting categories of owners defined in terms of social and cultural meanings similar to the ones we have described, programs encouraging owners to adopt a particular management strategy can be designed to achieve optimal levels of implementation (Birch 1986).

Achieving Effectiveness in Getting the Message to PNIF Owners

We have stated previously (Kurtz and Irland 1987) that "present delivery systems for education are aimed at influencing the greatest number of owners rather than the greatest number of acres.'' Although our initial writing was related primarily to timber production on PNIF lands, the same argument can easily be made for integrated timber/wildlife management. This existing framework does not provide for the most efficient manner of allocating limited budgets. According to McDowell (1985), extension information is generally packaged for a broad spectrum of applicability so staff has little role after initial preparation and distribution. Though the aggregate user benefit from such an arrangement might be large, the value to individuals often is small because of the general nature of the information. In contrast, information that is developed primarily for individuals or groups often has considerable advantage in generating individual benefits.

It has been suggested that a marketing approach for providing services and programs to PNIF owners would yield insight regarding owner assistance needs (Irland et al. 1984). The marketing concepts of product line identification, market size and trend identification, market segmentation, product life cycle, and product recognition and awareness can be used in developing an effective strategy for PNIF-oriented program development, whether for timber or wildlife benefits. According to Lionberger et al. (1979), ''. . . identification of clienteles in terms of their basic value orientations offers a great potential for more effectively designing educational programs that serve their interests and needs.'' Thus, we see market segmentation as a key component in relating program content and approach to owners' needs.

Reaching Landowners Effectively: The Missouri Experience

Surveys by the Missouri Department of Conservation have shown the presence of a rural clientele willing to accept assistance in support of wildlife. Experience shows that assistance programs need not be complex or expensive (Sheriff et al. 1981). Nonetheless, differences exist between owners and society regarding wildlife on private lands. The key to success to gaining landowner cooperation is communication, particularly the exchange of relevant information by both parties.

An extensive study of the Cooperative Forest Management Program of the Division of Forestry, Missouri Department of Conservation, in which each agency forester in the state was interviewed, showed an acute awareness of wildlife and the importance of establishing relationships with owners in terms of their unique interests regarding use of their land holding (Kurtz 1986). Wildlife awareness was considered essential to any contact with PNIF owners because of pervasive landowner interest. Foresters viewed wildlife-related work as complementary to their forestry responsibilities because of the avenue to forest management provided through owners' interest in wildlife habitat management. They considered this to be especially significant for landowner relations because they felt that ''resource management advice must be consistent with owner objectives otherwise it will not be followed.''

New England PNIF Owners: Appreciation for Wildlife

A distinct appreciation for wildlife was expressed by a sampling of PNIF owners in Connecticut, Massachusetts and New Hampshire (Alexander 1986). However, in contrast to their expressed interest, few owners actually applied forest management activities considered beneficial to wildlife. In addition, the majority of owners felt that the best approach for wildlife would be either to ''leave things alone'' or ''maintain present conditions.'' Forestland was considered an important aspect of their lifestyle, however, imparting a sense of pride in its ownership and stewardship.

For the owners included in the above sample, the author felt that landowners needed to be convinced that application of forest management practices actually benefits wildlife, so that timber management could be used as a vehicle to achieve broader forest management goals. Relating to owners' predominant feelings toward their land and wildlife might be more effective in achieving some level of management rather than appealing to their limited interest in economic returns.

The Challenge for Reaching PNIF Owners

Achieving social change through PNIF owner education is possibly the foremost challenge facing today's forest and wildlife management professionals. Although subsidization of private investment in forestry practices on private lands is a rather widespread tool for encouraging the application of management practices, from the standpoint of stimulating net additional private investment, the efficiency of such programs remains questionable (deSteiguer 1983). To a great extent, forestry cost-sharing programs, though well-meaning, have inherent drawbacks that lead to inefficiencies in a social context and, given present evaluation methods, are difficult to assess accurately (Irland 1984). Also, available funds have limited these practices to only a fraction of potential treatment needs.

The more specific tasks of defining owner information needs clearly, coordinating agency actions effectively and choosing optimum communications techniques always will be at the forefront of educational concerns. However, broader, more strategic challenges lie ahead for those in planning and directing capacities for educational programs aimed at PNIF owners (Irland 1987).

1. *Adequacy of resources*—Increasing budgetary pressure on conservation programs, coupled with agricultural problems that have reduced the traditional political support base, places additional pressure on those agencies responsible for providing educational programs.
2. *Program targeting*—This is a means of achieving program efficiency by directing program emphasis toward the most serious problems or the most rewarding opportunities. This approach is vulnerable to the accusation of discrimination against those who are not within target guidelines, which is considered by some to be quite impolitic. Targeting is inconsistent with internal agency culture.
3. *Local control versus national resource goals*—Continuance of the entitlement ethic is virtually assured as long as local control of program activities remains dominant. Essentially, this limits consideration of national resource goals which should be important factors to consider in long-term strategic planning.
4. *Clear federal role*—A clear statement of the role of the institutional responsibilities at the federal level is necessary for state-level as well as private sector institutions to plan and function most effectively in landowner education. These local institutions are driven to some extent by federal policy and actions, usually reacting to federal initiatives. Clarity of purpose and intent at the federal level would enable them to utilize their strengths to their greatest effect.

Overall Implications

Ownership of PNIF lands changes constantly, with forested tracts changing hands on the average of about every 20–30 years. With this change comes a new challenge to educate new PNIF owners with different objectives for use of their lands (Carpenter 1985). Because wildlife is generally not considered in an economic context, but rather as a naturally produced consumer good, approaches to achieving wildlife habitat management must be related to owner interests.

Agency forestry personnel can be trained to be more sensitive to the importance of determining owners' objectives for their forestland. Likewise, educational programs can be designed to align more closely with specific types of owners and their particular management strategies to achieve integrated timber/wildlife management. In order to be most effective, however, program content must be "tailored" to fit individual owner needs and interests.

We have no doubt that artfully designed programs to promote timber management can benefit wildlife. Beyond this, landowner interest in wildlife habitat improvement can provide an important opportunity for increasing landowner motivation to engage in more active timber and land management.

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Treasure Forest—Alabama's Unique Approach to Multiple-resource Forest Management

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Background

Alabama's private, nonindustrial landowners own almost 75 percent of the nearly 22 million acres (9 million ha) of forest land in the state. A unique statewide cooperative effort by 12 state and federal natural resource management agencies has attacked the problem of low productivity, low intensity management, and insensitivity to wildlife habitat on these and other forest lands by the implementation of the TREASURE Forest program. The program features interagency teams on the county level working with forest landowners to develop multiple-use, sustained-yield management plans. Landowners who successfully implement these plans are recognized statewide by an awards program. The program requires the consideration of timber, wildlife, recreation, aesthetics, watersheds, and soil and water conservation in all management decisions. The impact of the program on the development of Alabama's total forest resource is evident and the program is gaining in acceptance and popularity among all segments of the forest resource management community.

Introduction

Alabama contains some of the richest natural resources in the continental United States. Of its more than 33 million acres (13 million ha), about 66 percent (22 million acres) is classified as commercial timberland (Rudis et al. 1984). The Conservation Reserve Program has the potential to take 1.4 million acres (566,800 ha) of marginal cropland out of agricultural use. At present, about one-half of the nearly 500,000 acres already in the program is planted in pines, and additional acreage is in wildlife habitat. Alabama's forest lands contain large, healthy and diverse wildlife populations that are comparable to those of any southeastern state.

Forest management varies greatly across ownership categories. Alabama's woodlands, like those of many southeastern states, are largely privately owned. Fully 94.6 percent of Alabama's forests are owned by private interests, with farmers owning 27.1 percent, forest industry another 20.6 percent, and nonfarm, nonindustrial owners 46.9 percent. The remainder of Alabama's forests, about 1.16 million acres (470,000 ha) or 5.4 percent, are managed by various federal, state and local governments. The controlling federal agencies include the U.S. Forest Service (3.2 percent), the

U.S. Fish and Wildlife Service, and various branches of the Armed Forces for a total of about 4.4 percent of Alabama's forest lands. The Alabama Forestry Commission, the Alabama Department of Conservation and Natural Resources, and various other state agencies own about 0.6 percent of Alabama's forest land, and other government agencies only about 0.4 percent (Rudis et al. 1984). By most economic indices, forestry is Alabama's largest industry (McKee 1986).

By law, most of the federal land and much of the state land are managed for multiple uses, and timber and wildlife fare well on these areas. Typically, forest industries in Alabama manage very well for timber production and practice a level of forest management generally beneficial to many wildlife species. In most cases, however, wildlife is an incidental product and, in only a few incidences, is it regarded as an income producer. Achieving that status in industry circles seems to be the key to deliberate attempts to improve wildlife habitat. Currently in Alabama, hunting rights and wildlife management are regarded by most forest industries as public relations tools that might or might not return adequate funds to recover the costs of road repair, wildfire, gates, locks, signs and increased supervision that result from opening lands to public hunting. A few industries, notably Gulf States Paper Company, have made extensive efforts to make wildlife management an integral part of their overall forest management plans, with an eye to making it also an income producer.

Without a doubt, the greatest potential for increasing the quality and quantity of Alabama's forest and wildlife resources lies in the private, nonindustrial sector. Although some of the best management examples may be found within this group, the norm is far below that found among other ownership groups. Much of this 16 million acres (6.5 million ha) of Alabama forest land is understocked, undermanaged, unburned and probably yielding forest products at about one-half their potential. There are various reasons for this situation, but lack of forest management knowledge and difficulty in obtaining proper assistance can often be pinpointed as the major problems.

Alabama Forestry Planning Committee

There are a dozen or so state and federal agencies in Alabama that provide natural resource management information and/or assistance to the general public. In many instances, duplication of effort or conflicting information has resulted from this multiplicity of resources. In 1971, in an attempt to coordinate state and federal assistance programs, 12 agencies formed the Alabama Forestry Planning Committee (AFPC) to encourage cooperation and reduce competition between the member agencies in offering assistance to the state's forest landowners. The AFPC is comprised of the following state and federal agencies: (1) Alabama Department of Conservation and Natural Resources; (2) Alabama Department of Education, Vocational Division, Agribusiness Education; (3) Alabama Forestry Commission; (4) Alabama Soil and Water Conservation Committee; (5) Alabama Cooperative Extension Service; (6) School of Forestry, Auburn University; (7) USDA-Farmers Home Administration; (8) USDA-Forest Service; (9) Alabama Agricultural Experiment Station; (10) USDA-Soil Conservation Service; (11) USDA-Agriculture Stabilization; and (12) Tennessee Valley Authority (Wade and Moody 1983).

The committee, consisting of the head of each participating state or federal agency, meets twice a year and formal actions are by consensus. Despite the expected difficulties, this arrangement has proved workable. In 1976, the AFPC appointed two special committees—one to coordinate service programs, and the other to coordinate educational programs. In 1983, a third committee was created to coordinate forest productivity programs. These three subcommittees are made up of staff members of the various participating agencies. They meet quarterly and report directly to the AFPC.

In 1981, the AFPC requested that forestry planning committees be formed on the county level. These committees, comprised of the county-level counterparts of the AFPC members, are charged with identifying and addressing forestry, wildlife and conservation issues in their respective counties. Most Alabama counties have responded by forming such committees. Much of the forestry activity in the state is now initiated at the county level.

TREASURE Forests

The AFPC has been involved in several successful programs in its short tenure, but the flagship program, particularly in regard to forest values other than timber, is the TREASURE Forest Program. The very name of the program is an acronym representing multiple-use, sustained-yield forest management: Timber, Recreation, Environmental enhancement and Aesthetics for a Sustained Usable Resource. The program was conceived in 1974, and the first TREASURE Forests were recognized in 1975. Since that time, about 535 forest landowners have received recognition as TREASURE Foresters.

In a typical sequence, a forest landowner seeking management assistance is identified by members of a county forestry planning committee. At that time, he is made aware of the TREASURE Forest program and urged to participate. If interested, he is asked to sign a TREASURE Forest Creed which pledges him to the concepts of multiple-use, sustained-yield management and protection of environmental quality. The Creed, like the TREASURE program itself, is nonbinding. The landowner's property is then listed as a potential TREASURE Forest and he becomes the target of a cooperative assistance effort in developing a management plan for his property that incorporates the precepts of the program. Ideally, the landowner would receive timber management advice from the various forestry agencies represented on the committee—wildlife management advice from Alabama Game and Fish biologists or other biologists on the committee, and general conservation and natural resources management counsel from SCS, ASCS or Extension professionals. Each landowner must identify primary and secondary management objectives chosen from among timber, wildlife, aesthetics, recreation, watershed and environmental enhancement. After adequate progress has been made toward achieving these management objectives, the landowner may be submitted as a candidate for TREASURE Forest certification. The district TREASURE Forest coordinator, an Alabama Forestry Commission district office employee, then appoints an inspection team for an on-site evaluation of the accomplishments of the landowner. At a minimum, this inspection team must consist of a graduate forester and a graduate wildlife biologist. Other natural resource professionals may also accompany and participate in the inspection.

A detailed inspection record is completed on each property. Information recorded includes acreages, age classes, forest types and accomplishments in the last five years in timber management, wildlife management and/or management for other chosen objectives. In addition, forest management plans for the next five years must be prepared, indicating planned changes in land use, anticipated timber harvests, future regeneration activities, protection schemes involving salvage, sanitation and wildfire, and the use of prescribed fire as a management tool.

The inspecting wildlife biologist must complete a checklist of accomplishments in wildlife habitat management. Questions cover prescribed burning practices, adequacy of den trees and snags, diversity of stand types and age classes, irregularity of stand boundaries, adequacy of mast production, wildlife species being managed, protection, harvest procedures, population levels, permanent openings, etc. These questions must be addressed by all landowners regardless of management objectives.

A third section of the inspection record summarizes the overall adequacy of conservation practices on the property, including protection of soil, water and air quality, with special attention paid to erosion control and stream protection. General appearance of the property is noted, although comments generally are limited to extremely unattractive situations, such as open dumps. When aesthetics or recreation is a management objective, a section on accomplishments in development and management of these resources is completed by the inspection team.

The completed inspection form, with the inspection team's comments and recommendations, is returned to the district TREASURE Forest Coordinator, often with supporting documents from the County Forestry Planning Committee. Use of the property for demonstrations or other educational or research activities is encouraged in the TREASURE Forest program and documentation of such use is also often included in TREASURE Forest applications. The District Coordinator then forwards the application, inspection record and supporting documents to the State TREASURE Forest Coordinator, a staff forester with the Alabama Forestry Commission.

The TREASURE program is administered by the Services Subcommittee of the AFPC, which is made up of the State TREASURE Forest Coordinator and foresters, biologists and natural resource specialists from several of the member agencies of the AFPC. The Services Subcommittee meets quarterly to evaluate TREASURE Forest nominations received during the quarter. Field personnel are urged to be on hand to answer questions about applications from their respective counties. The subcommittee rules on each nomination and results are returned through the district level to the appropriate counties. Applications may be approved for certification by the subcommittee, deferred for clarification or further information, or disapproved. In instances where nominations are disapproved, county planning committees and landowners are apprised of the reasons for disapproval and strongly encouraged to resubmit the application after corrective measures are taken. TREASURE Forest certification is valid for a five-year period. At the end of five years, the property is reinspected to ensure its continued compliance with the TREASURE Forest guidelines.

There are currently 535 TREASURE Forests in Alabama, containing 928,500 acres (374,400 ha). An additional 866 Creed signers, representing 378,000 acres (153,000 ha), are striving for TREASURE status. Any forest landowner in Alabama may qualify for TREASURE status regardless of ownership type. All forest land owned in the state must be considered, however, and a minimum of 10 acres (4.047

ha) is required. Existing TREASURE Forests range in area from 15 acres (6.07 ha) to 328,000 acres (132,793 ha). The landowner receives several small awards when certified as a TREASURE Forest owner and becomes eligible for statewide recognition. The Helene Mosely Memorial TREASURE Forest Awards provide annual monetary awards to the three TREASURE Forests judged best in their respective districts, and additional recognition is given to the landowner judged best in the state. At this point in the program, peer recognition and personal satisfaction appear to be the motivating factors for most TREASURE seekers. Interviews with TREASURE Foresters reveal a general concern for the land and for future generations.

It is revealing that almost 80 percent of the TREASURE Forest owners list wildlife as either their primary (12 percent, 53,960 acres) or secondary (68 percent, 823,087 acres) management objective. Only timber is mentioned more often, with some combination of the two being most common. Under the precepts of the program, the landowner must display numerous positive accomplishments toward his primary objective, several accomplishments toward the management of his secondary objective, and demonstrate management of his property in such a way as to minimize detrimental impacts on all other forest resources. These requirements ensure that wildlife values will be at least protected on every TREASURE Forest. Although there was no intent to downplay the importance of other resource uses, such as recreation and aesthetics, the TREASURE program places an emphasis on provisions for the protection of timber and wildlife resources.

An integral facet of the program is the presentation of the TREASURE award. Ceremonies with attending media coverage are strongly recommended, and the resulting publicity has generated an amazing amount of landowner interest in the program. Some of the most impassioned and effective spokesman for the program are TREASURE landowners themselves.

All agency personnel, TREASURE Forest landowners, TREASURE Creed signers and others involved in natural resource issues receive free of charge a subscription to the publication *Alabama's TREASURED Forests*. This attractive magazine is published quarterly by the Alabama Forestry Commission and contains management advice for all of the resources covered in the TREASURE program. It is oriented toward the private, nonindustrial forest landowner and contains "how to" articles by natural resource professionals from around the state. As of January 1, 1988, 7,650 people were receiving the magazine.

The TREASURE concept has begun to permeate the management assistance efforts of all the individual agencies involved in the program. Landowners participating in industry assistance programs are beginning to request more multiple-use management assistance as the TREASURE concept has gained in acceptance and popularity. Many forestry consultants use their records as managers of TREASURE-qualified lands as a selling point in their dealings with landowners. The Alabama Forestry Commission has recently contracted with several private consultants to spread the TREASURE doctrine throughout the state. In addition, the Commission has included a TREASURE Forest instructional unit in its Forestry Academy for all new employees. During February and March of 1986, the Services Subcommittee provided a series of training sessions designed to educate county-level agency personnel in the administration of the program. These sessions were held in 10 locations through the state and featured information on the AFPC and its programs, an overview of the TREASURE Forest program, and a detailed "how-to" session on management for each of the resources featured in the TREASURE program. These sessions were designed to enable agency personnel to assist in the development of management plans that would lead to TREASURE Forest certification. In addition, the sessions were expected to better prepare potential TREASURE Forest inspectors for evaluating TREASURE Forests.

The impact of the TREASURE program on the wildlife management being practiced on the participating forest lands is obvious. Not only is wildlife often a featured management objective, but consideration of wildlife habitat and welfare must be a part of every management decision. As the TREASURE Forest program grows, more acreage will be managed in this manner. Still, the acreage actually in the program is relatively small and does not reflect its impact on the management being practiced in the state. Many landowners and managers, although not active participants in the TREASURE program, have begun to adopt the concept in their management. General acceptance of multiple-use management has been increased through the program and through the emphasis placed on it by the member agencies of the AFPC in their everyday landowner assistance activities.

The Alabama Forestry Commission has taken the lead in implementing the TREASURE concept, but the key to the ultimate success of the program is the involvement of all management agencies, particularly on the county level. One of the highlights of the program is the appreciation gained by the members of the various agencies for their counterparts in other agencies. The interdisciplinary exchanges have been particularly rewarding for all involved, increasing understanding among natural resource professionals of the management implications of the various interrelated forest resources. The interagency nature of the program makes it unique, and the coordinated, cooperative effort is appreciated by landowners. Many landowners may never make it into the TREASURE program, but, as a result of the TREASURE Forest program, the concept of multiple-use management on a sustained-yield basis has become better accepted in Alabama as the most desirable forest management goal.

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Summary

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I have been asked to summarize the essence of the nine very fine and stimulating presentations at these two panels on woodland management. This morning, Larry Jahn charged us to generate new approaches, innovations and incentives for managing private woodlands. The presentors at this session certainly responded effectively to that challenge.

The Changing Clientele

Almost all of the presentors made it very clear that the owners of private, non-industrial forest (PNIF) lands are changing—socially, economically and in terms of their attitudes and preferences—and that the resource manager's perceptions of who these owners are and how they view their woodlands are also changing. Briefly, we have heard that:

- Nationally, PNIF lands are the dominant source of wood supply, and the nation must become even more dependent on them in the future if it wants to maintain reasonably priced supplies of wood.
- Most PNIF owners are relatively well-educated, white or blue collar workers or retired people. They are younger and wealthier today than were PNIF owners in the past. The proportion of owners who are farmers is declining. Farmers are no longer the majority. Absentee ownership is increasing. On the average, PNIF owners control relatively small acreages (<50 acres) although these ownerships vary greatly in size. The total number of ownerships has been steadily increasing, so there has been a continuing fragmentation of ownerships into smaller parcels. Average size of parcel is declining. On the whole, smaller parcels are less likely to be managed for timber production and are relatively more difficult to manage for wildlife, which do not respect ownership boundaries.
- Relatively few owners (regardless of the size of their woodlands) hold PNIF lands solely or even primarily for income enhancement. Most hold them primarily for wildlife, aesthetics, recreation or other activities related to personal or family enjoyment. Even those few who do hold their forests primarily for timber or other income producing purposes very often have a strong interest and commitment to noneconomic values.
- Many—perhaps most—owners are not averse to harvesting if they perceive that the harvest can be carried out in such a way as to enhance—or at least not harm—the value of their forest for wildlife (and/or aesthetics, recreation, etc.). In fact, the more sophisticated PNIF owner of today may be more receptive to forest harvest (an management) than was his/her predecessor, as long as the harvest or timber management goals are compatible with his/her other more primary goals.

Education and Assistance

According to one of our presentors, there is little evidence that Leopold's land ethic (i.e., man's relation to land and the animals and plants on it) has been a significant part of southeastern pine management. This may also be true of the rest of the nation. The intensity of wildlife management is low. There are exceptions, and we need to continue to encourage and support them, but they are not the rule.

At the same time there are some indications that this situation may be changing—due to instability in timber prices and growing opportunities for leasing land for recreation—on private, industrial lands.

Of course, there is a difference between having people *recognize* Leopold's land ethic and actually having *respect* for it. Shifting people's dominant economic and utilitarian values to values that would assure real respect for the forest ecosystem will occur only through the development of an ecological awareness that will lead to integrated management of the forest. This is basically a job of education—not education *just* by the academic (probably not even *mostly* by the academic), *but by all of us*. We all need to play a major active role in developing woodland owners ecological awareness if we are to get closer to the goal of a broadly *practiced* land ethic.

Most presentors seemed to agree that educational and technical assistance efforts for both timber production and wildlife habitat can and should be more effectively targeted at the owner's needs and interests. They also seemed to agree that the wildlife manger needs to assume a much more active and prominent role in advising the PNIF owner, a field which today is dominated by the forester.

Two suggested strategies were:

1. The development of partnerships for advising the woodland owner, in which the wildlife manager and the consulting or service forester would be equally involved in advising on those management practices that will enable the owner to attain his/her primary wildlife goals and, at the same time, achieve some compatible timber production goals. This approach would have the wildlife manager playing a much more active—the leadership—role than he/she has in the past in the development of forest management plans.
2. Market segmentation strategies—in which groups of PNIF owners are identified in terms of their value orientations, and then are provided educational and technical assistance programs that are specific to their interests/needs/preferences. One presentor identified three groups (resource conservationist, forest recreationist, forest utilitarian) that are distinctive enough in their needs/interests to benefit from such an approach.

Though not suggested by any of the presentors, the new emphasis on owner preferences suggests that there may also be a role for those trained in human behavior—the sociologist or social psychologist—in the area of understanding landowner motivation and motivating landowners, in concert with the resource manager.

Delivery Mechanisms

The combination of increasing numbers of PNIF owners, absentee ownerships, real declines in state and federal resources devoted to educating and assisting PNIF owners, and advances in communications technologies (satellite, uplink/downlink capabilities, in-home video, etc.) prompted one presentor to suggest that there are opportunities to use these technologies to reach larger audiences than can be reached by the traditional face-to-face contacts between the resource manager and the PNIF owner. In contrast, another presentor cited research that shows that PNIF owners prefer to receive management advice through personal visits to their property by the resource professional, that they learn more effectively that way and are more likely to put the advice into practice. Perhaps the new technology could best be used for developing awareness of the need for management and the options and possibilities available, while the face-to-face contact would be more appropriate for actually preparing and assisting in carrying out the individual management plan. In any case, our delivery systems need to be designed to reach owners living in urban settings as well as reaching farmers.

Monitoring Changes in the Forest Resource

At least two of the presentors reminded us that, while understanding changes in PNIF owner characteristics and preferences is essential, that knowledge is not of itself sufficient to being an effective resource manager. The resource manger must be just as aware of changes in the forest resource, for the forest, if left unmanaged or if mismanaged, sometimes changes in ways that don't benefit those wildlife species we want to benefit or that landowners most prefer. In the New England forests, for example, the trend toward uniform age and structural conditions, and the consequent reduction in nesting and foraging opportunities threaten to impoverish desired sectors of the faunal community. Loss of oak range lands in California has had undesired impacts on wildlife food sources, reproduction and escape cover, the total acreages of range land, rural aesthetics, and residential land values. We need to know, on a continuous basis, what is happening and about to happen on these acreages—harvesting, development, fragmentation, management potential, etc.

In short, we need a system for monitoring private forests that is equivalent to that now used to monitor the National Forest System. Recent improvements in satellite photography and computer systems will help in this regard.

Experiments in the States

Our presentors also treated us to descriptions of the specifics of several programs for achieving wildlife management on PNIF lands.

The Coverts Program (Connecticut and Vermont). The premises of this program (now in its fourth year) were that, in the past, programs for landowners have tended to be technical and service-oriented in approach, lacking the interpersonal communications that have been proven to be quite effective in *motivating* landowners to adopt forest management practices (forest management in this case being defined as encompassing the optimization of owner-defined woodland benefits in addition to timber production). The innovative aspect of this program was its use of peer (friend/neighbor) volunteers, whose advice is much more likely to be heard, believed and acted on than is the advice of strangers, even if the strangers are professional resource managers. To qualify as a volunteer, one needed to demonstrate a belief in holistic management (multiple-use management?), leadership qualities and a commitment to wildlife as a high priority. At this point, informal evaluation indicates that this approach has been very successful—as measured by the number of hours contributed by volunteers, the number of PNIF owners contacted, number of media contacts, workshops and tours offered, proportions of contacts seeking out professional advice, and acres of forestland subsequently under wildlife management practices.

Treasure Forest Program (Alabama). This program, begun in 1974–75, has resulted in more than 535 landowners being recognized as Treasure Foresters. Some of the innovative aspects of this program are: (1) the management objectives from which participants *must* select, include wildlife, aesthetics, recreation, watershed and environmental enhancement, as well as timber; (2) the management plan is a cooperative effort of the landowner, a forester, wildlife biologist and other experts; (3) at a minimum, the wildlife biologist, as well as the forester, *must* be involved in evaluating landowner progress toward his/her management goals; and (4) successive five-year management plans are required for continued participation in the program. Moving from the status of participant to Treasure Forester is not simple or easy; numerous positive accomplishments are required, including protection of wildlife values. The program apparently appeals to landowners of all size parcels (Treasure forests range in size from 15–328,000 acres). The modest monetary and other material awards made to owners when they become Treasure Foresters are not the main motivating factors. Those factors are peer recognition and the personal satisfaction they receive. In addition to the benefits to the landowner and the resource, another result of the program has been that many of the participating natural resource professionals better understand and hopefully promote the full range of management opportunities (wildlife, recreation, aesthetics, timber, etc.) that exist in the forest.

Integrated Hardwood Range Management Program (California). Begun in 1987, this program is an attempt, through research and education, to solve the problem of decline in the distribution and abundance of California's oak woodlands, which are valuable for both economic and noneconomic (aesthetics, values and traditions) reasons. Though the program is in its infancy, notable aspects are: (1) it addresses both economic and noneconomic considerations; (2) it integrates a wide range of values, including timber (firewood) production, wildlife, livestock forage and aesthetics; (3) it makes an explicit attempt to provide educational programs to *both* the large and small acreage owner; (4) it tests whether research and education can be effective, in lieu of regulations, to solve a complex biological and land-use problem; and (5) it represents the type of program—a program-specific and client-specific initiative—that is most likely to be publicly funded in the future in California, and perhaps in other states. This Integrated Hardwood Range Management Program also strongly reminds us of the necessity to base our program to encourage management for wildlife on a strong research foundation.

Managed Forestlands Program (Wisconsin). Wisconsin's Managed Forestlands Program, enacted in 1985, is the only one of the four programs described here that relies heavily on a financial incentive—substantially reduced property taxes—as the inducement for owner participation. The paper on this program gave us an insightful and fascinating look at the interest groups and "politics" involved in making major policy changes. The program brings many innovatives aimed at encouraging private forest management responsive to both owner preferences and the larger societal needs. Unlike the programs it replaced, the Managed Forestlands Program: (1) offers the landowner much greater encouragement than in the past to manage for wildlife/aesthetics/recreation in addition to timber production, and it establishes criteria and detailed administrative rules for the preparation and content of management plans; (2) while continuing to promote the concept of public access to private lands receiving property tax relief, it offers the participating owner the option of closing *some* of his/her enrolled lands to public access; (3) requires that hiking and cross-country skiiing as well as hunting and fishing be permitted on enrolled lands to public access; (4) provides for public information about the location of enrolled open lands; (5) mandates landowner educational programs (with no concommitant increase in funds for education); and (6) provides for a systematic evaluation and report to the Legislature on the impacts of the program jointly by the Department of Natural Resources and University Extension. Depending on the results of the evaluation, additional modifications to the program may be forthcoming. As the presentors told us, even more dramatic innovations were seriously proposed but *not* adopted at this time, being too big a bite for the policy makers. These innovations included: (1) targeting of incentives to forest regions of high value for wildlife and scenery as well as wood production, through a process of forest land-use planning at the county level; (2) statewide resource protection standards for major private forest resources; (3) approval of the owner's management plans by a certified silviculturist; (4) analysis of means other than property tax relief to induce owners to prepare and carry out multiple-resource management plans; (5) increased public-access options for landowners such as closing their lands, opening them only for nonhunting recreation or combinations of these. Now that these proposed innovations have been made visible to the public and state decision makers, it is expected that they will be further developed and debated in the process of making modifications to the program in the future.

Subsidies, Education, Regulation

At least one presentor questioned the effectiveness of federal subsidies for forestry practices, citing research that indicates that such subsidies do not stimulate private investment. There is enough conflicting evidence on the subsidization issue that much more in-depth assessments are needed in this area.

On the whole, the papers reflected a very strong orientation toward education and technical assistance as the preferred—perhaps the most effective—means of encouraging woodland management based on owner preferences as well as societal needs. Only one paper addressed regulation and quickly dismissed it, for now, as an unacceptable alternative to research and education.

I found this is somewhat surprising, since at least 16 states and some municipalities now regulate harvesting on private forest lands, primarily to prevent environmental degradation, including erosion, sedimentation of streams and for the sake of aesthetics. There may well be innovative regulatory approaches that could more directly benefit wildlife on private lands. A 1984 survey in Illinois indicated that regulations were acceptable to most people (though not necessarily the landowners themselves) as a means of limiting deforestation. Perhaps there would be more public support than we imagine for reasonable land-management regulations to benefit wildlife habitat.

Conclusion

If I were forced to choose just one overriding theme that these papers represent it would be that of growing awareness among foresters (and wildlife managers, for that matter) that PNIF woodland management can no longer be viewed simply as a timber-production issue. The preferences of owners demand that timber production be considered as only one—and often a minor one—of a cluster of goals they may want to pursue. In most cases, efforts to encourage PNIF landowners to manage for a single purpose will not be successful unless attention is given to other values—wildlife, recreation and aesthetics. To the extent that these papers represent the forestry and wildlife communities' current thinking, we seem to be making remarkable progress toward a broader understanding, and acceptance and implementation of that truth.

Special Session 2. *Emerging Concepts in Wildlife and Wildland Management*

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Ecological Dependency: The Concept and Its Implications for Research and Management

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Knowledge will never replace respect in man's dealings with ecological systems.
Rappaport

Introduction

The past 15 years have been exciting for those interested in the application of ecological principles to wildlife management. Not long ago, wildlife managers relied on such simple axioms as "good timber management is good wildlife management." Next, we began to produce management plans that specifically provided for game species that were of interest primarily only to those who hunted them. Only in the most recent times have we expanded our view to include a broad array of nongame species in our planning. These include species that are of interest to many people for their aesthetic appeal, as well as a number of ecological indicator species that are intended to represent an array of associated species, and consequently provide for the maintenance of biological diversity. Detailed information bases and analytical procedures now supply information on these species for land management planning.

During this period, the challenge to wildlife managers has been great. Those who have participated, both individuals and organizations, should recognize that enormous progress has been made. Yet, it is essential that we critically review our accomplishments with an eye to improvements and innovations that still must be made. The process is too new and too vital for us to accept the *status quo.* One area that needs attention is the definition of biological needs or requirements of a species.

Background

The Endangered Species Act of 1973 (16 U.S.C. Sec 668 [1976]) was the initial statutory requirement for maintenance of viable populations of wildlife species. The concept was carried forward in the National Forest Management Act and pursuant regulations (MacCleery 1982), which require maintenance of viable wildlife populations on lands of the National Forest System. This mandate can involve resource production trade-offs, and managers are often asked to minimize these trade-offs and still meet the biological needs of wildlife species. As the costs associated with trade-offs increase, so does the desire to define species needs precisely.

Habitat needs or requirements are generally described simply as habitats or components of habitat on which a species is ''*dependent*'' for survival. As wildlife biologists, we have been trained to think that the needs of wildlife populations can be readily measured and described. Students of wildlife management are taught from the outset that species require food, cover, water and living space to sustain populations. Virtually all wildlife biology textbooks (e.g., Dasmann 1981, Bailey 1984, Shaw 1985, Peek 1986) devote a section to wildlife habitat requirements. Terms like ''sustain populations'' and ''requirement'' are used freely and seem simple. A close look at underlying ecological concepts, however, reveals no clear basis for such a simplistic view (Clark 1987). Yet, wildlife biologists who provide information to aid management decisions are often challenged to distinguish between what a wildlife species uses or *prefers* and the bottom line of what it must have—what it really *needs* or *depends* on for survival.

In the Pacific Northwest, a number of species are reportedly dependent upon economically valuable old-growth Douglas-fir (*Pseudotsuga menziesii*) forests for survival (Meslow et al. 1981). The northern spotted owl (*Strix occidentalis caurina*) is best known of these species (Forsman et al. 1984, Gutierrez and Carey 1985), and it has served to focus national attention on the issues of habitat dependency and maintenance of viable populations (Salwasser et al. 1984, Marcot and Holthausen 1987). In this region, researchers have been asked to identify wildlife species that are truly dependent on the late stages of forest development, and to elucidate the critical biological tolerances that determine habitat dependency (Ruggiero and Carey 1984). Similar concerns are being raised in other regions across the United States (Thomas et al. in press). However, neither an explicit definition of dependency, nor an operational approach for measuring or recognizing dependency has yet been offered (Clark 1987, Faaborg and Donaldson-Burger 1987, Haefner and Morton

1987). This is apparently due to the fact that dependency involves an extremely complex and dynamic array of ecological relationships.

The literature of wildlife management, conservation biology and theoretical ecology bearing on the subject of dependency indicates that species requirements, or species dependence, is not a static relationship that can be defined as a single habitat or habitat component. To understand the habitat on which a species depends, we have to account for variation among individuals and environmental variation over time. We must also recognize that spatial and temporal factors interact in complex ways. Thus, even if we could determine the specific *kind* of environment a population depends on for survival, we must still describe the amounts, sizes and arrangements necessary to ensure persistence of both the environment and the dependent population. Thus, populations are as dependent on the spatial configuration of habitat as they are on habitat *per se*. This more refined view leads us to believe that the most useful way to view dependency is as a conceptual framework that can guide us as we plan for environments that will provide for the *persistence* of populations over time.

A Concept of Ecological Dependency

Population persistence is likely to involve complex and often very subtle or cryptic relationships that vary with time (season, year and longer) or with chance conditions that may affect environments and populations in dramatic ways. Thus, although all organisms are in some way dependent on the environments in which they exist, dependency is best thought of as a concept rather than a precisely and readily measurable state of nature. We coined the term "ecological dependency" to stress the dynamic and interactive nature of the concept in both space and time.

Ecological dependency is the relationship between a population and the environment(s) required for its persistence. Populations will persist only if: (1) there are sufficient kinds, amounts and patterns of environments available to meet the biological needs of individuals within populations; and (2) these environments provide sufficient resources to sustain populations as environmental, genetic and demographic conditions fluctuate over time.

Implications for Research and Management

Individuals, Populations and Species

The concepts of dependency and population viability both focus on the issue of population persistence. Discussions of viability have consistently dealt with populations (Marcot and Holthausen 1987, Salwasser et al. 1986, Shaffer 1981, 1985, Samson et al. 1985), while discussions of dependency have addressed several biological scales (e.g., Porter and Church 1987) or have been independent of scale. Observations of one or a few individuals are too often generalized to the population and even species level of biological organization. For example, the extent to which northern spotted owls are associated with old-growth Douglas-fir forests is often questioned on the basis of anecdotal information about individuals that are found or may even reproduce in other environments (e.g., Engel 1987).

Populations have attributes (e.g., habitat associations, the weight of individuals, etc.) that have statistical properties such as central tendency and variance. These attributes can be denoted by statistical distributions. By definition, individuals within a population fall somewhere within the characteristic range of variation for any particular attribute. Their actual position can vary from near the typical or average expression of the attribute to a relatively rare or atypical expression. Moreover, a given segment of a population (e.g., juveniles) can exhibit a characteristic distribution for an attribute.

Statistical tests can tell us when we have observed enough individuals from a population to estimate reliably the mean and variance associated with a given attribute. Until we have done so, we have no way of knowing where any particular individual will fall relative to the full range of variation within the population. By definition, there will always be individuals at the extremes of the range. Because of this, it is imperative that questions about dependency address population attributes and not individual attributes.

When based on observations of atypical individuals, estimates of the kinds and amounts of habitat needed by the population as a whole will either be excessive or inadequate. As a corollary, habitat being provided for population maintenance should be adequate to support individuals that express traits falling within a large portion of the full range of variation for the population. Providing only for exceptional individuals with traits at the low end of the distribution would cause significant risk to population viability.

Ecotypic Variation

The nature of populations should be dealt with explicitly in discussions of habitat requirements and dependencies. Failure to identify discrete and ecologically meaningful populations produces confusion about population versus species attributes and about ecotypic variation within species. Ecotypes are populations adapted to a set of "local" conditions, i.e., some part of the overall species range. In other words, an ecotype is a set of individuals that, on average, occupy a habitat distinct from other such sets of individuals (Cox 1975). Ecotypes should be considered separately because the statistical distribution of their attributes differs from the distribution of attributes within the species as a whole. Failure to do so can result in generalizations that fail to meet the needs of locally adapted populations. For example, it is important not to confuse the habitat associations and environmental needs of the northern spotted owl with those of its southern relatives. Explicit delineation of distinct ecotypes is the first step towards ensuring that research and management activities are properly designed and evaluated.

Ecotypic adaptation (Emlen 1973) requires many generations, and the range of ecotypic variation is a species attribute. Because spotted owls or pileated woodpeckers (*Dryocopus pileatus*) may exist as ecotypes across a broad range of environments does not mean that a given ecotype is equally plastic and can quickly "adapt" to drastically altered environments. We cannot assume that adaptations exhibited by one ecotype are within the range of genetic potential of another ecotype.

The Limits of Experimentation

Many studies have provided very useful information on relationships between wildlife species and their habitats. Experiments that would prove a state of dependency would have to look at responses of populations rather than individuals, and deal with long-term persistence rather than short-term existence. Research and experimentation can likely tell us how populations would respond to different patterns of habitat distribution within a landscape. And, if the observed range of habitat conditions was broad enough, it could include landscapes within which the population's density was critically low. However, it is unlikely that experimentation could show us, with much precision, the ecological threshold at which a population would disappear from a landscape. The following points would have to be considered in the design and interpretation of such experiments.

1. Habitat that could sustain a population at one point in time might not allow it to persist under a different set of conditions, e.g., a 50-year drought. Thus, experimentation could at best deal with short-term existence and not long-term persistence.
2. The processes that lead to population disappearance (e.g., inbreeding and demographic variation) could take years or decades to express themselves as experimental results. Thus, habitat that appeared to support a population for a short time might fail to support it over the long-term.
3. Results may be equivocal due to the complexity of the system under study and the difficulty of providing rigid experimental controls. For example, it could be argued that animal movements away from experimentally treated areas constitute inconclusive results because animals may be displaced by the disturbance created by the treatment.
4. Experimental verification of ecological dependency entails the potential sacrifice of a population, and replication of the experiment would so jeopardize several populations.
5. Depending on the organisms' density and mobility, the necessary scale of experimental manipulation could be infeasible.
6. The ability to generalize the results of such an experiment would be limited by its geographic scope.

Research and experimentation can provide us with much better information than is currently available on species/habitat relationships. Such information will allow us to determine a range of habitats within which population needs would continue to be met. However, it is unlikely that experimentation can tell us the precise kinds, amounts and configurations of habitat that would meet population needs at the lowest possible level.

Environmental Components

Questions about ecological dependency originally concerned only the kinds, amounts and arrangements of environments required by a species. However, as biologists were asked to be more precise in their recommendations, they began to consider specific components within habitats. As described by Carey (1984:28), ". . . where the costs of providing wildlife with amenable environments is great (for example when old-growth Douglas-fir forests appear to be the most amenable environment) questions of dependency have become more specific. For example, managers have asked what specific elements of old growth are necessary to maintain a particular species and can these elements (or substitutes) be provided in young forests?" Thus, the concept of dependency was related to *components* of ecosystems. It was assumed that we could precisely define the parts of environments and their amounts that are required for population persistence.

In the Pacific Northwest, fisher (*Martes pennanti*) use tall, large-diameter trees as rest sites and hollow, large-diameter logs for denning (Buck et al. 1979, Buck 1982). The likelihood of a fisher population persisting without these or comparable components in the environment is low. This kind of information is important for management and is best obtained through intensive autecological studies on broad geographic and temporal scales. However, to identify the smallest diameters and lowest densities of trees and logs that fishers would use and still maintain population persistence, or to identify what components could substitute for these features, would require studies of questionable practicality. But more importantly, management solely for habitat components would result in habitat modification that may fail to provide for long-term persistence of the target species. Furthermore, the potential consequences of such a management approach raises questions about the use of ecological indicators in wildland management.

Management Indicator Species and Biological Diversity

Indicator species are selected for several reasons (MacCleery 1982). Among these, a species is given indicator status because it is believed to require an environment that is also required by associated species. It is hypothesized that if the needs of the indicator species are met, so too will be the needs of associated species. Accordingly, management requirements are developed for indicator species as a way of ensuring that they, and the species they represent, are provided for in managed landscapes (e.g., Sidle and Suring 1986).

When questions about dependency and biological requirements are directed towards very precise identification of the ecosystem components needed to support an indicator species, there is a need for caution (Block et al. 1987, Patton 1987). As management requirements are focused more tightly around very precisely identified needs of an indicator, the resulting management becomes less likely to provide for other species associated with it and, hence, for the maintenance of biological diversity.

When management for ecological indicators is based on entire ecosystems rather than components of ecosystems, however, the likelihood is increased that needs of associated species will be met. For example, the Pacific Northwest Region of the USDA Forest Service is using spotted owls, marten (*Martes americana*) and pileated woodpeckers as ecological indicators for mature and old-growth forests. Management requirements for these species provide for the retention of tracts of mature and old-growth forest that contain specific elements like snags or downed logs. A strategy that called only for retention of specific elements within managed forests would be less likely to provide for these and other species associated with late-successional forests.

Landscape Patterns

Using a single species to define precisely the amount and arrangement of a required environment can lead to fragmentation and isolation of that environment. This process could result in landscape patterns that fail to maintain target species and/or associated plant and animal communities over the long-term (Norse et al. 1986, Harris 1984).

Species within communities differ in mobility, dispersal behavior, status as predators or prey, and ability to withstand competition from other species. These are among the factors that affect a species' ability to persist in a given landscape. Therefore, a given landscape pattern will not affect all species in the same way.

Patches of a fragmented environment that are too small and/or too isolated to maintain some species may be ideal foraging areas for more mobile species. Thus, providing a pattern of habitats that meets the precisely defined requirements of an indicator species is not likely to meet the needs of all the species the indicator is intended to represent.

Preferences and Needs: An Operational Approach to Ecological Dependency

At least two authors have suggested that habitat preferences are unreliable indicators of biological needs, and they contend that preferred habitats may be excessive relative to requirements for species survival (Peek et al. 1982, Irwin 1986). This argument does not adequately address differences between attributes of populations and attributes of species or the difference between existence and persistence within an environment.

The preference versus need question, as with other issues of ecological dependency, must deal with the persistence of populations. Persistence is, in turn, a function of the survival and reproduction of a sufficient number of individuals to maintain the population over time. Environments vary over time, however, in both the short-term (seasons, years, or generations) and in the long-term (hundreds or thousands of years). A preference for a given habitat may become an absolute need as environmental conditions fluctuate. It is likely, in fact, that habitat *preferences* are indicative of the long-term *needs* of a species, since each species (and each ecotype within a species) has become adapted to its environment over thousands of years of varying environmental conditions. Making observations on a population during a short period of time and then drawing conclusions about long-term persistence is an inherently imprecise and potentially misleading process.

Different populations and different species use specific environments (e.g., closed-canopy forests) in different ways. For example, a population may use an environment (1) exclusively and under all conditions, (2) exclusively but only at certain times or under certain conditions (e.g., winter conditions), (3) as one of several environments used under certain conditions, or (4) as one of several regularly used environments. Periodically, suboptimal environments may become totally unsuitable and optimal environments may become refugia that permit population persistence. Thus, conclusions about wildlife/habitat associations (and, hence, possible dependency) pertain only to conditions at the time of the observations. Given the complexity of ecological systems, failure to observe associations indicating dependency does not mean that such conditions do not exist or will not exist under future conditions.

Therefore, when evaluating the importance of an environment to a species, it is important to recognize all ecologically meaningful time frames, and to realize that a species' need for an environment cannot be evaluated solely on the basis of frequency or exclusivity of use. The persistence of a population can depend on use of different environments for different purposes, under different conditions (Davis 1973, Fonstad 1984, Harder 1980, Noon et al. 1980, Porter and Church 1987, Winternitz 1976).

Habitat preferences are based on evolved behavior and thus relate directly to the probability of persistence. Therefore, habitat preferences must be viewed as reliable information about the environments needed for population persistence, and should be considered a valid basis for management decisions. The following caveats must be recognized, however, when interpreting preference data:

1. Habitat selection is a hierarchical process. A full understanding of habitat preference requires information on both the selection of home ranges and the selection of habitats within home ranges. This becomes more important as species mobility increases because home range selection *per se* constrains the selection of environments within home ranges. As stated by Johnson (1980:69), ". . . selection of habitat types within a home range of an animal is higher order than selection of the home range because the availability of each habitat type is determined by the selection of the home range." Preference data needs to be interpreted in this context.

2. Habitat selection can be constrained. An environment preferred at a specific location may be inadequate for sustaining a population. Environments cannot be used if they are unavailable to the population under study. It follows that the best available environment could fail to support a population over time, even though it is observed to be preferred in a given area. Preference, therefore, must be interpreted relative to availability by determining preference across a range of temporal and geographic conditions. Reproductive success and survival within an environment must also be measured to determine its ability to provide for population persistence.

3. Critical environments may not be preferred. Preference of an environment is usually defined as selection at greater frequencies than would be expected based on its availability (Johnson 1980). But home ranges may be selected because some environment occurs there even though that environment may be utilized less than expected. Concluding that such environments are not important (because they are not "preferred") could be erroneous.

4. Interpretations of a preference must include population considerations. Simplistic interpretations of data that indicate preference *or lack of preference* can be misleading. Peek et al. (1982:369) said, "Interpretation of habitat preference must include an evaluation of characteristics of the population inhabiting the area in consideration." This is critical when dealing with populations in which relatively poor ("not preferred") environments support nonbreeding individuals that may serve as replacements for reproductively active individuals. These replacements may be underrepresented in habitat-use studies but essential for population persistence.

In summary, measures of the degree of preference (e.g., Jacobs 1974, Johnson 1980, Neu et al. 1974, Pearre 1982, Strauss 1979) that populations show for various habitats and resources can be used as reliable measures of dependency. Whenever possible, however, population performance across the full range of available environments should be evaluated in conjunction with measures of habitat preference (Van Horne 1983, Carey 1981). With the above caveats in mind, we propose the following operational approach to evaluating ecological dependency: when patterns of species abundance and measures of survival and reproductive success show a close association with a particular environment(s), we should conclude that the environment(s) is *required* for species persistence.

Macroecology: An Essential Perspective for Land Management

As the scale of human influence on ecological systems grows and the scope of ecological knowledge broadens, ecological perspective must also change. Selective focus on species within narrowly defined habitats is inadequate for identifying environments that provide for population persistence. Subpopulations and metapopulations (Levins 1968, Shaffer 1985) should be viewed from the "macro" perspective of communities and ecosystems within landscapes. This view must consider all ecologically meaningful time frames and not be limited to particular seasons or years (see Wiens 1973). It must also be a hierarchical view that integrates understanding of environmental components and species responses at various levels of landscape organization, e.g., sites within environments, environments within landscapes, landscapes within physiographic provinces, etc.

It is within this framework that the concept of ecological dependency should be applied to questions of population and species persistence. An operational approach based on patterns of species abundance and patterns of species response within and among landscapes seems appropriate. Such patterns indicate how closely associated a population is with a range of environments or environmental components. This pattern of association, in turn, is a reliable basis for evaluating the importance of an environment(s) relative to population persistence.

Conclusions

There are species that have very general needs and there are those with very specific needs. In these extreme cases, simple studies of patterns of abundance may be adequate to supply information for management decisions. But, for the majority of species, environment relationships, the conditions of need and, hence, of dependency are complicated by many environmental and demographic factors. Even when relationships and needs are clearly discernible, it is crucial to recognize the dynamics of ecological conditions in space and time. In conclusion:

1. Patterns of species abundance and response to environments is the best information available concerning the importance of environments to population persistence. Specifically, unless definitive, empirical data exist that demonstrate ecological dependency, dependency can be inferred by observing patterns of preference of environments.
2. Research and management questions about dependency should be asked in a context that recognizes the importance of ecological scale, temporal variation and levels of biological organization. Dependency should be viewed as a function of populations within landscapes over many generations.
3. Management decisions can and should proceed without absolute proof of dependency or knowledge of minimum requirements of species. The researchers who provide biological data and the managers who use that data should recognize that such absolute knowledge is not attainable.
4. As our information on species and population needs improves, we should continually examine the way that it is used. Critical questions remain about the use of concepts such as ecological indicators, and those questions will not be resolved by better information alone.

Although questions of ecological dependency and maintenance of viable populations are complex and difficult to answer, we believe that the tools for addressing these issues are available, and that research can provide this information to land managers and decision makers. Given the nature and importance of the problem, however, interpretation of this information in the light of our existing knowledge of ecology, and a careful assessment of the risks associated with management decisions will be essential.

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Edge Effect: A Concept Under Scrutiny

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Introduction

The concept that edge habitats are beneficial to wildlife populations is a widely held and firmly established maxim in ecology (Leopold 1933, Odum 1971, Smith 1977, Bailey 1984, Robinson and Bolen 1984). Vegetative heterogeneity is created by the junction of two habitat types or seral stages, and results in increased species diversity and density at edges (MacArthur and MacArthur 1961, Odum 1971, Roth 1976). The creation of edge habitats traditionally has been viewed as an "improvement" to existing habitats (Yahner 1988). Much routine management is predicated on the benefits of edge; examples include enhanced big game forage (Reynolds 1966, Ward 1976, Halls 1978, Wallmo 1978, Hanely 1983), increased interspersion for game birds (Rosene 1969, Farris et al. 1977, Gullion 1977, Leopold 1977), and improved habitats and nesting sites for woodland passerines (Johnston 1970, Owens and Myers 1973, Taylor and Taylor 1979, Anderson 1979, Kroodsma 1984, Dickson et al. 1984). Strong belief in edge effects has even influenced design of research not directly related to edges. For example, Niemi and Hanowski (1984) selected study areas specifically to minimize edge effects. Edge effect has become an accepted paradigm of wildlife management.

The term "edge effect" has recently acquired a different connotation than the more traditional meaning. Some authors define edge effect as the changes in a community due to the rapid creation of abrupt edges in large units of previously undisturbed habitats (Lovejoy et al. 1986, Soulé 1986). Excessive edge may lead to reduced populations of species dependent on large blocks of forest interior (Robbins 1979, Whitcomb et al. 1981, Ambuel and Temple 1983). Many managers realize that large amounts of edge do not provide adequate habitat for some species (Laudenslayer 1986, Hunter 1987). This awareness is also expressed in recent textbooks (Shaw 1985, Soulé 1986). While upper limits to the amounts of edge have been discussed for specific areas (Thomas et al. 1979), ". . . wildlife managers will continue to increase edge . . ." (Shaw 1985:40) because of the supposed benefits to some game species and the realities of intensive forest management.

Most research has examined the impacts of increased amounts of edge due to forest fragmentation and the impacts of the size and isolation of habitat islands (Verner 1986). Yahner (1988) conducted a thorough review of wildlife responses to edge habitats. In addition, other aspects of edge habitats have been the recent focus of wildlife research. The objective of this paper is to review recent work involving aspects of edge ecology, with particular reference to avian species. These studies are revealing patterns that may change approaches to the management of edge habitats.

Recent Edge Research

Influence of Predators

Predators may be attracted to edge habitats (Bider 1968) and densities of predators may be greater in more fragmented, man-influenced habitats (Angelstam 1986). Predation may be important as a mechanism of reduction or extinction of forest interior species (Wilcove et al. 1986). In addition to the ''area effects'' of forest fragmentation (i.e., species richness declines as the area of habitat is reduced through clearcutting, agriculture, road construction or other human activity), reductions in size and proximity of forest habitats may cause ''extinctions over and above those expected through reduction in the total area of habitat'' (Wilcove et al. 1986:245).

Wilcove (1985) tested the hypothesis that predation rates were related to size of forest fragments. He placed artificial nests containing quail eggs in forest blocks ranging from 3.8–209,000 hectares. The largest blocks consistently showed the lowest predation rates. Yahner and Scott (1988) conducted a similar test and found that sites with 50 percent of the area clearcut showed greater predation than sites with less area clearcut. To ensure minimal impacts of predators in forest interiors, circular reserves are suggested and, if clearings must be created, they should be clustered close to an outer boundary (Wilcove et al. 1986). Larger forest preserves are preferred because they should minimize access by edge-inhabiting predators and nest parasites to birds nesting in interior sites (Whitcomb et al. 1981, Wilcove 1985, Lovejoy et al. 1986, Martin 1988).

For more than 10 years, the single habitat variable used most to predict the presence and abundance of forest bird species has been total area of continuous forest (Forman et al. 1976, Galli et al. 1976, Lynch and Whigham 1984, Blake and Karr 1987, Martin 1988). The influence from edges extends some distance into the interior, thus affecting both flora and fauna (Lovejoy et al. 1986). This distance might vary with habitat type as well as size of the reserve, the matrix of surrounding habitat (Angelstam 1986, Janzen 1986) and the species of animal or plant.

Temple (1986) found that total area of a forest fragment was not the most accurate predictor of local bird species presence and abundance in Wisconsin. Sixteen of 43 species in 49 forest fragments were sensitive to fragment size and occurred less frequently in 0–10 and 11–100 hectare fragments than in larger blocks. Using these data, he developed a core-area model. The core area was defined as all forest habitat in a fragment more than 100 meters from an edge. Core area was a better predictor (higher r) of avian species presence and abundance than was total area of the fragment. Forest birds may use core areas as refugia from predation and brood parasitism (Temple 1986).

Brood parasitism by brown-headed cowbirds (*Molothrus ater*) was implicated in population declines of Kirtland's warbler (*Dendroica kirtlandii*) (Mayfield 1977a, 1977b) and may be responsible for reductions in other forest species such as the acadian flycatcher (*Empidonax virescens*), veery (*Catharus fuscescens*), red-eyed vireo (*Vireo olivaceus*), American redstart (*Setophaga ruticilla*), and Louisiana waterthrush (*Seiurus motacilla*) (Mayfield 1965, Brittingham and Temple 1983). Cowbirds are not native to forested regions of eastern North America, but have entered these areas following settlement by humans (Brittingham and Temple 1983). Cowbird density in Wisconsin was inversely related to distance from open habitats, and cowbird parasitism declined from 65 percent to 18 percent from within 100 meters to more than 300 meters from an edge (Brittingham and Temple 1983). Gates and Gysel (1978) also found that cowbird parasitism rates declined with distance from edge. Cowbirds apparently respond to forest openings and thus may reduce forest nesting host species that are vulnerable within small units of forest habitat or along edges (Brittingham and Temple 1983).

Limited evidence supports conclusions that fragmentation of eastern deciduous forests creates avenues for both predators and brood parasites to exploit forest interior habitats which results in lowered densities of area-sensitive species. Studies in European forests are basically in agreement (Andren et al. 1985, Angelstam 1985, McLellan et al. 1986, Haila 1986). However, recent work presents a more complex picture than merely a habitat size-edge relationship (Soulé 1986).

Habitat Considerations

Rosenberg and Raphael (1986) presented results of a study of Douglas-fir (*Pseudotsuga menziesii*) habitat fragmentation in California. They surveyed birds, mammals, reptiles and amphibians on 136 study plots in 46 forest stands. Species richness of both birds and amphibians correlated with length of edge, and bird abundance was higher in more fragmented stands. However, the western flycatcher (*Empidonax difficilis*), brown creeper (*Certhia americana*), and golden-crowned kinglet (*Regulus satrapa*)—all forest interior species—were more abundant in insular stands, but seldom detected along edges. Larger mammal species, i.e., fisher (*Martes pennati*), gray fox (*Urocyon cinereorgenteus*), ringtail (*Bassariscus astutus*), and northern flying squirrel (*Glaucomys sabrinus*), were sensitive to fragmentation. Nonetheless, the majority of species studied showed no detrimental impacts from reduced forest patch size or from increased forest/clearcut edge. Rosenberg and Raphael (1986) noted that clearcutting and fragmentation in western coniferous forests is more recent and has not modified as great a proportion of the habitat as has occurred in the East. Long-term impacts of habitat modification, patch-size reduction, and patch isolation may not yet be apparent.

The influence of habitat and topography on the extent of impacts of fragmentation remain unknown. Western montane forests may be naturally more diverse and fragmented and have more inherent edge (after Thomas et al. 1979) than eastern deciduous forests because western topography presents a more complex mosaic of insolation, moisture, and soil regimes often associated with dramatic changes in elevation (Kilgore 1981). Species adapted to western coniferous forests may not experience the negative aspects of fragmentation so severely as species in eastern deciduous forests. Rosenberg and Raphael (1986) noted the lack of research on taxa other than birds and in forest types other than deciduous.

The role of habitat structure in determining predation rates in edge habitats remains poorly understood. Yahner and Wright (1985) examined this relationship using artificial nests placed on the ground in 2- and 6-year-old clearcuts and in mature (55- to 60-year-old) aspen (*Populus* spp.) plots in Pennsylvania. No nest was farther than 50 meters from an edge. Predation differed with respect to plot age with a higher rate in the mature plots, but did not differ with distance from edge. Yahner and Wright speculated that densities of small shrubs (which were denser in the clearcuts) may have provided more vertical layering of vegetation at ground level and improved concealment of nests. In addition, large trees in the mature plots served as perch sites for American crows (*Corvus brachyrhynchos*), the major nest predator. This may have allowed crows more foraging time in mature plots. In a similar study, Yahner and Cypher (1987) placed artificial nests up to 1.5 meters about ground within 25 meters of an edge in 4-, 8- and 60-year-old clearcut aspen plots. More nests were disturbed by predators in the 8- and 60-year-old plots than in the 4-year-old plots. Yahner and Cypher (1987) speculated that arboreal nests within 1.5 meters of the ground may be less disturbed in a relatively simple habitat with little or no overstory or understory. Perhaps predators use simple habitats less often than more complex, older habitats that offer more microenvironments in which to forage, or perhaps nests were simply less detectable in the short, dense shrubs in the 4-year-old plots (Yahner and Cypher 1987).

Ratti and Reese (1988) compared predation rates on artificial nests containing quail eggs in two 6-year-old clearcuts and two mature (55- to 60-year-old) mixed conifer plots along edge in Idaho. Steller's jays (*Cyanocitta stelleri*) and gray jays (*Perisoreus canadensis*) were considered the major predators. One forest plot contained greater shrub cover and experienced less predation than the other. Greater shrub cover may make nest detection more difficult for visual predators like birds. Similar conclusions concerning vegetative complexity were noted by Bowman and Harris (1980), Chasko and Gates (1982), and Redmond et al. (1982). In addition, Ratti and Reese detected that about five times as many nests were disturbed by predators in forest stands than in clearcuts. Recent clearcut habitats provided fewer perch sites for avian predators, which may prohibit foraging by corvids as discussed by Yahner and Wright (1985).

The impacts of predators on forest interior species may be related to both vegetative structure and the species of predators exploiting the edge and nearby habitats. Many studies implicate corvids as the primary predators at edges (Wilcove 1985, Yahner and Wright 1985, Angelstam 1986, Yahner and Cypher 1987, Yahner and Scott 1988, Ratti and Reese 1988). Patterns of nest predation by corvids and other visual predators likely differ from that of mammalian predators. Ground nests may receive greater predation in habitats where mammals (and possibly reptiles) are the dominant predators (e.g., Chasko and Gates 1982) or where vegetation density and/or structure prohibits efficient foraging by avian species (Yahner and Wright 1985, Yahner and Cypher 1987).

Type of Edge

If predation rates differ between habitats based on vegetative complexity, then predation rates at and near edges may also differ with type of edge. Low habitat complexity may be conducive to high nest predation (Bowman and Harris 1980, Chasko and Gates 1982, Angelstam 1986). Angelstam recognized three types of edge: pristine—the edge type created in undisturbed habitats by fire or logging; rural—the edge type between forest and a surrounding mosaic of other land uses; and urban—the edge type between forest and human habitations. Predation pressure may be greatest in fragmented forest patches at rural or urban edges where generalist predators are most numerous (Andren et al. 1985, Angelstam 1986). Forest reserves in urban or rural sites may need to be larger and/or more nearly circular to mitigate this impact (Angelstam 1986, Lovejoy et al. 1986).

In northern Idaho, Ratti and Reese (1988) compared predation rates on artificial nests in edge habitats with different vegetative structures. One edge was "abrupt," i.e., formed by a 6-year-old clearcut, the other was a 70-meter-wide "feathered edge" of partial timber removal (shelterwood cut). Predation in the abrupt edge was greater than in the feathered edge. The feathered edge provided more complex vegetation structure, which may have reduced predator efficiency.

Ecological Trap Hypothesis

Gates and Gysel (1978) studied natural nests within 123 m of forest/field edges in Michigan and reported a decrease in nest predation with increased distance from edge. They proposed the ecological trap hypothesis, i.e., passerines in general are attracted to the vegetative complexity at edges but experience greater nest predation in narrow, man-made edge habitats. Abrupt-edge habitats are largely due to recent environmental perturbations by man, and birds are poorly adapted to predation in abrupt-edge zones (Gates and Gysel 1978). Natural edges tend to be less abrupt than those created by agricultural and silvicultural practices, and are more complex and provide greater security from predators. Greater predator activity at edges may be due to increased prey density (Johnston and Odum 1956) and a function of the natural travel lanes created by abrupt changes in vegetation (Bider 1968).

Tests of the ecological trap hypothesis are rare. Chasko and Gates (1982) examined avian nesting success in habitat along transmission-line corridors and found that nest success did increase with distance from the corridor edge. However, the study sites were maintained through periodic mowing or application of herbicides, and the influence of these was unclear. Working in tallgrass prairie habitats in Minnesota, Johnson and Temple (1986) found that nest success for three of five species was higher for nests farther from an edge (> 45 m). Wilcove (1985), using artificial nests, found that the edge-related predation effects may extend 300–600 meters into a forest. However, other research with artificial nests has not detected an edge effect with respect to predation. For example, Yahner and Wright (1985) compared predation on artificial nests at 5 and 50 meters from an edge; Angelstam (1986) compared artificial nests from 0 to more than 1,500 meters from an edge; and Ratti and Reese (1988) examined artificial nests from 0 to 120 meters from edge. All failed to demonstrate a decrease in predation with distance from edge. These contradictory results suggest one or more of the following: (1) an important aspect of the hypothesis is predation on neonates in the nest, i.e., activity at the nest by adults and food-begging nestlings may attract predator attention; (2) research with natural nests are biased due to differences in detectability of nests in forest and field habitats; (3) research with artificial nests does not accurately represent predation on natural nests; (4) the predator complex may determine predation patterns between study sites and those with predators that concentrate along edges may reflect patterns consistent with the ecological trap hypothesis; and (5) different methods and analyses limit interpretation (Ratti and Reese 1988). For example, Gates and Gysel (1978) and Angelstam (1986) used research designs with unequal nest numbers per plot and unequal plot widths, while Yahner and Wright (1985) and Ratti and Reese (1988) standardized nest number and plot dimensions.

The ecological trap hypothesis is important not only with respect to impacts on forest interior species, but also to the management of forest birds that favor edge habitats (Yahner 1988) or exist in small woodlots in urban areas. Gotfryd and Hansell (1986) studied breeding bird use of small urban woodlots. The length of plot edge accounted for up to 96 percent of the variation in bird abundance and up to 82 percent of the variation in species richness. Gotfryd and Hansell (1986) recommended maximizing edge in areas no larger than 7 hectares to produce a more diverse urban avifauna. Avian diversity and abundance does increase at induced edges (Gates and Gysel 1978, Strelke and Dickson 1980, Gates and Mosher 1981, Chasko and Gates 1982, Morgan and Gates 1982). However, if fledgling success of birds using edge habitat is reduced below that of interior habitats then abrupt, artificial edges may act as population sinks providing no benefit to the species. Managers may attempt to provide edge for nesting birds but unknowingly reduce abundance of desired species through inadequate recruitment due to increased losses to predation or brood parasitism.

Management Implications

A management decision to create edge habitat can have mixed results. Increased bird abundance and species diversity can be predicted, but increased predation or brood parasitism in habitat interiors, and/or ecological traps for breeding passerine birds may be an additional effect. Proper management of edge habitats is difficult because of the need to simultaneously consider local and larger-scale impacts on individual species of birds. Edge created by a clearcut should be viewed as a larger landscape element when forest fragmentation is of concern, but the scale must be reduced and localized when on-site avian breeding habitat and reproductive success are considered relative to individual species. Hunter (1987) addressed scale in presenting a forest harvesting strategy designed to provide both large edge-to-area ratios and large uncut stands.

Providing habitat for sustainable populations of nongame or endangered species may need reappraisal. For most species, inadequate data exist for assessment of population levels necessary for prolonged survival. Nonetheless, estimates of minimum viable numbers for numerous species in specific habitats have been made (Towry 1984). Regardless of the validity of these estimates, the impacts of edge creation through human activity, of forest fragmentation and of species' use of edge habitats should be considered. Minimum or desirable population levels in a forest planning unit may be severely underestimated if reproductive success of individuals at or near edge zones is reduced by intense predation or brood parasitism.

As an example, populations of northern spotted owls (*Strix occidentalis caurina*) have been reduced over much of the species' range due to habitat loss (National Audubon Society 1986). Spotted owls in Washington, Oregon and northern California appear dependent on old-growth Douglas-fir stands. Rates of predation by great horned owls (*Bubo virginianus*) and northern goshawks (*Accipiter striatus*) on spotted owls in old-growth forest stands may be less than in other habitats (Forsman 1980, National Audubon Society 1986, Marcot and Holthausen 1987). In the context of earlier discussions of forest fragmentation, amount of edge and predation at edges, larger and more circular stands of old-growth should reduce the potential problem of predator/prey interactions. The core-area model of Temple (1986) may be of value, especially with respect to the distance that great horned owls and goshawks penetrate old-growth while foraging. The extent of core, effective old-growth as habitat for spotted owls could be reasonably assessed from existing old-growth stands. The core-area model may need refinement for use in various habitats because predator responses may vary with edge width and structure.

Edge width and structure are presently recognized as important determinants of wildlife use of habitats. Induced edges will provide better habitat if created to mimic natural, inherent edges (Logan et al. 1984). However, no research has compared wildlife use of natural versus induced edges to develop prescriptions for the design or creation of silviculturally or agriculturally derived edges.

To our knowledge, no research has examined predation or brood parasitism rates within edge habitats in relation to seral changes in vegetation. Predation rates may be high in early successional stages and then decline as vegetative complexity increases with age, i.e., as contrast at the edge declines, or vice versa depending on species and habitats. Types of predators in the community and their potential impacts on nesting birds interrelate with physical structure as examples with corvids demonstrate. The ecological trap hypothesis may operate in specific edge habitat/predator complex situations that could conceivably be mitigated with modifications of existing silvicultural practices. Ratti and Reese (1988) demonstrated the potential value of a 70-meter-wide shelterwood cut at a forest/clearcut edge in reducing predation on artificial nests. Obviously, additional research is needed to evaluate other possible silvicultural practices, such as edge undulations (Gotfryd and Hansell 1986) or selective leaving of plants (Logan et al. 1984) that might reduce predator activity or success at edges.

Romesburg (1981:293) defined unreliable knowledge as "a set of false ideas that are mistaken from knowledge." Because the beneficial aspects of the edge-effect concept are largely assumed from the knowledge of increased diversity and density at edge zones, these presumed benefits may well be a case of unreliable knowledge for many species. Wildlife managers must consider edge habitats with renewed skepticism and carefully assess impacts of edge creation, location and manipulation. Recent research dispels the traditional view that edge habitats are always beneficial. Unfortunately, relatively little empirical evidence is available for managers to consult when making decisions regarding edge zones. In addition, nearly all research has been inconsistent with respect to habitat type, geographic location, edge age and structure, wildlife species, research design, replication and analysis. Yahner (1988) recognized this and called for well-designed, long-term studies to develop a standardized protocol for measuring and comparing edge effects in different landscapes. Considering the relevance and importance of edge habitats and edge effects to ecological theory, habitat fragmentation and habitat management, more research is needed to assist management of edges within larger ecosystems.

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Reconsideration of the Habitat Concept

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Introduction

The concept of habitat has long been of central importance in ecology, and especially in wildlife management. It is the first conceptual link relating organisms to their external environment, and some ecologists view habitat as a principal force underlying the evolution of species (Southwood 1977, Sibly and Calow 1985). Despite its importance, the meaning of habitat has often been taken for granted. Udvardy (1959), for example, stated that "habitat is such a generally accepted, understood and used term that few ecology textbooks above the elementary level bother with its proper definition." Many attempts have been made to articulate a definition (Uvardy 1959, Cain 1966, Whittaker et al. 1973, Maguire 1973, Goodall 1986), but we find there is still confusion surrounding the term and the concept.

The advancement of legislation requiring the impact assessment of development projects (e.g., National Environmental Policy Act) has caused many state and federal agencies to develop rapid procedures aimed at habitat assessment and monitoring. During the late 1970s, the U.S. Fish and Wildlife Service developed a strategy and a series of Habitat Evaluation Procedures (HEP) based on Habitat Suitability Index (HSI) models (U.S. Fish and Wildlife Service 1976, 1980a, 1980b, 1980c). During the 1980s, the U.S. Forest Service initiated a Habitat Relationship Program (HRP) to assist forest managers in better understanding the relationships between forest management activities and wildlife abundance (e.g., Nelson and Salwasser 1982, and especially Verner 1986). In addition, several nongovernmental organizations, such as The Nature Conservancy and the Trust For Public Lands, have begun aggressive land-acquisition programs based on priority evaluation procedures. Even under the best of circumstances, when the HSIs or habitat relationship models are developed by leading authorities, they are commonly used and abused by personnel who have few if any habitat-assessment skills. We believe there is a tendency to oversimplify the subtleties and complexities of habitat assessment and, as a consequence of this, the wildlife resource is being unduly impacted. While reviewing various aspects of the habitat concept, we present recommendations for future improvement of habitat-evaluation models.

The Habitat Concept

There are at least two basic concepts of habitat that are commonly used and confused. The more fundamental is that of a place that provides the life needs (food, cover, water, space, mates, etc.) for an organism. The word "habitat" itself is, perhaps not coincidentally, a combination of two words, "habit at," that imply existence at a particular kind of place. Odum (1971) refers to this concept as an organism's "address," that is, the ". . . place where it lives, or the place where one could go to find it." The important feature of this concept is that there is a specific relationship between an organism and the type of place where it is typically found.

An unfortunate consequence of this definition is that the organism's occurrence in a given area may result as much from historical and habituation phenomena as from its specific life needs or the present habitat conditions. For example, the behavioral trait of philopatry may dictate that a 25-year-old marine turtle return to its natal site for reproductive purposes, even though the natal habitat was destroyed 20 years ago. An allied difficulty with this definition involves the specificity and essential nature, but infrequent occurrence of certain life history needs. In the case of the turtle cited above, fully 99.99 percent of its lifetime is spent as a pelagic creature in the marine environment. Yet, the critical habitat requirement is access to a nesting beach on which the creature is very rarely observed. Nonprofessionals who consistently see the species in commonly used environments are prone to conclude that these environments constitute adequate habitat. This issue led Harris (1984) to propose a distinction between "primary habitat," which consists of the suite of areas and conditions necessary for all life requirements, and "secondary habitat," in which the organism may spend the predominant amount of time but still not meet all life requirements. We now go further, as others have (e.g., Hoover and Wills 1987), to propose that the definition of primary habitat for a species must extend beyond the requirements recognized for the individual, and explicitly include sufficient area to support a viable population of the species in question. Secondary habitat would be that which will suffice to meet the life needs of individuals or a small remnant subpopulation but not maintain a viable subpopulation through time. Areas that meet most of the requirements of the species or all of the requirements for much but not all of the life cycle should be relegated to tertiary habitat status. More will be said about this later.

The second and totally different concept of habitat is that "habitat may also refer to the place occupied by an entire community" (Odum 1971). The important feature of this definition is the community concept, wherein no species-specific relationships are implied, and habitat is simply a generic place where organisms exist. Moreover, the composition of the community is generally not specified, and over the last few decades the concept has come to refer largely to vegetative types.

Abuses of this concept abound, as developers convince judges that they are not destroying any habitat, but rather, only creating new habitat. The general public is left confused because, at the same time the wildlife profession asserts that habitat alteration and loss are the most critical issues facing wildlife, engineers and planners assert that the reason for creating small greenspaces or retention ponds is to provide "wildlife habitat." Land-acquisition proponents commonly put forth the argument that a specific tract should be purchased because of its wildlife habitat value. But rarely do they specify the wildlife species that will be served. And even more disturbing is the fact that a very small population, perhaps only a few individuals, might occur in the area. The implication is that such areas constitute habitat for species that are in dire need, when, at best, it might constitute habitat for a few individuals of the species that are already too common.

Assumptions of Habitat as a Concept

Although the habitat concept has obviously been helpful in understanding the natural history of species and facilitating their conservation, it does rely on critical assumptions that often go unrecognized. It is important to examine these assumptions because the strength of the concept and its use in management rests on their validity. We share Van Horne's (1983) concerns about assumptions underlying the valuation of habitat quality, and now consider three specific assumptions that are implicit in most assessments of habitat quality.

1. That "habitat" is an equally useful concept for all species. We treat this under the topic of species/habitat relations.
2. That structural characteristics or indicator species can be used to predict occurrence of faunal assemblages. These are discussed under the topic of community/habitat relations.
3. The quality or value of a tract of habitat can be assessed independently of the landscape context within which the habitat occurs. This follows under the topic of landscape/habitat relations.

Species/Habitat Relations

In theory, the life requirements of each species should be identifiable, and management should be able to proceed on the basis of identified environmental variables. However many examples can be cited for which the relation between a species and its habitat is not as clear as the definition of habitat implies.

As early as 1913, Shelford noted ". . . some animals move about so much that it is with some difficulty that we determine what their true habitats are." Leopold (1966) suggested that some animal species were inherently adaptable to habitat change. Cain (1966) introduced terminology that distinguished between habitat specialists and generalists. Thomas et al. (1979) devised a quantitative index, called the "versatility index," to describe the breadth of different habitats that species use. The index value shows the extent to which a species is restricted to a specific habitat type (habitat specialist) or utilizes many habitats (habitat generalist).

Because within-community diversity is commonly referred to as "alpha diversity," perhaps habitat specialists that are restricted to identifiable vegetation communities might be referred to as "alpha species." On the other extreme, regional- or landscape-level diversity is commonly referred to as "gamma diversity." Therefore, species that range widely and depend on a regional landscape for their existence might well be referred to as "gamma species." A principle referred to as the inverse pyramid of habitats suggests that habitat specialists usually occur low in the trophic pyramid, while species that require several distinct habitat types occur high in the trophic pyramid (Elton 1966, Harris in press). Habitat specialists and species that have distinct and easily identifiable habitat requirements seem to be favored by habitat-assessment models and monitoring programs.

Swainson's warbler (*Limnothlypis swainsonii*) and red-cockaded woodpecker (*Picoides borealis*) are two examples of habitat specialists or alpha species. Within-stand or "content" variables are not only of critical importance to these species, but assessment, monitoring and management of these variables will apparently serve as effective means for their conservation. On the other hand, Harris et al. (1982) observed that five species of large mammals (*Ursus arctos*, *Canis lupus*, *Martes pennanti*, *Gulo gulo* and *Lynx canadensis*) had either been extirpated from or were rare in the state of Oregon. All are carnivores with large home range size and seem to be creatures of the landscape rather than of any specific habitat type. Their occurrence appears to be associated more closely with regional land-use decisions than with specific habitat types or habitat management *per se*. How does one define or manage grizzly habitat short of managing the entire region? The home range requirements for species such as these are so large that, with rare exception, it is impossible to acquire or possess sufficient habitat for a viable population. It seems to us that the concept of habitat is not particularly useful when dealing with such large and wide-ranging species, and we suggest that a greater reliance should be put on the concept of the individual's range when referring to these species. Even though the issue is primarily one of scale, it seems unreasonable to suggest that the concept of 10,000 square kilometers of southern Florida panther (*Felis concolor coryi*) critical habitat is comparable to the concept of critical habitat for one of the specialists referred to above.

We conclude that the concept of habitat is not equally useful for all wildlife species, and that presently available assessment models favor those with small home ranges and specialized habitat requirements over those with large home ranges and diffuse requirements. Until now, this has meant that impact assessments discriminate against the large, wide-ranging species, in favor of the more locally restricted habitat specialists. Moreover, the historical failure to differentiate between the habitat requirements of individual organisms and viable populations of such species has resulted in ineffective and expensive conservation of small, nonviable subpopulations that ultimately dwindle away for want of adequate space. The net result is that we continue to lose our regionally distinctive biodiversity heritage and supplant it with a homogenized array of wildlife species that are able to flourish in fragmented and intensively utilized landscapes.

Community/Habitat Relations

Either explicitly or implicitly, forest stands, tracts of habitat or communities of vegetation are often presumed to support a distinctive array of wildlife species. As noted above, one of the definitions of habitat is an area in which a wildlife community exists. Although high degrees of correspondence between vegetation type and the occurrence of distinctive animal communities may still exist in certain parts of the world, most faunal assemblages have been impacted by human modification to sufficient extent that the natural relations between floral and faunal assemblages have been nearly obliterated. Thus, the implication that faunal assemblages can be predicted to occur in or be conserved by small tracts of distinctive "habitat" seems increasingly tenuous. Without consideration of additional variables, such as the size, shape and configuration of the tract, as well as its contextual setting, the accuracy of prediction from structural characteristics to the attendant animal community is not great. This is especially significant in regions of high human density where natural areas exist only as isolated ecological islands that are too small to support viable populations of many native species (Noss and Harris 1986).

Of particular concern to us is the increasing pressure to use indicator species to predict the co-occurrence and status of entire suites of animal species. There is a long and substantially valid history of indicator species described in the ecological literature, but limitations on the usage are great. The many National Forest Management Plans that are now proposing to monitor only a few arbitrarily selected indicator species need careful review and reconsideration.

Of equal or greater concern is the inference that habitat quality is adequate simply because a species occurs in a given tract until now. In states experiencing rapid human population growth or in areas of rapid forest clearance, the contextual setting of habitats is changing so rapidly that the presence of small faunal populations is a good predictor of neither adequate habitat, nor the likely future occurrence of the species.

States such as Florida that are spending large sums of money for conservation and recreational land acquisition are commonly advised that critical wildlife habitat is being purchased when, in fact, the proposed tract only maintains individuals that are residual from a former time when the contextual setting was substantially different. At the same time that the public is led to believe that we are acquiring critically valuable habitat for species of special concern, we are spending limited resources on small tracts that support only dwindling populations at best.

Landscape/Habitat Relations

Habitats occur in a landscape that provides their contextual setting. ''Context'' refers to the mix of land-use types that occur in the landscape matrix surrounding the individual habitats. As humans modify landuse—and thus the composition of landscapes—the matrix and context of individual habitats are changed. Regardless of whether the content of the surviving habitat fragments is directly altered, changes in the contextual setting will inevitably lead to indirect changes in the structural content of these habitat fragments. Such changes in response to habitat fragmentation occur because of such factors as altered climatic regimes, increased abundance of potentially invasive species surrounding the tract, and the degree to which the resident species can or cannot utilize the new matrix to meet their life requirements. We speculate that the magnitude of indirect changes, and the degree to which the original fauna of a habitat patch collapses, will be proportional to the magnitude of change in the contextual setting. Because these changes in the fauna occur over time, the degree of faunal collapse that will ultimately occur may not be evident or predictable from measurements taken at the time of initial fragmentation.

Because each species presumably exhibits a different degree of tolerance to the altered matrix, and possesses different abilities to move through it, the consequences of fragmentation for the various wildlife taxa inhabiting a fragment will not be identical. Subtle changes in the biological and physical environment might represent a severe isolating obstacle for some species and yet be hardly noticeable to others. While birds can obviously fly over obstacles as large as mountain ranges, the movement of fish or fossorial mammals might be totally restricted by a concrete weir or the bed of a railroad.

The implications of these factors for the definition and utility of habitat are profound. Habitat fragments that possess the most ideal structural characteristics imaginable will not constitute usable habitat unless the wildlife species in question has free access to move between fragments and maintain genetic continuity with con-specifics. This might seem like a trivial issue, until one considers statistics such as the following.

The average home range size of the Florida panther is more than 100,000 acres (40,000 ha) (U.S. Fish and Wildlife Service 1987). This means that the 150,000-acre Loxahatchee National Wildlife Refuge—the second largest National Wildlife Refuge in the eastern United States—is barely large enough to support a single pair of Florida panthers. Because panthers occur in southern Florida, where human population density, tourism and resulting automobile traffic are intense, the large home range size virtually ensures that panthers must cross heavily travelled high-speed highways. It should not be surprising that the most important known mortality source on Florida panthers derives from vehicle collisions.

But because Florida has been constructing hard-surface primary and secondary highways at the rate of 4.6 miles per year for the last 50 years, and because many kinds of vehicular traffic are increasing dramatically, numerous other species are also jeopardized by vehicle collisions. The largest mammal, the manatee (*Trichechus manatus*) is endangered, and the principal cause of mortality is boat collisions. The next largest mammal, the black bear (*Ursus americanus*), is listed as threatened, and its principal mortality source outside of two legal hunting areas derives from roadkills. The same holds true for the endangered Key deer (*Odocoileus virginianus clavium*). Thus, the four largest of Florida's mammals and no doubt other species are jeopardized by the same habitat fragmenting and isolating force—the high-speed highway.

This begs the question, what does it mean for wildlife to inhabit an area? Does it mean the wildlife must occur in the area all of the time or only most of the time? Clearly, if the area is not of sufficient size to contain the individuals or the subpopulation totally, then the animals must move outside the area and be exposed to mortality forces that occur not just in the habitat, but also in the context. Any assessment of black bear or panther habitat quality that only considered conditions within the Loxahatchee National Wildlife Refuge or within the 300,000-acre (120,000 ha) Big Cypress National Preserve would erroneously conclude that the habitat was adequate to maintain these species. On the other hand, only habitat assessments that evaluate the internal characteristics of these very large habitats in the context of their location and surrounding environments will lead to reasonable conclusions about their adequacy.

Conclusions and Concept Revision

Based on the material presented above, we conclude that several modifications to habitat interpretations and evaluations should be considered.

1. The definition of the primary habitat of a species should be extended to include the requirement that the area have sufficient size or configuration to support a viable population of the species in question, not simply the provision of a single organism's life requirements.
2. Fraught with pitfalls and dangers is usage of the concept of habitat as the place where an entire community of wildlife species occurs. This problem exists primarily because the exact species implied to occur in the habitat patch are commonly not specified, and there is no assurance that viable populations exist even if a few individuals are shown to be present in the area. Structural characteristics and indicator species are not sufficiently robust or accurate predictors

of animal occurrence to ensure the maintenance of the wildlife species of concern. Land-acquisition proposals based on the rationale that the area will provide wildlife habitat for some nebulous and unspecified community of wildlife should be reviewed with great caution.

3. The habitat concept is not equally applicable to all species. Present monitoring and evaluation procedures seem to discriminate in favor of habitat specialists with small home range sizes, while paying inadequate attention to the needs of large, wide-ranging species that depend on entire regional landscapes to meet their life requirements. Future models and assessment procedures must recognize the need for wide-ranging species to move between habitat patches, just as they recognize the need for specialist species to move within patches.
4. The notion must be rejected that habitat quality and utility can be assessed simply by evaluating characteristics and conditions within the habitat tract. Animals have needs to move and to maintain genetic continuity between small isolated subpopulations. If these needs to move throughout the landscape matrix are not considered along with the structural characteristics within the patch, the evaluation procedure will overestimate the quality and utility of the habitat.
5. Ultimately, it is the composition and configuration of an area that is sufficiently large to maintain a viable population of the species in question that need to be assessed when evaluating habitat adequacy or the impacts of individual development, management or acquisition decisions.

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Reappraisal of the Costs and Benefits of Habitat Heterogeneity for Nongame Wildlife

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Introduction

A tenet of wildlife management is that habitat heterogeneity benefits wildlife through the "edge effect" (Leopold 1933, Dasmann 1964, Yoakum and Dasmann 1969). As a result, managers often break up large homogeneous patches to "improve" wildlife habitat. The promotion of habitat edges reflects an historical bias towards management for game animals, many of which use a mixture of habitats throughout the year. Not all evidence that habitat heterogeneity favors wildlife, however, comes from game management literature. Many classical studies of forest succession show that the diversity and biomass of bird species reach their maximum in the early to middle stages of succession (e.g., Odum 1950, Johnston and Odum 1956) and that many nongame species depend on forest edge (Kendeigh 1944, Johnston 1947, Whitcomb et al. 1981). Therefore, a heterogeneous mix of successional habitats with abundant edges can increase local bird species diversity (Faaborg 1980, Harris 1984). Similarly, bird species diversity is often higher in disturbed or managed patches than in surrounding homogeneous habitats, due to an increased local diversity of foraging and nesting sites (Johnston 1970). Evidence also suggests that migrating birds concentrate along habitat edges and in disturbed areas (Blake and Hoppes 1986, Blake 1986, Martin 1980).

Over the last decade, however, this orthodoxy has come under severe criticism, chiefly from scientists studying nongame animals. Wilcove et al. (1986) and Reese and Ratti (current volume) detail these objections, which I summarize briefly here. First, small habitat patches often are insufficient for large, wide-ranging species (Whitcomb et al. 1981, Harris 1984, Blake and Karr 1987, Hunter 1987). Second, small habitat patches contain a disproportionate number of generalist species that compete with habitat specialists and/or act as potential predators (Blake 1983, Wilcove et al. 1986). Third, nesting success of many species suffers in small habitat patches due to the abundance of a brood parasite—the brown-headed cowbird (*Molothrus ater*), and the presence of various nest predators along edges (Gates and Gysel 1978, Chasko and Gates 1982, Brittingham and Temple 1983, Wilcove 1985). And fourth, because small forest fragments fail to provide adequate forest interior habitat and such special microhabitats as streams and steep slopes, they often lack many forest birds (Bond 1957, Whitcomb et al. 1981, Lynch and Whigham 1984). Forest birds that winter in the tropics appear to have suffered the most from the increasing fragmentation of habitats (Whitcomb et al. 1981), but many grassland and thicket species also need large areas of suitable habitat (Graber and Graber 1976). The increased local diversity observed in heterogeneous habitats may, therefore, be deceptive because habitat specialists, many of which are regionally rare, may be absent, and many species may not reproduce successfully (Wilcove et al. 1986). Increasing local diversity by managing for habitat heterogeneity often decreases regional diversity (Faaborg 1980).

In this paper, I summarize the results of a case history study of the effects of habitat heterogeneity on nongame birds in central Illinois. The goals of this study were to evaluate avian abundance in a variety of upland habitats, and to assess the impact of habitat modifications on nongame wildlife. I first use the data from this study to address such local community patterns as species richness and density along a successional gradient and in habitats managed for maximum heterogeneity. I then look at the effects of habitat heterogeneity on the distribution of habitat specialists, including some that are regionally rare, and on reproductive success.

Study Area

Regional Context

Lake Shelbyville, a flood-control reservoir constructed by the U.S. Army Corps of Engineers, is located in central Illinois in Shelby and Moultrie counties. This area was formerly covered by tall-grass prairie; woodlands were confined to major rivers and tributaries. Since the 1800s, all of the tall-grass prairie and most of the floodplain habitats in the region have been converted to row crops or were flooded when the Kaskaskia River was dammed to form Lake Shelbyville. The areas of land managed by the Corps of Engineers and the Illinois Department of Conservation along the border of the lake contain in aggregate more than 15,000 acres of upland habitat, making Lake Shelbyville one of the two or three largest areas available for wildlife management in central Illinois. The small woodlots and thickets that border Lake Shelbyville form an archipelago of small habitat islands in a sea of corn and soybeans. As such, they have considerable regional significance.

Local Landscape

The land managed by the Corps of Engineers along the edge of Lake Shelbyville is a mosaic of small patches of woodland, successional thickets, lake inlets, flood-damaged banks and agricultural lease lands (Figure 1). Many of the upland areas have been undergoing succession since they were acquired by the Corps of Engineers in the late 1960s and early 1970s. The majority of the thicket habitats are old pastures on slopes that were too steep for row crops, though the Corps has allowed some abandoned row crop fields to undergo succession. Some of the woodlands were extensively used as wooded pastures; others were used for periodic timber cutting and firewood.

Most habitat patches are small and contain abundant edge (Figure 1). The largest area of forest is only 70 hectares (the "Boot" in Figure 1) and has numerous flooded ravines, rapidly eroding banks, and row crop fields, which give it a combined edge of 13 kilometers. No area of relatively uniform habitat is more than 250 meters from a habitat boundary. The area is overwhelmingly heterogeneous, and currently is being managed to maintain or increase this condition.

Study Plots

This paper includes data from seven small, relatively homogeneous plots along an upland successional gradient, including three woodlots of varying sizes, and from two plots that contain a heterogeneous mixture of small woodlots and thickets.

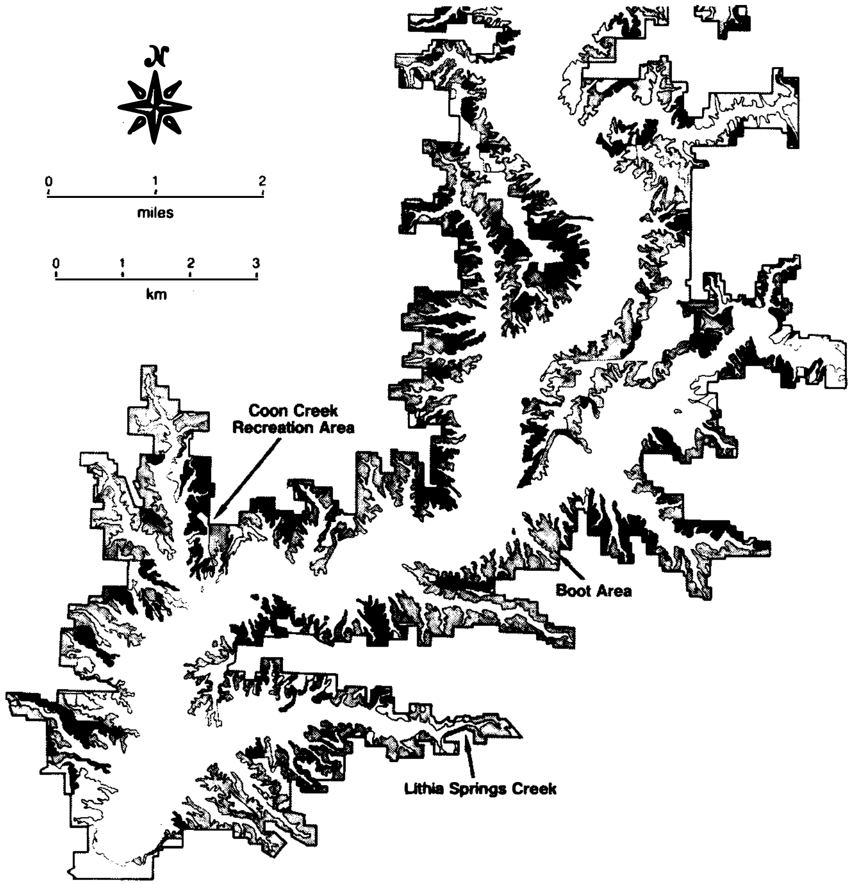

Figure 1. Map of terrestrial habitats in lands managed by the U.S. Army Corps of Engineers in the southern section of the Lake Shelbyville area. Shaded areas represent wooded patches and black areas represent thickets and old fields.

5–8-year-old field. This plot includes a 9-hectare former row crop field that has been allowed to undergo succession. The vegetation is dominated by multiflora rose (*Rosa multiflora*), shrubs, small saplings, and a variety of weeds and grasses.

10–15-year-old thicket. This 11-hectare study area was pastured until it was gradually abandoned over a period of approximately five years. This thicket resembles a fescue savanna with scattered 5–10 meter honey locusts (*Gleditsia triacanthos*) and patches of shrubby hawthorns (*Crataegus* spp.) and multiflora rose.

18–22-year-old thicket. This 10-hectare overgrown pasture, which was abandoned about the time the lake was formed, is dominated by honey locust in the relatively open canopy layer and hawthorn in the understory. The ground layer is covered with almost impenetrable multiflora rose thickets. Only a few patches of fescue remain.

25–30-year-old thicket. This 10-hectare overgrown pasture has a taller, more closed canopy than the 18–22-year thicket and a very dense shrub layer dominated by hawthorn and saplings of such woodland species as oak (*Quercus* spp.) and hickory (*Carya* spp.).

14-hectare woodlot. This woodlot has never been pastured and has no permanent streams or ravines. The closed canopy is dominated by large white oaks (*Quercus alba*) and shagbark hickories (*Carya ovata*).

25-hectare woodlot. This woodlot has a closed canopy dominated by trees in the range of 8–30 centimeters dbh. Only a few scattered honey locusts remain; oaks dominate the canopy. A deep ravine with a permanent stream cuts through the center of the plot.

70-hectare woodlot. This woods (the "Boot" in Figure 1) is the largest in the Lake Shelbyville area. It consists of a flat ridge top dissected by numerous ravines, two of which have permanent streams. The ridge top were wooded pastures as recently as 30 years ago and are dominated by huge white oaks. The steep, more mesic ravines are also dominated by oaks, with a sugar maple (*Acer saccharum*) understory.

Mixed plot. This plot is located in the Camp Camfield Ecological Study Area, which is managed to promote habitat heterogeneity. The 18-hectare study area contains five small (<2 ha) thickets, a small (<1 ha) pond, and a narrow (<100 m wide) strip of oak woodland that borders each of the thickets and the pond.

Open woodland. This 20-hectare study plot also is managed for maximum heterogeneity. The open canopy layer consists of large, widely spaced oaks and hickories. Between the oaks are dense thickets of hawthorn, multiflora rose, and slippery elm (*Ulmus rubra*).

Methods

Bird Censusing

Breeding birds were censused using the spot-mapping method of Kendeigh (1944). Briefly, observers walked fixed routes through each study plot in 1985 from 1 June to 15 July, and mapped the location of each bird heard or observed. Some routes included habitat edges.

In 1985 and 1986, an effort was made to visit each large block of habitat in the Shelbyville area at least once during the breeding season. Each observer stopped every 150 meters and recorded the approximate location of every species on a detailed contour map. Aerial photos were used to aid in locating large habitat patches. These data were compiled to provide regional population estimates, especially for rare, patchily distributed species.

Mist Netting

Capture data supplemented census data. Mist nets were opened from 1 June to 30 July 1985 and 1986 in two census areas—the 70-hectare woods and the 18–22-year-old thicket. On three days each week, 20–25 nets strung end to end in a straight line were opened. Each captured bird was marked with a numbered aluminum band and a unique combination of colored plastic leg bands. More than 900 individuals were captured during the two seasons.

Nest Monitoring

A team of field workers searched for and monitored the fates of nests in the three thicket and three wooded plots during the summers of 1985 and 1986. After nests were discovered, they were marked on a map, and their contents were recorded. A mirror on the end of a pole was used to examine high nests. Each nest was observed every two days.

Results and Discussion

Community Patterns: Breeding Birds

In general, patterns of bird species richness, population density and biomass conformed with those reported elsewhere in the literature (Odum 1950, Johnston and Odum 1956). The number of breeding bird species was highest in mid-successional plots (10–22 years after abandonment) and in the two heterogeneous habitats—the mixed and open woodland plots (Figure 2a). The largest woodlot contained more breeding species than either of the two smaller woodlots (Figure 2a). Similarly, overall densities were highest in mid- and early successional habitats and in heterogeneous habitats (Figure 2b). Community biomass also reached its peak in the 10–22-year-old thickets (Figure 2c). In these respects, the mid-successional habitats were the most productive for breeding birds in the Lake Shelbyville area; the woodlands, on the other hand, contained relatively few birds. Heterogeneous plots fell somewhere in between. They contained more breeding species than other habitats but had intermediate densities and community biomasses.

The abundance of edge habitat and the small size of most habitat patches, however, complicate interpretations of diversity patterns. The species richness of forest habitats increases greatly if one includes such species as the indigo bunting (*Passerina cyanea*) that nest commonly along the edges of woodlands (Figure 2a). Most edge species are also found in the interior of successional thickets; apparently many species of early successional habitats can also breed in the narrow strip of shrubby vegetation that often grows along forest borders (Kendeigh 1944, Johnston 1947). Many other species that nest in forest interiors, such as northern cardinals (*Cardinalis cardinalis*), rufous-sided towhees (*Pipilo erythrophthalmus*) and black-capped chickadees (*Parus atricapillus*), have much greater densities along forest edges. Conversely, many species of forest birds regularly visit successional thickets, especially in search of fruiting trees. Wood thrushes (*Hylocichla mustelina*) and scarlet tanagers (*Piranga olivacea*), for example, visit fruiting black cherries (*Prunus serotina*). Many birds of open, disturbed habitats also visit both forest and thicket habitats in search of food. Flocks of common grackles (*Quiscalus quiscula*), for example, forage in both thickets and woodlands throughout the breeding season. If both edge species and regular visitors are included, the species richness of all plots is roughly the same (Figure 2a). Only the 5–8-year-old thicket has relatively few species, undoubtedly because it lacks a canopy layer and is seldom visited by arboreal birds.

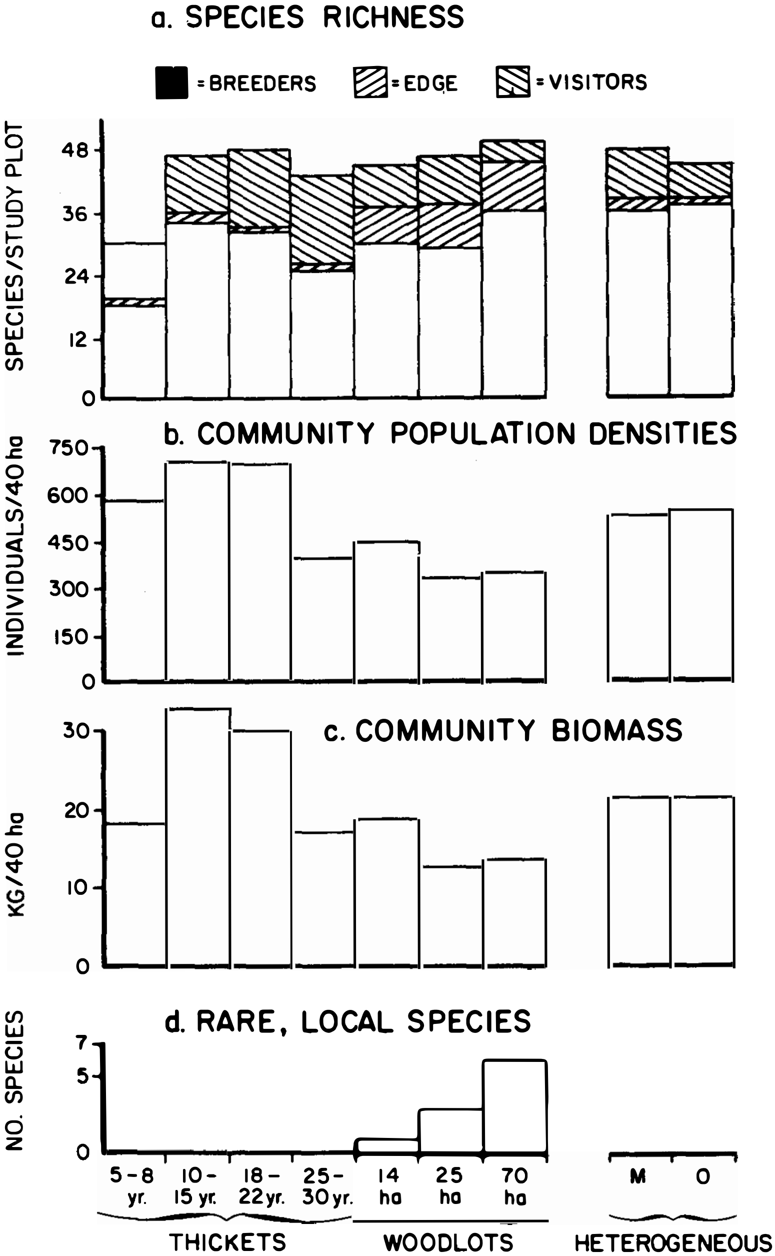

Figure 2. Patterns of species richness (2a), population density (2b), biomass (2c), and regionally rare (2d) species in the study plots censused in 1985. Thicket habitats are arranged in order of increasing successional age, woodlots in order of increasing size, and the two heterogeneous plots (M = mixed woodland and thicket, O = open woodlot) are placed separately to the right. Regionally rare species have estimated populations of less than 50 pairs in the Lake Shelbyville area.

As the preceding data suggest, the small habitat patches that form the heterogeneous landscape of the Lake Shelbyville area do not contain distinct bird communities. Most breeding bird species move between habitats and nest in a variety of successional stages or along habitat boundaries. This finding might be interpreted as evidence that habitat heterogeneity and edge habitat enhance or do not have a negative impact on local bird community dynamics. There are, however, a number of dangers in using local community patterns, which can prove unreliable as an index of habitat quality.

The Problem of Retaining Habitat Specialists

One problem with analyses of landscapewide patterns such as those shown in Figure 2a–c is that they are not significantly affected by occurrences of rare, local species. Managers can maximize local species diversity by setting back succession and creating more edge habitat; however, when they destroy large habitat patches, they potentially threaten regional species diversity. In the Lake Shelbyville area, for example, many species that have regional populations of less than 50 pairs are found only in the largest woodlot (Figure 2d). One species, the worm-eating warbler (*Helmitheros vermivorus*), breeds only on steep north- and east-facing slopes in the 70-hectare woodlot. Ovenbirds (*Seiurus aurocapillus*) nest only in woodlots where there are flat ridgetops. Several other species depend on permanent streambottom habitats, which are scarce in the Shelbyville area because high water levels during floods tend to destroy most low-lying forests. Even some thicket-nesting species, such as Bell's vireo (*Vireo bellii*), are restricted to large open areas.

Some of the species that nest in the Shelbyville area apparently breed nowhere else in southcentral Illinois, at least as far as is known. Ovenbirds and worm-eating warblers, for example, are known to breed in fewer than 20 sites in Illinois, and none of these is within a 50-mile radius of Lake Shelbyville (Graber et al. 1986). These species deserve special attention in any management plan, yet have little effect on local species diversity because their numbers are few. Rare, local species make up less than 10 percent of the individuals and less than 10 percent of the biomass in all of the study plots. Relatively large, ubiquitous species, such as northern cardinals, rufous-sided towhees, blue jays (*Cyanocorax cyanocitta*), brown thrashers (*Toxostoma rufum*), American robins (*Turdus migratorius*) and northern flickers (*Colaptes auratus*), account for most of the avian biomass and total bird numbers. Devising a management plan that would significantly reduce the abundance of these species would be very difficult. Yet, cutting timber in three or four woodlands could lead to the local extirpation—a step to the regional extinction—of several habitat specialists.

The Problem of Interspecific Competition

The large number of edge species and regular visitors that use each plot (Figure 2a) potentially compete with habitat specialists for local food resources. Gauging the extent to which competition might affect the breeding success of habitat specialists is difficult. Nevertheless, the large flocks of grackles, for example, that rummage through forest leaf litter in June and July might well depress the resources available to such terrestrial species as wood thrushes and ovenbirds. Similarly, the flocks of European starlings (*Sturnus vulgaris*) that visit fruiting trees may reduce the food available for such endemic species as wood thrushes and tanagers and other forest and thicket-nesting species that supplement their diets with fruit.

The Problem of Local Reproductive Failure

Most forest and some thicket-nesting species appeared to have low reproductive success on the study plots, due to nest predation and brood parasitism. In a sample of 90 open cup nests (not including cavity nests) representing 25 species, the daily survival probability of nests was 0.937, which means that 6.3 percent of all nests were preyed on each day. If we assume a nest cycle of at least 20–25 days, an average of about 80 percent of all nests were destroyed by predators. This figure is considerably higher than has been reported in many other areas (cf. May and Robinson 1985), though data from such a diverse and limited sample must be interpreted with caution.

Nest parasitism rates were also extremely high in the areas studied. Of 52 nests of woodland species that accept (i.e., do not throw out) cowbird eggs, 65.4 percent (34) contained at least one cowbird egg. These nests fledged an average of less than one host young per nest. In general, this rate of host reproduction is considered too low to offset annual mortality in many species (May and Robinson 1985).

Several other lines of indirect evidence suggest that reproduction in many of the study areas was low. Despite intensive mist netting, very few young were captured in July after most species had the opportunity to raise young. This paucity of young was especially true of birds that winter in the neotropics—birds that are often thought to be more vulnerable to habitat fragmentation (Whitcomb et al. 1981). Only 14 (5.7 percent) of the 244 captured individuals of species that winter in the neotropics were in their hatching year. In contrast, short-distance migrants (21.5 percent of 121 individuals) and year-round residents (34.8 percent of 256 individuals) had significantly higher percentages of juveniles than did neotropical migrants (Chi-square = 63.8, $df = 2$, $P < 0.001$). Year-round residents and short-distance migrants have much longer breeding seasons than neotropical migrants, a characteristic that gives them more opportunities to raise young (Whitcomb et al. 1981). Neotropical migrants, therefore, are more likely to be adversely affected by nest predation and parasitism than are other birds.

Intensive mist netting and observations of color-marked individuals also suggested that many males using the study plots were unmated. In one late successional thicket, 15 male and only 3 female Kentucky warblers (*Oporornis formosus*) were captured. Similarly, an intensive survey of 21 ovenbird territories from 1985 to 1987 revealed only 11 females. Clearly, unmated males cannot produce young if they remain unmated.

None of the lines of evidence in this study is sufficient to determine whether or not locally nesting songbirds are producing enough young to replace themselves. Resolving questions of the dynamics of local populations requires extensive data on the reproductive success of females throughout entire nesting seasons. In addition, standard equations for population dynamics require reasonably accurate estimates of juvenile and adult survival rates as well as reliable estimates of immigration and emigration (May and Robinson 1985). Unfortunately, such data are extremely difficult to obtain in the field (May and Robinson 1985) and beyond the scope of this study. Nevertheless, the data from Lake Shelbyville are consistent with the data in other studies that found evidence of overwhelmingly high nest predation and brood parasitism in fragmented habitats (reviewed in Wilcove et al. 1986). Small habitat patches may indeed represent "sinks" that attract young dispersing birds, which fail to reproduce successfully.

Conclusions

Managing for Habitat Specialists

The majority of terrestrial bird species that breed in the Shelbyville area occur commonly in a wide variety of habitats and thrive in agricultural and residential landscapes. Monitoring the abundance of these species provides little information about the habitat structure of a particular piece of land because generalist species persist with or without management. Yet, these are the sorts of species that are favored when managing for local species diversity. Heterogeneous habitats with abundant edge have high local biomass, richness and diversity (Figure 2a–c) but generally lack such regionally rare species as ovenbirds and worm-eating warblers (Figure 2d).

The best way to avoid a regional loss of diversity may be to develop management plans centered around native habitat specialists. The reasoning behind this suggestion is that managing for species restricted to a particular habitat should help guarantee the continued existence of all of the species that depend on that habitat. By primarily considering habitat specialists, this management approach avoids the problem posed by large common species that swamp rare species in community-level management plans—species that occur in an area regardless of how it is managed (Graber and Graber 1976). Rare, local species are also more likely to respond to management. One of the major problems with the way that habitat evaluation models (HEP) are used is that most species selected are too generalized to be good management indicators. A HEP model for the black-capped chickadee, for example, would have little predictive power in the Shelbyville area because chickadees breed commonly in nearly every terrestrial habitat. A HEP model for species such as the ovenbird or worm-eating warbler would show restricted habitat use, and thus could be a more useful guide for managers. Models for rare, local species may also prove to be simpler than those for generalists—the presence of a wooded, relatively flat ridgetop of a certain minimum size may be an accurate predictor of the presence of ovenbirds.

The first step in managing for habitat specialists would be to locate the major blocks of habitat in an area, and to choose census routes that cover all habitats. These areas then could be censused at least once during the breeding season to determine which species may be restricted in their distributions to particular habitats or particular areas, unless they are regionally significant (e.g., endangered or threatened species). Species that breed commonly throughout the area could be excluded from further analyses. A few of the rare, local species could then be selected as "habitat indicators," based on the extent to which they are individually restricted in their habitat use. These species then could be monitored, and habitat models developed to aid in management plans. Areas with a high diversity of habitat specialists could be set aside as "natural areas," while areas with few habitat specialists could be managed for other purposes. In the Lake Shelbyville area, for example, setting aside the "Boot" area (Figure 1) would ensure the continued presence of the habitat necessary for seven regionally rare species that occur only in larger woodlots (Figure 2d).

Managing to Increase Reproductive Success

The size of habitat patches must also be considered in management plans. Small woodlands with abundant edge not only lack many forest interior species (Figure 2d), but they also have high populations of nest predators and brood parasites, which are much less common in the interior of large habitat patches. As a result, nest predation is much higher along habitat edges (Gates and Gysel 1978, Chasko and Gates 1982, Brittingham and Temple 1983, Wilcove 1985). Birds nesting in the fragmented Shelbyville landscape appear to suffer extraordinarily high levels of nest predation and brood parasitism. Taken together, these studies suggest that large habitat blocks are essential for the reproductive success of many birds.

Relatively homogeneous habitat blocks often have low bird species diversity but may be the only areas where some regionally rare or endangered species reproduce successfully. Management plans that create edge habitat, such as roads or wildlife clearings, in homogeneous stands reduce or destroy the source refuge for many species that nest with poor success in smaller habitat patches. The extent to which management plans should include large, uniform habitat blocks, however, varies among areas. Lake Shelbyville, for example, has no area large enough to provide a refuge from parasitism and predation. The wildlife management plans for Lake Shelbyville should therefore include plans to preserve bird species restricted to rare habitats. Larger holdings, such as national forests, on the other hand, can be managed in such a way that large habitat patches are set aside as refuges from nest predators and brood parasites.

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Special Session 3. *Resource Management Challenges and Innovative Responses*

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Introduction

The Soil and Water Resources Conservation Act (PL 95–192) of 1977 (RCA) requires the Secretary of Agriculture to conduct an assessment of soil, water and related natural resources at five-year intervals. The RCA appraisals are designed to assess the status, condition and trends of selected natural resources on 1.5 billion acres of the nation's nonfederal lands. A further description of RCA appraisals—their impact on USDA Soil Conservation Service (SCS) programs and relationship to fish and wildlife habitat assessment—is given by Hoekstra et al. (1983) and Chalk et al. (1984). The SCS responded to the RCA legislation with the National Resources Inventory (NRI), a multiresource assessment to inventory land use, soil resources and other natural resources. The U.S. Department of Agriculture is required to consider through the RCA appraisals the impacts of agency programs on present and future soil, water and related resources. To enhance the value of the NRI to wildlife habitat planning, the SCS and Missouri Department of Conservation (MDC) developed a supplemental wildlife habitat inventory for Missouri's portion of the NRI. The purpose of this paper is to describe how the NRI was used by both agencies for statewide planning and program development.

Methods

In 1982–83, SCS collected inventory data in Missouri at 29,150 randomly selected primary sample units (PSU), using a nationwide NRI field booklet with 115 inventory elements (U.S. Dep. Agric. 1980a). Samples were selected using standard techniques of stratification, area sampling and clustering to produce statistically reliable data by major land resource areas, geographic units characterized by similar soils, climate, water resources, land use and potential natural vegetation. In addition, sampling intensity was increased to provide statistically reliable data for 12 counties. More detail on statistical design is available in the NRI Users Guide (U.S. Dept. Agric. 1984).

The NRI booklet contained nine inventory elements primarily related to wildlife habitat. Six elements concerned habitat diversity with distance from the sample point to broad habitat types such as cropland or forest land recorded in feet. Three elements were directed at the type and height of overwinter crop residues in the crop field habitat. Vegetation data also were recorded for forest land sample points and included basal area, diameter of trees, understory species composition and forest overstory composition.

Thirty-two supplemental wildlife habitat inventory elements were added to the Missouri NRI. Supplemental data were collected on habitat parameters important to 17 wildlife species. These supplemental inventory elements, in combination with the elements in the national booklet, could be used to calculate a habitat suitability index (HSI) at each sample unit for 17 species. The habitat suitability index, ranging from a low of 0 to an optimum of 1.0, is calculated with species habitat models (U.S. Dep. Inter. 1980, 1981). Species models for the NRI were adapted from Baskett et al. (1980). The supplemental wildlife habitat inventory produced information on cavity trees, field borders, habitat size, ground cover and other habitat model parameters.

All inventory elements were defined and procedures for data collection were standardized (U.S. Dep. Agric. 1980b). The SCS field staff was trained in the visual estimation of model parameters. Periodic checks of field data were made to ensure accuracy of data collection. Missouri's portion of the NRI including the supplemental inventory elements was transferred to the University of Missouri computer network in 1985 where it is available to biologists at remote terminals.

Missouri Department of Conservation Applications

The MDC has applied the NRI to wildlife management planning and program development. It has prepared comprehensive plans for selected species to coordinate all aspects of their management and to provide long-term management continuity (Urich and Cannon 1985). The NRI provided baseline habitat inventory for comprehensive plans for the northern bobwhite (*Colinus virginianus*), ring-necked pheasant (*Phasianus colchicus*) and river otter (*Lutra canadensis*).

Northern bobwhite habitat was summarized from the NRI by four broad regions to document habitat quality problems as the first step in a comprehensive planning process for this species. Low-scoring habitat model parameters were determined for each region. An example of tabular output from the NRI is given in Table 1. Habitat weaknesses varied by region, indicating that habitat improvement programs must be

Table 1. Selected northern bobwhite habitat model parameters from the National Resources Inventory in Missouri used to prepare a comprehensive northern bobwhite management plan and to document the need for management programs.

	Percentage of the primary sample units				
	Region				
Habitat parameter	North	West-central	Ozark	Bootheel lowlands	State average
Cropland					
Without residue	19	14	14	27	17
Without woody cover in field	74	75	80	68	75
With field border <4.5 m wide	61	60	76	58	66
Grassland					
Without legumes	43	31	35	37	38
Cool-season grass 2.5–10 cm tall	53	57	63	55	58
Cool-season grass <2.5 cm tall	20	20	17	27	20
Without forbs	59	53	52	74	57
In poor forage condition	34	34	36	31	34
Forest land					
Grazed	29	39	30	19	29
In tracts <4 ha	27	18	7	7	16
Habitat interspersion					
Distance to cropland >.2 km	19	30	62	26	36
Distance to grassland >.2 km	31	21	24	67	32
Distance to forest land >.2 km	30	40	16	48	28

tailored to regional needs. To address the habitat problems for northern bobwhite shown in Table 1, several programs were developed including MDC cost-share payments for habitat development on Conservation Reserve Program (CRP) lands, cost-share payments for native prairie management, accelerated management on selected state-owned lands and promotion of northern bobwhite habitat through SCS and University Extension personnel and programs (MDC 1987a).

Existing habitat conditions for the ring-necked pheasant in 19 counties open to pheasant hunting were described with the NRI to document habitat weaknesses (MDC 1987b) and to aid in the development of MDC and SCS private land programs for improving habitat conditions. Habitat suitability index objectives were established for private land to support a range expansion program with wild-trapped birds that will be released in unoccupied habitat. These HSI objectives are minimum habitat standards that must be achieved through management on private land before wild-trapped pheasants will be released. The NRI was useful in developing the ring-necked pheasant management plan and establishing private land habitat improvement objectives by documenting existing conditions as the basis for establishing the HSI management objectives at potential pheasant release sites.

River otter riparian habitat conditions were described with the NRI for a comprehensive management plan pertaining to this species (MDC 1986). The MDC is releasing wild-trapped river otters to expand this species range. Tabular data on acres of bottomland hardwoods, riparian forests by width categories and nonforest wetlands were summarized by each of 14 major river basins. The NRI is the only statewide wetland inventory that can be used to quantify river otter habitat conditions by river basin.

The MDC has a private land biologist in each of the seven SCS area offices (Miller et al. 1985). These biologists work with SCS personnel to integrate wildlife habitat considerations into the application of land-treatment systems designed to protect eroding land. Wildlife habitat data from the NRI for six species—northern bobwhite, ring-necked pheasant, white-tailed deer (*Odocoileus virginianus*), greater prairie chicken (*Tympanuchus cupido*), wild turkey (*Meleagris gallopavo*) and fox squirrel (*Sciurus niger*)—were summarized for each SCS area. Habitat parameter scores from each habitat model and the HSI by species were used to document habitat quality weaknesses. MDC specialists, acting in the capacity of an SCS staff biologist, designed methods and techniques for incorporating wildlife habitat into conservation farm plans to address low scoring habitat parameters. MDC biologists have established habitat objectives for inclusion in SCS annual county and area work plans. These habitat objectives include such items as acres of cropland soil erosion reduced with strip-cropping and acres of cropland protected from wind erosion with field borders. In addition, ring-necked pheasant habitat improvement objectives were established for three northwestern Missouri counties where native grass waterways and sediment filter strips will be established to improve habitat and reduce soil erosion. The integration of soil conservation practices and wildlife habitat requires that resource managers in different disciplines document existing soil erosion and wildlife habitat conditions and establish target objectives. The NRI serves this purpose by quantifying habitat quality problems.

Soil Conservation Service Applications

The SCS Small Watershed Program (PL–566) is directed at flood control and soil conservation. In Missouri, flood control is typically achieved with the construction of five- to six- (surface) acre floodwater-retarding structures to hold runoff in the upper reaches of a watershed. Soil conservation is accomplished with land-treatment measures such as conservation tillage, stripcropping, terraces and other measures designed to protect soil from erosion. Habitat lost to floodwater-retarding structures must be mitigated and the Habitat Evaluation Procedures (HEP) are used to quantify impacts (U.S. Dep. Inter. 1980). The NRI provided documentation on watershed land-use patterns to improve the accuracy of the HEP.

An example application of the NRI to the Small Watershed Program is the Upper Locust Creek Project that will result in flood control and soil conservation on 238,700 acres in northcentral Missouri. Nearly 2,400 acres of terrestrial wildlife habitat will be lost to 347 floodwater-retarding structures. The NRI revealed that the watershed land-use pattern included 53 percent grassland, most in poor forage condition. The large amount of grassland habitat in the watershed and its poor quality for wildlife habitat depressed habitat quality on potential mitigation sites. Thus, replacing habitat units (U.S. Dep. Inter. 1980) lost to floodwater-retarding structures would be difficult, and mitigation sites would not achieve HSI objectives. To address the habitat weaknesses in this watershed revealed by the NRI, a mitigation plan was designed to integrate wildlife habitat with flood-control and soil conservation measures. The final project plan contained an objective for increasing northern bobwhite indexes on 14,230 acres or 30 percent of the watershed acreage receiving soil erosion control measures from an average existing HSI of 0.37 to post-project HSI of 0.50. In addition, 7,000 acres of existing forest land will be improved through management to provide an economic return from forest products, increase the HSI for selected species and prevent the conversion of woodland to other land uses. This integrated mitigation plan will result in an average 21-percent increase in the HSI for the four indicator species used to evaluate project impacts with the HEP. The NRI provided the documentation on land-use patterns and habitat quality on 238,700 acres to make an integrated mitigation plan possible.

The SCS and MDC also prepared a statewide status report on wildlife habitat with the NRI. Habitat conditions for six species—including white-tailed deer, wild turkey, ring-necked pheasant, greater prairie chicken, northern bobwhite and fox squirrel—were compared to a 1937 statewide survey of resident game and furbearers (Bennitt and Nagel 1937) undertaken to estimate population numbers and determine reasons for low populations. The NRI documented the changes in habitat quality for these species that occurred since 1937. Four major fish and wildlife resource management problems were identified as the basis for future program development: (1) excessive cropland erosion on 48 percent of the state's cropfields; (2) sediment from cropland and streambank erosion adversely affecting the state's streams, rivers and wetlands; (3) conversion of forest land to other land uses producing erosion and decreasing wildlife habitat quality and quantity; and (4) loss of native grasslands that may ultimately eliminate the greater prairie chicken from Missouri. Future program development to address these issues was supported with the NRI and included: (1) cooperative SCS—MDC conservation farm planning to reduce soil erosion and improve wildlife habitats; (2) MDC technical assistance and cost-share programs to take advantage of 1985 Food Security Act conservation compliance provisions; (3) continuation of the comprehensive species-planning process to document habitat quality problems and to design programs for addressing those problems; and (4) cooperative SCS-MDC grassland and forage management programs with technical and financial assistance for native grass restoration.

Monitoring

Salwasser et al. (1983) pointed out the importance of monitoring fish and wildlife programs to measure the attainment of objectives and to support adjustments in resource management activities. Application of the NRI to wildlife management planning has demonstrated the need for monitoring program impacts. Programs developed with the aid of NRI data must be monitored to determine if desired effects are achieved and to document the need for program changes. Monitoring by SCS and MDC personnel occurs on lands where conservation farm planning or wildlife habitat improvement is a priority. The NRI elements pertaining to northern bobwhite habitat model parameters are monitored routinely, while ring-necked pheasant and greater prairie chicken NRI model parameters are monitored for programs impacting these species. Personnel from SCS and MDC monitor habitat parameters for these species during land management planning sessions on farms and on follow-up assessments to check on applied conditions. Appropriate forms containing habitat parameters for target species are completed and results stored on the University of Missouri computer network. Biologists at remote terminals can access a data base containing 21,518 locations that have been monitored since the 1982 NRI was completed. Monitoring is necessary to determine if HSI objectives are being met in PL–566 small watershed projects and the land management objectives and proposals outlined in comprehensive species plans are being achieved. Monitoring also is used to track changes in habitat quality that occurs during the period between national assessments.

Future Assessments

Another NRI was completed by SCS in 1987. The sampling frame for this NRI was designed to provide statistically reliable data by multistate regions and nationally. Therefore, a supplemental wildlife habitat inventory was not practical for Missouri's portion of the NRI because the same supplemental wildlife habitat data must be collected in other states. A NRI is planned for 1992 as the basis for a report to Congress in 1995 on the condition of the nation's soil, water and related natural resources. An intensive sampling frame similar to the 1982 effort will be used, and a supplemental wildlife habitat inventory is planned for Missouri.

Several changes will improve the wildlife habitat inventory. The number of wildlife species for HSI calculation at each sample point will be reduced from 17 to 4, and include white-tailed deer, pileated woodpecker, ring-necked pheasant and northern bobwhite. These species were chosen to represent certain habitat conditions and resource management issues such as habitat fragmentation, grassland forage condition, habitat interspersion and forest products/wildlife habitat integration. Reducing the number of wildlife species for Missouri's portion of the NRI will allow the design of a supplemental inventory form that will contain more habitat parameters per species and, thus, improve the ability of the HSI to distinguish between small differences in habitat.

Experiences with the HSI applications from the 1982 NRI indicate that habitat models able to detect subtle environmental changes or a high degree of resolution (Farmer et al. 1982) are necessary for developing wildlife management programs. Integrated SCS-MDC programs involve applying land management practices such as field borders, waterways, tree planting and other practices that impact small acreages. Predicting the impact of these practices on a regional or statewide basis requires a detailed inventory and assessment procedure with a high degree of resolution.

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Mitigation Banking as an Incentive to Industry and to Fish and Wildlife Agencies

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Background

As a nation, we have determined that wetlands are important, that they possess and/or contribute to certain societal values, and that they should be protected (Tiner 1984). The need for protection has arisen because of repeated documentation that our wetland base is eroding. According to the U.S. Fish and Wildlife Service, approximately 215 million acres of wetlands existed in the lower 48 states at the time of settlement. By the mid-1970s only 99 million acres, or just 46% of the original acreage, remained (Tiner 1984). That loss will likely continue unless an incentive-based protection program can be implemented. Regulatory programs will come under increasing pressure as our population—growing by 1.7 million annually—continues to seek to develop our coastal areas (Tiner 1984). Indeed population density in the coastal zone, one of the key wetland ares, was six times that of the rest of the U.S. in 1976 (Council on Environmental Quality 1981).

Even when the regulatory process works, it provides only partial protection. By definition, certain wetlands are exempt. Other are sacrificed for the public good. However, the blame is not restricted to those seeking to develop the wetlands for what is perceived to be a higher economic value. The fault lies with society's historic inability to translate public values convincingly into market values. Until this is done, there will be—in an expanding capitalistic society—economic incentives to destroy wetlands. If the public values can be translated into market values, not only will the incentives to destroy wetlands be removed, but a need for incentives to maintain and possibly even enhance wetlands will become obvious.

This paper will focus on current programs, both regulatory and acquisition, to protect wetlands and then examine the potential for an incentives approach. To illustrate the potential for an incentives approach, preliminary results from the Tenneco LaTerre mitigation bank will be discussed.

Regulations

Governments at all levels have adopted some form of regulatory protection for wetlands. At the national level, the primary wetland protection programs are the Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq), Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 401 et seq), and Section 404 of the Water Quality Act (100 U.S.C. 33 et seq). These Acts focus on reducing adverse impacts rather than fostering wetland management and/or enhancement. They assume an adverse impact, attempt to reduce that impact and strive to mitigate any remaining impact. Indeed, Section 404 was intended to be a deterrent to pollution from dredge-and-fill operations. It gives authority to deny the discharge of fill material when such discharge will have ". . . an unacceptable adverse impact on municipal water supplies, shellfish beds and fishery areas (including spawning and breeding areas), wildlife or recreational areas'' (100 U.S.C. 33 et seq.). The requirement to obtain a permit enabled state and federal fish and wildlife agencies, under the aegis of the Coordination Act, to seek less damaging alternatives and mitigation. Thus, the Coordination and Water Quality Acts have evolved into a wetlands protection program, with a permit serving as the stick that drives the process.

Obtaining a permit requires identifying the least damaging alternative and techniques for mitigating any unavoidable impacts. Because the specific mitigation requirements are usually unknown until the permit is applied for, the focus tends to be on satisfying the permit requirement rather than the broader need for wetland protection (Zagata 1985). A permit applicant is generally not in a position to be altruistic and expend private capital to protect public values. The applicant agrees to mitigation as a means to obtaining a permit rather than as a means to achieving a national goal to protect wetlands. An incentive, as opposed to this stick approach, might offer the applicant an opportunity to contribute willingly toward meeting that national goal.

Incentives

Federal, state and local governments have adopted numerous incentive programs designed to encourage landowners to set aside wetlands voluntarily. These fall into four categories: (1) acquisition whereby the landowner relinquishes title or certain property rights to the wetland; (2) subsidy for protection, e.g., Federal Waterbank Program; (3) tax credits or some form of financial incentive for protection often involving transfer of development rights; and (4) programs to educate the public. Only one of these programs, acquisition, usually leads to some form of active management or enhancement efforts and these generally are accomplished either with public funds or with charitable contributions. The other programs tend to be passive in that they focus on protection or preservation of status quo. Depending on goals and the condition of the property, passive management may or may not be appropriate.

As important as it has been and continues to be, acquisition alone can not be successful at protecting our wetlands. Most wetlands are in private ownership (Heimlich and Langer 1986) and are likely to remain there due to the increasingly prohibitive cost of government acquisition. In addition, wetlands already in public ownership often suffer from neglect due to inadequate financial resources.

Despite regulatory and voluntary programs to protect them, wetlands continue to be lost throughout the United States at an alarming rate (Tiner 1984, Gagliano et al. 1981, Templet 1987). Part of the explanation for this continued decline may lie with the fact that wetlands possess societal values perceived to be worth less in the marketplace than are property values. In large measure, the values of wetlands accrue not to the landowner, but to society. However, because those values belong to the ''public,'' they are owned by everyone and thus by no one—a classic case of the ''tragedy of the commons'' (Hardin 1968). However, it may be possible to use public funds to reimburse the private sector for funds expended as incremental project costs to protect or enhance public values. Tax incentives to encourage preservation of wetlands represent a potentially valuable tool (Tiner 1984, Kreutzwiser and Pietraszko 1986). The regulatory or stick approach has been in place since the passage of the Water Quality Act, and wetlands are still being lost. The incentives or carrot approach, in combination with appropriate regulation, may be able to reverse this trend.

Mitigation Banking as an Incentive to Wetland Protection

Until recently, there was little incentive for a private landowner to undertake wetland management or enhancement programs. Unless the lands were leased for hunting, trapping or fishing, it was unlikely that the landowner got a direct return on his investment. As a result of an innovative program implemented in 1984 on 7,200 acres of Louisiana wetlands, that situation has changed.

The program is called "mitigation banking" (Zagata 1985) and involves the receipt of habitat units of credit, determined by the U.S. Fish and Wildlife Service's Habitat Evaluation Program (HEP) (Schamberger and Krohn 1982), for enhancement work done in advance of a permit application. Those credits can later be used by the entity that produced them to fulfill mitigation requirements, or traded/sold to another entity for that purpose. Because it expedites the permit process by avoiding the delay often associated with determining and agreeing to what constitutes appropriate mitigation for unavoidable impacts, the concept saves money. This is true because delay often results in prolonged payment for idle leased equipment and in exacerbating the logistical problems associated with development projects.

Because the banking concept operates only on the enhanced increment, it protects the wetland base. This differs from traditional mitigation practices whereby part of the base is impacted and the remainder is used to mitigate that impact. Indeed, the system not only provides a win-win condition for conservationists and those interested in development projects, but it also affords the free enterprise system with a mechanism for protecting societal values. The incentive, a cost savings, allows societal values to be protected without imposing the uncertainties of the traditional mitigation process. By approaching wetlands protection from a cost savings approach, the applicant is able to avoid unnecessary costs and thus be competitive within the free enterprise marketplace.

How The Concept Works

In January 1984, the landowner, Tenneco LaTerre, signed a Memorandum of Agreement (MOA) with three federal and two state agencies (Zagata 1985). That MOA spelled out the purpose of the program, stipulated what would be done by Tenneco and outlined 18 general provisions detailing how the bank would operate. It was important to all parties that this pilot program not be viewed as an attempt to circumvent Section 404. To this end, provision 6 was drafted. It stated that: ". . . mitigation by debiting available annual habitat units from the mitigation bank is appropriate and will be used to offset unavoidable impacts on fish and wildlife when the applicant can demonstrate to the satisfaction of all parties to this agreement that there are no onsite alternatives which are available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."

Since the MOA was signed, Tenneco has implemented the enhancement program on 7,200 acres within the LaTerre property south of Houma, Louisiana. It consisted of installing four weirs, one of a flap gate, variable crest design, renovating an existing weir, and weekly monitoring of salinity and turbidity. If conditions indicate an additional weir is necessary, it will be installed. Two and one-half miles of new spoil bank were built along the project, and Tenneco agreed to maintain the structures and spoil bank over the 25-year life of the bank.

In exchange for this work, Tenneco was given habitat units of credit for wildlife, freshwater fish and estuarine fish for both Resource Category 2 (high value for evaluation species and scarce or becoming scarce) and 3 (high to medium value for evaluation species and abundant) (U.S. Fish and Wildlife Service 1981). Those credits were then annualized over the 77-year life of the project (mitigation bank) and reduced by the fraction 25/77 to reflect the company's 25-year commitment to the project. The remaining credits, represented by the fraction 52/77, were held in trust to offset impacts incurred in years 1–25, in case the company abandoned the project at year 25. If Tenneco recommitted to the project after year 25, the remaining credits will be renegotiated and deposited into the bank for future use.

Because of subsequent changes in the methodology used to calculate credits and debits, some minor changes are being made to the MOA. Calculations by the U.S. Fish and Wildlife Service show that the life of the wetlands, barring a natural catastrophe, probably will be extended for several years beyond their expected life as a result of the mitigation banking project (Soileau 1984, Zagata 1985).

Results To Date

Since the project was implemented, the site has been visited twice by the inter-agency team that negotiated the MOA, and the U.S. Department of Agriculture's Soil Conservation Service (1987) in Alexandria, Louisiana filed a report on the marsh management plan. Initial results of these inspections indicate that it is too early to document definitive trends in species diversity of indicator species. Variation within and between sites and years may be masking our ability to discern directional change from species associated with salty or brackish waters toward those associated with a more freshwater condition.

As of September 14, 1987, a total of 3,623 credits, out of a total of the original 158,949, had been debitted for eight permits (Table 1). Based on these results, two things are obvious: (1) there was no rush to utilize all available credits; and (2) because the unused credits are forfeited at the end of each year, there was a definite gain to the public values associated with the wetland (Figure 1). According to the MOA, available credits not used revert back to the "public" at the end of each year.

Benefits of Mitigation Banking

From the permit applicant's standpoint, the primary benefit is the cost savings that result from avoiding delay. These savings result from the ability to plan for mitigation in advance of a project, from the increased awareness about wetland values on the part of senior management, from being able to proceed in a normal rather than a crisis mode, and from avoiding charges for idle leased equipment.

From the public's standpoint, the concept provides an economic incentive to the private sector to engage in an action that enhances societal values. Credits not used are forfeited, and interest accrues to the wetland values and thus to society rather than to the bankee.

Because the project was done on a large scale (7,200 acres), it will be monitored. This is not the case with most mitigation projects. The advantage of monitoring is that it allows an evaluation or test of the predictions made in complex and uncertain conditions. This leads to improvement in subsequent predictions. Further, the ecological return per dollar spent is likely to be higher than is the case for small-scale projects. This is so because the money will be spent using equipment rather than

Table 1. Summary of the transactions for Tenneco LaTerre Mitigation Banking (9/14/87).

	Resource category 2			Resource category 3		
	Wildlife	Freshwater fish	Estuarine fish	Wildlife	Freshwater fish	Estuarine fish
Original credits in bank	50,433	57,770	38,690	12,056	0	0
Total debits	−1,860	0	−1,763	0	0	0
Credits remaining in bank	48,573	57,770	36,927	12,056	0	0

moving it from place to place, and because the project is large enough to impact on the overall water regime within the immediate vicinity of the project.

Beyond these benefits lies another benefit. As a result of negotiating, revising and monitoring this project, the company and the public agencies have benefitted by an increased awareness of and appreciation for one another's concerns. As a result, the parties are better able to work together to resolve issues of mutual concern.

Acceptance of the Concept

The concept has its critics. Mitigation banking is a new concept and thus untried. One concern is that the techniques to measure accurately gains or losses in habitat units are not precise enough. That concern was recognized and HEP was used in determining the habitat units. To reduce the potential for error, a conservative approach was taken and a substantial buffer was provided by withholding 52/77 of the credits until year 25 when the project would be subjected to rigorous review. It must be recognized by those making this argument that, even with traditional mitigation, predictions of impacts are uncertain. Banking has the advantage over the traditional approach in that it provides for monitoring and thus a systematic way to improve predictions.

Another concern was that the company would benefit from doing something it would have done anyhow. Tenneco spends about $1 million annually to manage extensively the 183,000 acres constituting the LaTerre property. This expenditure was in addition to that amount and made to reduce the uncertainty of future mitigation costs.

A third concern involved the use of credits produced in one area to mitigate for impacts elsewhere. The MOA provided that credits could be applied only within the same hydrologic unit, unless the signatories to the MOA granted an exception and only after alternatives had been pursued. A careful examination of the MOA will reveal the degree to which all parties to it sought to create a useful tool for wetland protection. However, as with anything new, as more people take the time to evaluate the concept on its merit, the number of skeptics should dwindle. As more properly structured banks are created, the author is hopeful that the concept will become accepted as a legitimate tool for protecting wetlands while accommodating sound development.

It is estimated that there are now 13 mitigation banks nationwide. Brown et al. (1986), while discussing two mitigation banks in the Southeast, stated that ". . . both banks are associated with wetlands permitting activities and are being used to accomplish desirable habitat preservation and management goals."

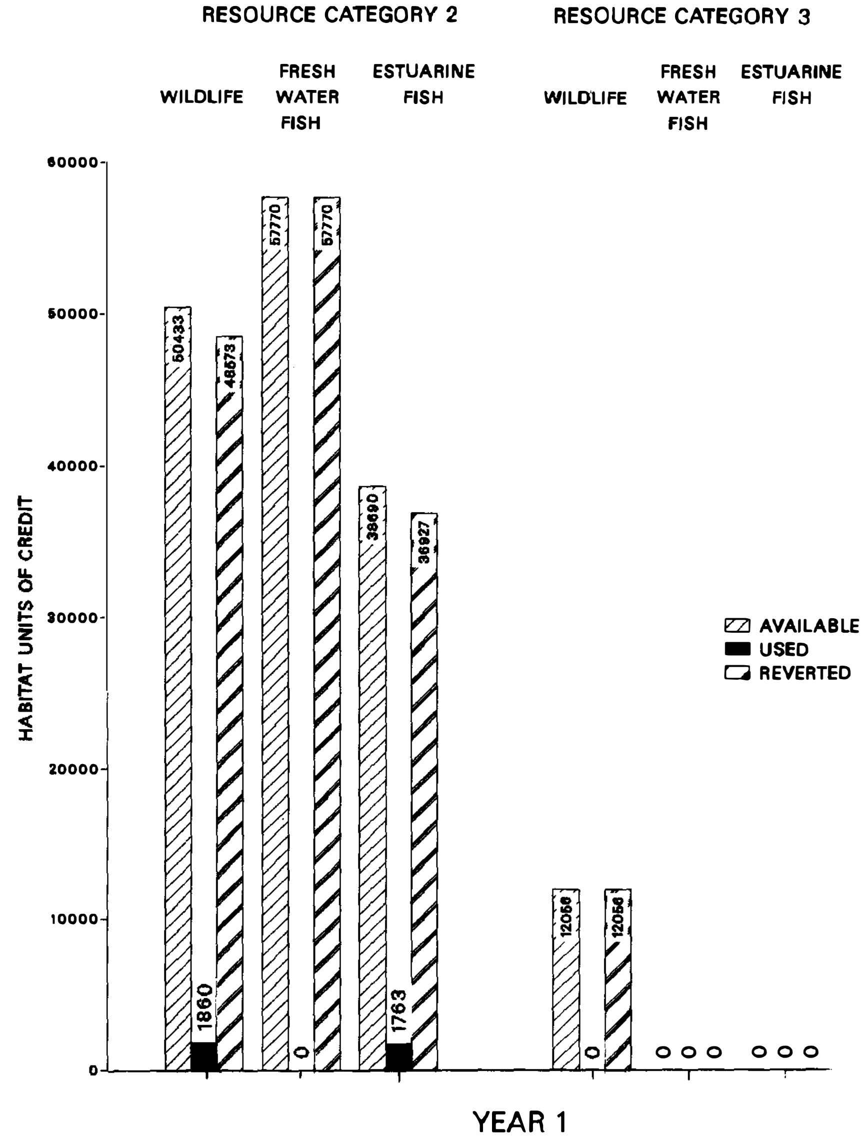

Figure 1. Relationship of the credits that were available, used and allowed to revert back to public ownership during year one of the bank.

Incentives as a Tool

Incentives are necessary if we expect private citizens and companies to expend their resources to protect societal values (i.e., fish and wildlife habitat). Mitigation banking is but one example of such incentives.

If we look at wetlands protection alone there are ways to avoid the need for mitigation by fostering the use of other less-damaging technology. For example, if board roads or directional drilling were used more frequently, the need for canals would be reduced. However, those techniques are more costly to employ. Is society willing to cover those incremental costs with an incentive such as a tax credit? If not, it will not happen except by regulation. If it happens by regulation, the cost will be borne by the industry and eventually the public by (1) increased cost for the product and (2) a deteriorating economy as our companies become less competitive in the international arena.

If we as a nation are sincere about protecting our wetlands, then we must be willing to assume ownership and pay our fair share by providing incentives to those willing to engage in the practices necessary to protect them. We have used the stick approach and created an adversarial environment in which the legal profession benefits. Is it not time to use the carrot and create an atmosphere in which the agencies and industry can meet to discuss ways to maximize the benefit rather than minimize the impact?

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In-Kind Match and Wallop-Breaux: Innovative Sources of State Support for Sport Fisheries Management

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Introduction

The Sport Fish Restoration Account, part of the Aquatic Resources Trust Fund, was created in 1984 by the Wallop-Breaux Amendments to the Federal Aid in Sport Fish Restoration Act (P.L. 98–369). Expanded successor to the Dingell-Johnson Fund, the Account has more than tripled available funds to the state agencies for state sport fisheries management programs. To obtain these funds, the states must match the federal dollars on a 1:3 (state/federal) basis. In lieu of using funds provided by the state fish and wildlife agencies, states may instead match federal dollars with "in-kind" contributions. In-kind contributions are non-cash donations provided by a third party outside the normal state fish and wildlife agency/federal relationship. Examples of in-kind match are: volunteer services; land donations; equipment donations; and easements. With the drastically increased need to match available federal dollars, states are increasingly turning to in-kind to provide the state match. However, the extent and types of state agency use of in-kind match have not been documented.

This paper documents the use of in-kind match through the Aquatic Resources Trust Fund (Wallop-Breaux). The use of in-kind match by state fish and wildlife agencies is an increasingly important means of support for sport fisheries management.

The Sport Fish Restoration Program

The Federal Aid in Sport Fish Restoration Act of 1950, known as the Dingell-Johnson Act, created a mechanism—the Sport Fish Restoration program—for obtaining a new source of federal funds. These funds were apportioned to the state fish and wildlife agencies to be used for state sport fish restoration and development projects. Patterned after the successful Federal Aid in Wildlife Restoration Act (the Pittman-Robertson Act) of 1937, the Act authorized the collection of a 10-percent manufacturers excise tax on certain items of sport fishing equipment. These revenues were collected by the U.S. Department of the Treasury, apportioned to the states on a formula basis by the U.S. Fish and Wildlife Service (Department of the Interior), and automatically appropriated to the states each year. To obtain these monies, the states matched on a 1:3 basis and got approval from the Federal Aid Division of the U.S. Fish and Wildlife Service for state projects that had to, among other criteria, meet the federal standard of being "substantial in character and design."

In 1984, the Federal Aid in Sport Fish Restoration Act was modified by the Wallop-Breaux Amendments. These amendments modified the program by expanding the sources and amount of monies collected in the newly created Aquatic Resources Trust Fund (known as the Wallop-Breaux Trust Fund). The new Trust Fund has two accounts: the Boating Safety Account, which provides funds for state boating safety programs; and the Sport Fish Restoration Account, which is the successor to the Dingell-Johnson Fund.

In addition to the sources of revenue collected under the Dingell-Johnson Act, the Sport Fish Restoration Account collects revenues from manufacturers' excise taxes on additional items of fishing equipment, a portion of the gasoline tax revenues attributable to the use of motorboats, and import duties on fishing equipment and boats. Apportionments to the states in the final year of collections through the Dingell-Johnson program (FY 1985) totalled $35 million. By comparison, with the first year of collections under the Wallop-Breaux Amendments (FY 1986), the states received $109 million. In FY 1987, the states received about $135 million (C. Moffett personal communication: 1988). Thus, the states now have more than triple the amount of dollars available under the previous legislation.

In-Kind Match

States have two basic options for matching Federal Sport Fish Restoration Account funds: use fishing license fees and other revenues under the state fish and wildlife agency's direct budgetary control; or by using third party in-kind match. Traditionally, states have relied on the former mechanism, especially on fishing license fees. But since passage of the Wallop-Breaux Amendments, in-kind match appears to be increasingly important as a state source of match.

State use of in-kind contributions has no legislative basis, but rather is based on policy issued by the Federal Office of Management and Budget (OMB), through OMB Circular A102 Attachment F (U.S. Fish and Wildlife Service 1982). This policy, established by authority of the Intergovernmental Cooperation Act of 1968, permits states to match federal monies using in-kind. The policy establishes criteria that must be met for the estate to be permitted to use an in-kind match. Each in-kind contribution must: (1) be documented in project records (i.e., the project proposal, progress reports and final reports); (2) not be used to match other grant projects (i.e., cannot be used more than once as a state match); (3) be *necessary and reasonable* for project purposes; (4) be an allowable cost for the project; and (5) not be paid for from other Federal funds.

The "necessary and reasonable" standard mentioned above is the key criterion. Another way of stating this requirement is that a state must demonstrate to the Fish and Wildlife Service that it would be forced to purchase the good or service to complete the project if it was not provided as an in-kind contribution.

Valuation of the contribution is an important component of in-kind matching. The value of a third-party, non-cash contribution is determined by the fair market value of the good or service (e.g., labor, property). Further, fair market value of leases, rents, easements and fee title transfers must be determined by an appraisal of the market value of the interest in the land that was donated (U.S. Fish and Wildlife Service 1982).

Types of In-Kind Match

There are many different variations of in-kind match, but they can be lumped into three conceptual categories: volunteer/personal services; real state-related donations; and material/supplies/equipment contributions. The following briefly describes each of these three categories.

Volunteer/Personal Services

States can use as an in-kind match the value of labor provided by individuals who volunteer to assist with implementing a state project. An example of this is use of volunteer labor provided by individuals from a local conservation club to assist with a stream-improvement project. The state could estimate the fair market value of the laborers' wages, multiply this by the number of man-hours invested in the project and derive the value of the in-kind contribution.

Real Estate-related Contribution

States can use the value of donated lands, easements, rents or rights-of-way associated with state use of the land for a state project. States can also use excess value of below-market value purchases as an in-kind contribution. An example would be the value of lakefront land that a municipality could donate to the state as part of a state boating-access project. The land would be appraised and its value used as part of the estate match of the federal dollars.

Materials/Supplies/Equipment

Similarly, a state can use the fair market value of donated materials, supplies or equipment needed to complete a project. An example would be the value of supplies donated by a conservation club used in a state artificial reef habitat-improvement project.

IAFWA Surveys

Information on states use of in-kind contributions was obtained from two surveys conducted by the International Association of Fish and Wildlife Agencies (IAFWA).[1]

One survey dealt with the Aquatic Resources Trust Fund (Wallop-Breaux) and the other with the state fish and wildlife agency public-involvement processes. Both gathered substantial information on in-kind and how it is being used. Results of the two surveys on in-kind match are presented in the following sections.

Wallop-Breaux Survey

The IAFWA (1987), in cooperation with the American League of Anglers and Boaters (ALAB), initiated a written survey to gather information on how the Aquatic Resources Trust Fund programs were being implemented by the states. The goal of the survey was to provide information to the IAFWA, Congress and other interested

[1]The IAFWA is a quasi-public organization of state, federal and provincial fish and wildlife agencies. All 50 states are members, as are the major federal land-management agencies.

parties during the upcoming reauthorization. A primary objective of the survey was to gather information on the Sport Fish Restoration Account of the Fund.[2]

The states' ability to match federal funds was seen as an important consideration, which, until this point, had been undocumented. As a result, state ability to match federal funds was included as a survey item. Information was gathered on state uses of in-kind match which had not existed prior to the survey.[3]

Section II, State Matching Funds

Section II of the Wallop-Breaux survey asked how in-kind contributions for matching were being used by the states for matching Sport Fish Restoration Account Funds. Section II was comprised of four questions, two of which gathered specific information on in-kind match.

The answers to these two questions provide some insight on the extent of in-kind use, how and in what manner the states were using in-kind contributions for matching federal funds, and also gave some indication on how use of in-kind contributions might be improved. Results gathered for these questions provided much of the data for this paper.

Analysis and Discussion of Wallop-Breaux Survey Results

It is important to note that it was not the intent of the survey to gather exhaustive or definitive information specifically on how in-kind match was being used by state fish and wildlife agencies. Rather, it was an attempt to gather a "broad brush" view of how in-kind was being utilized. These results should be viewed as preliminary, and represent only a first step towards documenting such use.

Results of the survey indicated that in-kind contributions are an important fiscal resource for the states in sport fisheries management. The approaches used by the states in applying in-kind match are creative, often unique and likely to expand. In-kind match probably has allowed the development of projects that would not have been accomplished had it not been available.

Forty-nine states responded to the survey. Of the 49 states, 33 (67.3 percent) reported using some form of in-kind. Sixteen states did not employ in-kind donations at the time of the survey.

[2]A special committee of ALAB designed the questionnaire, and the staff of the IAFWA was responsible for compiling, tabulating and analyzing the data. The survey provides data on how funds have been and are being used, are projected to be used in 1990, and the financial needs of the program in 1990. The survey instrument was lengthy but obtained detailed results on how the Wallop-Breaux Trust Fund is presently being implemented and how it will be implemented in the future.

[3]Each state fish and wildlife agency was sent a survey in February 1987, and requested to complete and return the questionnaire by March 1987.

States were asked whether or not they had problems matching federal funds, and whether or not they used in-kind contributions for match, and whether they had reverted federal funds.

The questions were stated: "If you use in-kind services as sources to match Sport Fish Restoration Account monies, which of the following has your state used (check as many as appropriate): a) volunteer services; b) equipment donations; c) rights-of-way; d) equipment use; e) land donation; f) excess value of below-market land purchases; g) easements; h) other (please identify).

"My state has NOT used in-kind sources of matching."

The various categories in question were intended to represent U.S. Fish and Wildlife Service Federal Aid categories, as well as a catch-all category "other." This was included in case a state's use of in-kind did not fit in the other categories.

Table 1. Percentage of states using various categories of in-kind match.

Category of in-kind	Percentage
Volunteer services	33
Equipment donations	6
Rights of ways	8
Equipment use	25
Land donations	29
Excess value	8
Easements	12
Other	43

Distribution of In-Kind Categories

The use of in-kind match was not distributed evenly between the various categories listed on the survey form. Table 1 illustrates the distribution of the various categories of in-kind match. As each state could use more than one category, the total percentages equalled more than 100 percent.

The list of in-kind categories was developed in consultation with the Federal Aid Division. The intention was that the categories listed would include most applications of in-kind match. This did not turn out to be the case. The number of states indicating "other" as a category that had been employed was surprisingly large. In fact, "other" was the most widely used category reported. Twenty-one of the 34 states using in-kind reported "other" as a use of in-kind match.

The high number of states reporting the use of "other" was substantial and bore further investigation. The 21 states reporting "other" as their use of in-kind were contacted by phone. Most indicated the survey in-kind choices did not fit their circumstances and did not accurately describe their agency's use of in-kind match, causing them to report "other" as their use of in-kind match. In most cases, their use of in-kind tended to: (1) not conform with the survey categories listed, instead of being an amalgamation of several categories; and (2) be unique and dependent on circumstances. The responses defied easy categorization; however, they give an illustration of the diversity of goods and services that are being provided through in-kind match utilization. Responses included: state-funded salaries; private groups and universities donating money and personnel; administration costs; personnel time; materials donations; and hunter education and aquatic education instructors.

Although some of the responses could likely have been included under the categories provided on the original survey form, the authors made no attempt to interpret for the states.

Sixteen states reported not employing in-kind match at the time of the survey. Prior to investigating reasons for not using in-kind, the authors hypothesized this might be due to state agency administrative decisions or policy. This proved not to be the case and, in fact, no state reported a policy prohibiting the use of in-kind. Rather, it was generally attributable to a lack of need, or an unwillingness to use in-kind due to a general lack of knowledge of what represented an acceptable use of in-kind.

Public Involvement Survey

The second survey to obtain information on how in-kind match was used was an IAFWA (1988) survey of state fish and wildlife agency public involvement processes.[4]

Information gathered from Question 5 of the survey has relevance here. Question 5 sought information on whether or not states had a contact person for accepting in-kind.[5]

Analysis and Discussion of the Public Involvement Survey

Of 50 states responding to the survey 44 (88 percent) had a contact person for accepting in-kind contributions. In many cases, this was the agency director or a mid- to high-level administrator.

These results suggest that the states were aware of the in-kind match, and that in-kind was not only acceptable, but important enough to warrant the designation of personnel, sometimes high ranking, to accept the in-kind match proposal.

It is interesting to note that, where earlier in the Wallop-Breaux survey, some states had reported not using in-kind, many now reported having an individual who was responsible for accepting in-kind donations.

Examples of Successful or Innovative In-Kind Matching

Many examples of innovative and successful uses of in-kind came to light during the course of this investigation. Some were very simple; others were quite complex, with the project's successful completion hinging upon the use of in-kind contributions. As the survey results illustrate, the manner in which each state used in-kind appeared to be the result of circumstances unique to the state and project.

One of the purposes of this paper was to elucidate the extent and nature of the use of in-kind in terms of their innovation. Because most cases seemed to display some degree of "innovativeness," not all projects are included here, for practical purposes. Some illustrations are presented that exhibited innovative qualities. Their inclusion here is not based on any established criteria for determining innovativeness; rather it is meant only to stimulate further use of an in-kind match that could benefit other states and ultimately the sport fisheries resource.

South Dakota. South Dakota reported that is primarily uses the value of overhead charges as its in-kind match (D. Hamm, personal communication: 1987). This has been applied to work done in cooperation with South Dakota University (SDSU),

[4]Members of the sport fishing industry, conservation organizations and private citizens have been interested in how the Fund is being used by the state agencies. Some were not aware that that fish and wildlife agencies had established mechanisms to provide forums for expression of their opinions and concerns about how monies from the Trust Fund were being spent. The IAFWA agreed to undertake a survey of existing state public-involvement processes, compile the results and make them available to anyone wishing to communicate with elements of state fish and wildlife agencies. The survey instrument was sent out November 4, 1987, with a follow up memorandum being sent out on December 29, 1987. By February 11, 1988, all 50 states had resonded to the survey.

[5]The question asked "Does you state have a contact person for accepting in-kind for matching services and equipment?"

where an agreement exists between the state fish and wildlife agency and SDSU, in which SDSU does not charge the agency an overhead payment. The value of the negotiated overhead, not charged, is subsequently used as an in-kind match.

This donation is being applied to a sport fisheries research project where the contribution comes in the form of housing for research personnel at a state park facility. Because many of the researchers receive low income, they use the park facilities for housing, and the value of the housing is then used as an in-kind match. South Dakota also reported using the value of a SDSU horse trailer as an in-kind match. South Dakota Fish and Wildlife Department personnel indicated there will likely be greater use of this form of in-kind match in the future.

Louisiana. Louisiana reported that all of its fisheries development projects instituted since the Wallop-Breaux Amendments have "involved some type of donation from a source from outside the Department" (J. Roussel, personal communication: 1987). The donations have been made from a number of different local governmental entities—from city councils to local levee boards.

One project that exhibited innovative qualities was the development of a fisheries water-control structure that involved the Louisiana Department of Transportation and Development, which provided engineering services as in-kind match. The Department of Wildlife and Fisheries provided equipment and labor as part of the match, and a local levee board which provided equipment and labor as in-kind match.[6]

Alabama. Alabama reported frequent use of in-kind contributions provided by county governments to help match federal dollars for boat ramp construction. In one use of in-kind that we found to be exceptional, Alabama reported the State Board of Corrections provided equipment, transportation and administrative costs for access area litter removal. (Hardes personal communication: 1987)

Indiana. Faced with scarce traditional matching funds, the Indiana Department of Natural Resources (IDNR) has developed a statewide program specifically designed to utilize funding provided by local governments for boating access projects (Vanderford personal communication: 1988). The program, called "Indiana Waters," greatly expands the matching ability of the IDNR and allows local governments to be more directly involved in development of local projects of interest to them. The IDNR solicits project proposals statewide that will meet the U.S. Fish and Wildlife Service's Project requirements. Upon IDNR selection of projects, the approval by the Fish and Wildlife Service, the local government provides the requisite in-kind contribution, which is then matched by federal funds. Indiana now has six projects completed or underway as a result of this program.

Colorado. Similar to Indiana, Colorado has established a program, "Fishing is Fun in Colorado," which is specifically designed to use in-kind match (SFI-1987). The Colorado Department of Wildlife (DOW) has established formal procedures, criteria

[6]In addition, the National Guard provided in excess of $100,000 worth of equipment and labor which, although it could not be applied because federal dollars cannot be matched with federal dollars, contributed significantly to the project. In this case, the Wallop-Breaux dollars were used only for the purchase of materials and supplies.

and a project-solicitation process which encourages in-kind contributions by private, nonprofit conservation groups, as well as local and county governments. The DOW solicits proposals and makes project selections that are matched with federal funds following Fish and Wildlife Service approval. Colorado reported it had set aside $300,000 of its Sport Fish Restoration program apportionment in FY 1987 for use in matching these in-kind contributions.

Benefits of In-Kind Use

The most obvious benefit from the use of in-kind match is for states to substitute services and donations for traditional matching revenues and thereby enhance development of sport fisheries management projects. This is particularly attractive for cash-strapped states where, despite limited funds, projects can be completed that may not be undertaken if in-kind was not available.

There are benefits beyond the increased number of projects completed. In-kind allows entities other than the state fish and wildlife agency to become involved in projects from which they will directly benefit. Involvement of other entities spreads stewardship in resource management to others.

Cooperating with local authorities and conservation groups on projects will likely be popular and, although harder to quantify, no doubt translate into increased support for state sport fish management programs.

In-kind contributions also provide an effective outlet to conservation organization members for participation in worthy projects. Whether the contribution is volunteer labor or real estate acreage, the organizations can play a key role in the successful completion of sport fisheries management projects. This participation may assist development of the organization by generating membership enthusiasm, and educating private citizens about management practices. Further, it establishes a cooperative relationship between the agency and the organization.

Finally, and most importantly, in-kind benefits the fishery resource, from an increased number of projects undertaken and completed through the use of in-kind match. Also the use of in-kind is expanded, there will be more creative and diverse applications of in-kind match, as a direct result of the success of projects using innovative in-kind approaches. Projects may result that may not have even been proposed due to the uncertain and limited nature of state fish and wildlife agency funding.

Creative approaches to existing and future problems affecting fish and wildlife will be needed as demands on the fisheries resource and supporting habitat increase. Allowing resource managers to approach these problems creatively, with reduced fiscal constraints, can result in solutions. In-kind match clearly can be used to spur new, diverse and additional solutions to existing sport fisheries management problems.

Recommendations for Expanding In-Kind

A number of conclusions can be drawn and recommendations made as a result of this research. First, in-kind matching contributions are important to state fish and wildlife agencies in the management of sport fisheries management. Without the use of in-kind, there would be fewer sport fisheries management projects, due to constraints on the states' ability to match federal dollars.

Often, when speaking to state fish and wildlife personnel, there was expressed a lack of awareness of what was occurring even in neighboring states regarding use of in-kind match. There appears to be a need for improved dissemination of information between states and regions about in-kind match and its opportunities. Improving communication and improving the information-dissemination process could lead to successful forms of in-kind match being imitated and improved.

At present, in-kind match has no legislative basis; rather, it is based on OMB policy. This needs to be rectified because of the uncertainty associated with this policy, i.e., the policy could be changed by the Administration at any time. The American League of Anglers and Boaters recently adopted a position that proposes that in-kind match be defined in statute, rather than merely as OMB policy. This would be a positive step. However, there are possible negative ramifications if regulations for in-kind match are too narrowly construed and restrict in-kind match use. If in-kind is to be incorporated into federal statute, it needs to be a sufficiently broad definition to allow creative and innovative applications, yet still give the U.S. Fish and Wildlife Service and the states direction in how best to proceed. This is a difficult, yet important, task worthy of the effort.

If the U.S. Fish and Wildlife Service promulgates regulations on what constitutes an appropriate in-kind match, it also must focus attention on what is *not* appropriate. Clearly defining what a state can not do in terms of in-kind match will reduce confusion and wasted effort. Work on a project that will later be rejected for being an inappropriate use of in-kind is inefficient and wasteful.

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Wild Fur Industry Under Challenge: The Canadian Response

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Introduction

Organized campaigns against the use of the leghold trap and opposition to trapping originated in the United States in the 1920s (Gerstell 1985) and in Canada in the 1940s (Standing Committee on Aboriginal Affairs and Northern Development [SCAAND] 1986). Such campaigns initially received little public attention, but as societal concern about the environment grew, they soon appealed to an ever-increasing number of people. Since the 1950s, nearly 300 new animal welfare and animal rights organizations have developed, established large memberships and garnered considerable funds (Association for Biomedical Research 1984, Rowsell 1984). Today, these organizations present a major challenge to the wild fur industry.

In Canada, the fur industry has a direct worth of approximately $600 million annually, apart from an additional $200 million it earns each year for allied industries such as transportation. An estimated 105,000 Canadians ear all or part of their income through the fur industry. Of these, approximately 100,000 are trappers, of which 50,000–60,000 are aboriginal (Indian, Inuit, Metis) people (SCAAND 1986, Todd and Boggess 1988). Despite the economical, historical and sociological significance of trapping in Canada, the anti-fur protest now threatens to be as devastating to aboriginal people as was the anti-sealing campaign which it parallels (see Herscovici 1985).

The objectives of this paper are: (1) to review the nature and trends of anti-trapping activities; (2) to describe and contrast the reaction of western countries to the anti-fur issue; and (3) to highlight the response of Canada in support of the trapping industry.

Anti-Trapping Groups and Campaigns

The United States

Organized anti-trapping campaigns began in the United States in 1925 with the formation of the Anti-Steel-Trap League, but they essentially disappeared from 1940 to the late 1960s, only to return stronger than ever during the 1970s (Gentile 1987). Initially, the objective was to make public the "cruel and inhumane" nature of the leghold trap, not to stop trapping (Gentile 1987). Current campaigns are largely similar to the initial ones because their primary strategy is to legislate against the leghold trap (Gentile 1987). Since 1970, the idea of stopping the killing of all wild animals has appealed to many individuals, however, and support for the abolition of trapping has progressively increased (Gerstell 1985). Many organizations (e.g., Animal Protection Institute, Animal Welfare Institute, Committee for Humane Legislation, Friends of Animals, and the Humane Society of the United States) argue that trapping is obsolete, cruel and unnecessary for wildlife management or human requirements. Within the United States, opinions on trapping are diverse and often reflect user groups. Based on a national survey, Kellert (1979) revealed that 78 percent of the general public but only 4 percent of trappers disapproved of conventional leghold traps.

As in the early days, anti-trapping groups play on human emotion and appeal to legislators, but strategies today have become more sophisticated, and campaigns enlist lobbyists and lawyers. Since 1900, more than 450 anti-trapping bills have been introduced in various state legislations and the federal Congress, and between 1968 and 1982, 90 local governments banned some form of trapping (Gentile 1987). From the beginning, anti-trapping groups acknowledged no obligation to provide a substitute for the leghold trap. Isolated efforts to find alternative traps have never included funding scientific studies, and consisted only of the offer of prizes/awards as incentives to inventors who could provide them with "truly humane" traps. This approach to develop new traps has so far been essentially fruitless.

Canada

In Canada, the perceived cruelty associated with the use of the leghold trap has been the subject of limited but persistent campaigns since the 1940s. In the 1950s, the Canadian Federation of Human Societies (CFHS) and the Canadian Association for Human Trapping (CAHT) became outspoken critics of existing trapping methods. What started as an anti-leghold trap crusade developed for some of the organizations into a campaign to destroy the consumer market for furs and a general attack on any human use of furbearers (SCAAND 1986). Although organized opposition to trapping evolved more slowly in Canada than in the U.S., Canada now appears to be a major international target of opponents of the industry. It may be that critics recognize Canada as more vulnerable to opposition campaigns against trapping than is the United States because of the smaller size of Canada and its high degree of dependence on foreign markets.

In contrast to animal welfare groups in the U.S., some Canadian organizations have actively searched for a humane trap. In the 1950s, the Association for the Protection of Fur Bearing Animals financially assisted Frank Conibear to develop quick-kill traps (SCAAND 1986). This trap, developed in Canada, qualified for a portion of the American Human Association's $20,000 award offered for the development of a new humane trap. The CFHS also established a Humane Trap Development Committee in 1968 and initiated the first scientific studies to develop more humane traps (Federal Provincial Committee for Humane Trapping [FPCHT] 1981). This program operated until 1973, but did not produce any suitable alternative to the leghold trap. Although the CFHS has many concerns about current trapping techniques in Canada, it acknowledges the value of ongoing research projects to develop more humane trapping systems (Gardiner 1986). In Canada, there have been no anti-trapping bills to date. However, the wildlife management authorities of three provinces have prohibited the use of conventional leghold traps in land sets for capturing most furbearers.

Global Perspective

On a global perspective, the anti-trapping movement has been even more apparent—more than 50 countries had banned the use of the leghold trap by 1980 (Nillson 1980). Gambia attempted to take the issue much farther by having the 1983 Convention on International Trade in Endangered Species (CITES) in Botswana support a resolution to prohibit export of furs from all countries permitting the use of the steel-jaw leghold trap (CITES Proceedings 1984). In a similar development, the 1988 meeting of the International Union for the Conservation of Nature (IUCN) in Costa Rica was asked to deal with resolution 17/32, 1987, which urges that the steel-jaw leghold traps be eliminated throughout the world. Both the CITES and IUCN resolutions were unsuccessful. Buoyed by their success in virtually destroying the Canadian sealing industry, many antagonists believe that a similar fate awaits the wild fur industry. Anti-fur campaigns have already been launched in the Netherlands, Switzerland and Great Britain (SCAAND 1986).

The Royal Society for the Prevention of Cruelty to Animals (RSPCA), the oldest animal welfare group in the world, has adopted a strong anti-fur position. Its entry into the battle, backed by very sophisticated anti-fur advertising and a public relations campaign, has given credibility to the anti-trapping movement. Recently, an Early Day Motion has been presented to the British house of Commons requesting the government to ban the import of all furs from countries that still legally permit the use of the leghold trap (Anonymous 1987). In addition, Britain now proposes to require the manufacturers of products containing fur from wild trapped canids and felids to attach a label stating the garment "includes fur from animals commonly caught in leg-hold traps." Britain appears to be the center of the anti-fur movement, although it has next to no fur industry of its own (Goddard 1986). There are similarities among the anti-fur campaigns underway in Britain, in that they all condemn the leghold trap but no group contributes money to trap research and development. These groups display almost total ignorance of trapping practices and regulations, use distorted facts and seem motivated by emotion (Goddard 1986).

The European and American Responses

Europe

In 1954, the British government established a Humane Trap Committee that had the mandate to develop by 1958 humane traps suitable to replace the gin trap (Lloyd 1963). The British government also offered £5,000 as incentive to individuals for developing alternative trapping devices (Collier 1957). Although the leghold trap was banned in Britain and Wales in 1958, no trapping device that approached the current Canadian standards resulted from any of these early British efforts. Today, fur trapping is not widespread in the European countries and most furs are imported or come from ranches in Denmark, Finland, Norway and Sweden.

In Sweden, Englund (1982) compared the injuries sustained to both teeth and legs of red foxes (*Vulpes vulpes*) captured in unmodified leghold traps, leghold traps with plastic covering and a newly designed footsnare. However, we are not aware of any comprehensive research program at present in place in European countries to find alternatives to the conventional leghold trap. The International Fur Trade Federation (IFTF), however, does provide significant financial support to the fur Institute of Canada's (FIC) research program (discussed later). Many European countries have responded primarily through restrictive legislation, especially relating to the use of the leghold trap.

United States

The Americans, in our view, have adopted an uncompromising defensive position in the face of the anti-trapping movement. In the 1950s and 1960s, organized trappers' associations were formed to air their position publicly. Trappers dismissed charges of cruelty by indicating that natural deaths of most wild creatures are far more cruel and painful than those met in traps. Trappers' associations advocated that furbearers were an important renewable natural resource that should be managed properly (Gerstell 1985).

During the period 1950–70, trappers' associations became the focal point for the dissemination of information about the status of state and federal trapping-related legislation. Associations also rallied members to become politically active and coached them in how to go about it (Gerstell 1985). Cattle ranches, wool growers, farmers, timber owners and others were lobbied to become involved by the realization that a trap ban would deprive them of the tool most often used to protect their livestock, crops and properties. These groups became strong allies in the flight to retain the use of the steel leghold trap (Gerstell 1985).

In 1975, the adamant, defensive posture of many American organizations and spokesmen was clearly evident at the U.S. Congress public hearings on proposed legislation relating to steel traps. The Honorable Don Young, U.S. Representative from Alaska, testified that the leghold trap " . . . is the most humane, efficient way to trap. . ." and discussed the impracticality of quick-kill traps and padded leghold traps. Duane Pursley, then Chairman of the Fur Resources Coordinating Committee of the International Association of Fish and Wildlife Agencies, also testified that ". . . the inhumaneness of leg-hold traps and their other alleged disadvantages have been greatly exaggerated . . . there does not exist a problem in connection with the use of steel leg-hold traps calling for federal intervention. . . ." In the United States, the atmosphere seems one of confrontation, where opponents in the trapping debate do not even speak to each other (Gerstell 1985). The resistance to change in trapping technology is clearly an American tactic, and there is some evidence that their approach has merit. Gentile (1987) indicated that the passage of restrictive legislation toward some aspects of trapping does not end the issue, but usually leads to the introduction of additional restrictive legislation.

The American response to the anti-trapping movement was not totally resistant. Trapper groups instituted educational courses where proper trapping techniques were taught. However, it was generally accepted that the leghold was the most practical and versatile trap which, when properly used, was not the medieval torture device claimed by its opponents (Daubel 1978). This view was apparently shared by many leading wildlife professionals because The Wildlife Society's 1985 policy directive on trapping stated that the Society "Recognize that the steel leghold trap represents an effective, practical means for capturing certain species of wildlife, . . ." (The Wildlife Society 1985). Schmidt and Brunner (1981) cautioned however that ". . . too many professional biologists tend to discount or ignore the concept of pain in animals." Indeed, the standard leghold trap on land has been rated as the most stressful trapping technique in common use (Todd 1987).

Financial rewards offered by the National Association of the Fur Industry, from 1925 to 1931, and by the American Humane Association in the 1920s and from 1949 to 1979, for new humane traps, were passive, fruitless searches for alternatives. To date, research in the United States has compared the efficiency of legholds of different models against each other (Linhart et al. 1986) and to quick-kill traps (Linscombe 1976), has assessed injuries caused by leghold devices (Bershielli and Tullar 1980, Linscombe 1986, Olsen et al. 1986), and has developed techniques for reducing injuries and increasing capture selectivity of the legholds (Linhart et al. 1981, Tullar 1984, Turkowski et al. 1984). These studies showed that it was possible to produce less injurious leghold traps, such as the Soft-Catch™ padded model, which presently are most promising but still appear unacceptable to many opponents of trapping. To our knowledge, an active research program to find an alternative to the leghold trap has never been developed in the United States. Furthermore, some American groups apparently are apprehensive about having findings from Canadian research programs forced on them by public pressure (Gerstell 1985).

The Canadian Response

Trapper Education

In the 1970s, trapper education courses became common throughout Canada. Today, 10 of 12 Canadian provinces or territories offer trapper education courses (DeAlmeida and Cook 1988). Also, in 1985–86, the Federal Department of Indian Affairs and Northern Development provided a national training course for native and northern trappers (SCAAND 1986). In 1983, the Fur Institute of Canada (FIC), a non-profit, federally chartered organization receiving both public and private funding, was created. FIC has three objectives—trapper education, public information, and trap research and development. FIC has created a task force to develop a national trapper education program that will address such issues as humane trapping procedures, pelt preparation and instructor training.

Public Information

The Canadian fur industry has learned from the experience of the anti-sealing campaign that it is vital to inform and educate the general public at home and abroad about the economic, social, cultural and historic importance of the fur industry in Canada. Independently and in cooperation with the Federal Environment Department and the Ecology Section (Denmark) of the International Fur Trade Federation, the FIC has issued a series of educational fact sheets and pamphlets. Moreover, indigenous people have become far more active in public education. Indigenous Survival International (ISI) represents 1.5 million aboriginal people in Canada, Greenland and Alaska, all of whom were affected by the collapse of the seal market. The ISI has launched an aggressive program to support their views and has met with a wide array of special interest groups including the European public at large. Similarly, the Aboriginal Trappers Federation of Canada (ATFC), an umbrella organization for aboriginal hunters' and trappers' associations across the country, has been visibly active in the fur debate and in the education of the Canadian public (SCAAND 1986). Participation by native groups has had substantial impact. In 1986, Greenpeace suspended a short-lived, anti-fur campaign following complaints by the Canadian native leaders who claimed that the campaign would threaten the livelihood and cultural survival of many northern Indian and Inuit communities.

Research

There are no parallels to the Canadian commitment to finding replacement devices for the conventional leghold trap through active research. In essence, Canada has recognized and is trying to resolve many of the trapping technology issues proferred by animal welfare groups as being unacceptable. From a tactical perspective, the large commitment to research by Canada has virtually isolated this country from the United States and other western nations.

There have been a number of milestones in the evolution of the Canadian program. Beginning in 1956, the Canadian government became involved in trap research and through the Canadian Wildlife Service and the National Research Council developed, and listed a number of killing prototypes. Efforts concentrated mainly on the engineering aspects of trap design, but the traps developed did not prove viable (SCAAND 1986).

Following additional research efforts from 1968 to 1973 by the CFHS, and in response to building pressure from a number of animal welfare organizations, the Federal Provincial Committee for Humane Trapping (FPCHT) was formed in 1973. FPCHT's mandate was, ". . . within a maximum of five years, to recommend to provinces, traps and trapping techniques for all furbearers which will, in so far as the state of the science or the art will allow, provide the greatest 'humaneness' in holding or killing furbearers. . ." (FPCHT 1981:11–12). This Committee received an extension and spent $1.3 million over seven years to gather scientific data on several aspects including mechanical properties of traps, behavior of animals in traps and forces required to kill different furbearers (kill thresholds). From trappers and inventors, it received 348 ideas or trap prototypes of which 16 were eventually judged as offering "humane potential." Again, despite the magnitude of the program, this extensive pioneering work did not develop any trapping devices to a point where they were recommended for marketing. Many of the prototypes judged as having "humane potential" were subsequently field tested and found deficient in terms of reliability, portability, efficiency or humaneness (Dwyer 1984).

With the formation of the FIC in 1983, the federal, provincial and territorial governments reaffirmed their resolve to improve trapping technology through trap research and development. Building on previous work the FIC has undertaken the most concerted research effort to date and has developed a multifaceted approach. A formal agreement between FIC and the Province of Alberta led to the installation of the Humane Trapping Research Program at the Alberta Environmental Centre in Vegreville. The research team consists of FIC and Alberta government funded biologists, engineers, technicians and related specialists. The objective is "to determine and/or develop for priority species one or more trapping devices that will allow, insofar as the state of the science or the art will allow the most effective (humane) harvest of furbearers''. To date, the research team is concentrating on improving killing trap systems that are used in Canada to harvest 12 species of furbearers in land sets (Jotham 1987).

Traps are tested in a series of sequential steps, most of which are carried out in the near-natural outdoor environment of the Centre's research compound. By protocol, candidate traps must meet performance standards established for each step. Traps are evaluated and modified until they can consistently place ≥5/6 animals in preferred strike locations (approach tests). In a series of tests with anaesthetized (preselection tests) and, later, unanaesthetized animals (kill tests), traps must render the animals unconscious and insensitive to pain ≤ 3 minutes (i.e., ≤3 minutes for small and medium-sized furbearers; time period based on FPCHT's work) with inevitable subsidence into death. Throughout the screening process, traps are mechanically evaluated and optimized (mechanical tests) (Cook and Proulx 1988) to meet FPCHT's (1981) energy threshold values. Once a trap has successfully passed all screening steps, it is further evaluated in additional kill tests to assess statistically its ability to kill target animals within three minutes (performance confirmation). Traps that pass all screening steps are tested on traplines in order to confirm their performance in relation to the compound tests and to evaluate their capture efficiency (field tests). During the last two years, the researchers have assessed a wide array of traps and have used mink (*Mustela vison*), marten (*Martes americana*), fisher (*Martes pennanti*), raccoon (*Procyon lotor*) and red fox (*Vulpes vulpes*) in compound tests.

Killing devices such as the planar Kania trap, the rotating-jaw Conibear series, spring-powered snares for the capture of canids and inventions (selected by the FIC's Trap Evaluation Committee) have been evaluated. Significant progress has been made and, in the case of marten and mink, a trap has been developed that meets all performance criteria of the compound testing program (Proulx et al. 1988a, 1988b). This mechanically improved rotating-jaw Conibear 120 trap was also field tested for marten and found to perform consistently and efficiently in the hands of professional trappers (Barrett et al. in prep).

In addition to the program at Vegreville, FIC has contracted research in a number of locations, including in the United States. There has been particular interest in assessing livehold trapping systems. Soft Catch leghold traps were found to reduce damage significant to red and gray foxes (*Urocyon cinereoargenteus*) and coyotes (*Canis latrans*) (Linscombe 1986), and FIC subsequently contracted with the University of Minnesota to carry out further research (Jotham 1987). A progress report on the physiological, pathological and behavioral response of red foxes to capture in Soft Catch legholds is now available (Kreeger et al. 1987). In addition, Environment Canada contracted with Laurentian University in Sudbury to evaluate a trapping system incorporating the use of ether in an airtight box or cylinder (Mallory and Dwyer 1987). The FIC recently has contracted Washington State University to begin research on the killing effectiveness of underwater trapping devices for beaver. In addition, the Alberta Department of Forestry, Lands and Wildlife has completed field testing a series of live-holding devices for coyote capture. Devices tested includes the Soft Catch, unpadded leghold trap, and two footsnares (A. W. Todd, pers. comm.).

Standards

Canada is the only country so far to have established national standards for specifications and performance of killing-type traps. The Canada General Standards Board (1984) has developed, for six categories of furbearers, performance criteria relative to the size, impact momentum, clamping force, strike effectiveness, field effectiveness and material standards for traps. Canada has been instrumental in creating, through the International Organization for Standardization (ISO) in Geneva, a committee to develop international standards for humane animal traps. This committee now has seven members—Canada, United States, Australia, Sweden, Finland, West Germany and Argentina. Canada, through its Standards Council, provides the facilities, secretariat work and leadership for this new committee. This new International Standards Organization Technical Committee No. 191, under the title of Humane Animal Traps, held its inaugural meeting on 19 March, 1987, in Quebec City, and agreed to scope of activity and established working groups.

Future Outlook

Based on recent international trends, we believe that opposition to the wild fur trade is likely to escalate in the near future. The long-term survival of the wild fur industry may be dependent on the ability of fur-producing nations to work with and satisfy the major complaints of animal welfare organizations. Indeed, the Canadian programs, particularly the research emphasis, reflect this philosophy. The more extreme animal rights groups, however, present philosophical positions that are seemingly impossible to resolve in the context of trapping. in our view, the more extreme groups that oppose trapping, hunting, fishing and farming will not receive enough support to affect current resource management philosophies and practices.

The current lack of international unity among fur-producing nations regarding trapping systems, standards, legislation, trapper education and public information, presents a degree of vulnerability to opponents. Anti-leghold trap resolutions at the most recent CITES and IUCN meetings may be examples of growing international dissatisfaction with the rate of progress with respect to trapping technology and legislation.

The issue of humaneness in the fur trade will never be resolved conclusively to the satisfaction of all opponent. Even with major progress, some anti-trapping groups will continue to challenge the performance standards of traps and the acceptability of some trapping systems. From a tactical perspective, however, Canada has committed to a long-term cooperative program in response to animal welfare concerns. The education, information and research programs carried out in Canada have gained, for the time being, the patience of many animal welfare organizations concerned with current trapping technology and furbearer management.

Recommendations for Canada

In the face of continuous controversy and criticism, it is essential for pro-trapping groups to consider all possible changes that would reflect positively on the fur industry and its proponents. From a Canadian perspective, we believe that the following recommendations are both appropriate and in the long-term best interest of the wild fur industry:

1. We encourage Canada, as a high fur-producing nation, to show leadership in responding to the major area of concern of animal welfare organizations by committing to an early phase-out of the conventional leghold trap for all terrestrial species. This program should begin immediately for species where suitable, and more humane devices are presently available.
2. Research programs must be retained to develop additional trapping systems that meet the national standards for the different categories of furbearers. Research is essential, particularly for those species that have received little attention to date and for which no sound alternative to the conventional leghold trap exists.
3. Through the ISO and other legitimate bodies, Canada must continue to lobby countries for international acceptance of rigorous trap standards. It is important that fur-producing nations take the lead in addressing the problems and not have change forced on them by agencies or countries that have little vested interest in the issue.
4. Governments in Canada are advised to implement a mandatory trapper education program for all first-time trappers, and institute special education workshops for veteran and native trappers.
5. The FIC has proven to be a strong and positive organization working on behalf of the fur industry in Canada. It must be retained as a permanent body with sufficient funding to continue the necessary coordination and support of programs beneficial to trapping.

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New Technologies Dealing With Marine Plastic Pollution and Efforts at Mitigation

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Introduction

Plastics were first produced commercially in 1868, when cellulose nitrate was used to make eyeglass frames. Plastic production and use, however, did not accelerate until World War II (Johnson 1987). Since then, production in the United States has increased at a near-exponential rate, with 48 billion pounds (22 billion kg; 1.2 trillion cubic inches [20 trillion cc]) of resin produced in 1985, and climbing. This is nearly double the combined output of steel, aluminum and copper (Manville 1987a). Currently, Americans annually generate an estimated 133 million short tons (121 million metric tons) of plastic waste—approximately 1,100 pounds (499 kg) per person. Plastic packaging represents about 3.7 percent (26,000 short tons/year [23,580 metric tons/year]) of the total waste stream by weight, but accounts for a considerably larger percentage by volume (Schneidman 1987). An estimated 9 million short tons (8.2 million metric tons) of solid waste per year generated in the United States are dumped at sea. Some 700,000 short tons (634,900 metric tons) of this is plastic (MacKenzie 1987).

Disposal of the resultant plastic waste, including both raw plastic and manufactured materials, has become a worldwide problem as vast quantities of plastic end up in the world's oceans (Smart et al. 1987). These compounds not only are durable, persistent—many estimated to last for hundreds of years before breakdown—and generally nondegradable, but they are estimated to kill millions of nontarget marine vertebrate organisms annually. Many of these organisms are members of endangered species (e.g., Gulf of California harbor porpoise [*Phocoena sinus*], Florida manatee [*Trichechus manatus*], right whale [*Balaena glacialis*], Hawaiian monk seal [*Monachus schauinslandi*], and Kemp's Ridley sea turtle [*Lepidochelys kempii*]) (U.S. Fish and Wildlife Service 1987).

Many of the products created from raw plastic—including fishing nets, fishing line, rope, buoys, strapping bands, six-pack yokes, bags, sheeting, styrofoam, bubble wrap, tampon applicators and even syringes—and the raw plastic particles themselves are extremely injurious to virtually all marine vertebrate organisms, including commercial and sport species, as well as many invertebrates (O'Hara and Iudicello 1986, O'Hara et al. 1986, Wallace 1985). In fact, plastic alone may be as great a cause of mortality to marine mammals, seabirds and sea turtles as are oil spills, pesticide poisoning or contaminated runoff (Schneidman 1987). In addition, garbage-strewn beaches are aesthetically unpleasing, discourage tourism and are costly to clean up. Plastics also foul boat propellers, block cooling intake vents, snag fishing equipment, entangle submarines and endanger divers.

The problem is worldwide in scope, but the U.S. is a major contributor, disposing of perhaps one-third of the plastic refuse found in the Northern Hemisphere's oceans today (Manville 1987b). Until recently, little concern or interest was shown by public, industry, port, fishery, wildlife or governmental groups. This, in part, was due to lack of information about the problem, lack of a constituency to represent the concerns of impacts of plastics on fish and wildlife resources, and lack of legislation to deal with the problem both on the federal and state levels. Much has happened in the United States over the past four years, most significantly in 1987, to begin dealing with this plastics problem. This paper will discuss the most important changes, including legislative, regulatory, scientific, commercial, educational and environmentally mitigating measures.

Discussion

Source and Types of Plastic Problems and Their Impacts on Fish and Wildlife

Marine plastic debris. The ultimate source of most of our plastic is petroleum. Although a few photodegradable and even fewer biodegradable plastics are being manufactured and marketed in North America—most are now only available in Europe (Society of the Plastics Industry 1987)—much more research and development on degradable plastics are needed. Marine plastic debris comes in two forms: (1) ***manufactured compounds*** including nets, bands, yokes, sheeting, bags, bottles, etc.; and (2) ***raw plastic particles***. Raw pellets resulting from the manufacture of finished products often are dumped into sewer systems, most of which are overworked and many of which are outdated, inadequate or improperly maintained, or are suspected of not complying with regulations. As a result, this raw plastic often bypasses sewage systems during peak, high-demand periods such as heavy rains and storms, or these plastics simply may not be adequately trapped in sewage screens and wiers during normal operations. In addition, other raw plastic is disposed of in landfills, where it may blow or wash into the marine ecosystem (Manville 1987b). Finished plastic products such as plastic tampon applicators, condoms, and thin pieces of plastic sheeting from sanitary napkins and disposable diapers also often find their way into sewage effluent (Swanson et al. 1978). Much of this plastic thus ends up in the ocean.

The origin of plastic debris thus can be further classified as ***land-based*** or ***ocean-going***. Although attempts have been made to quantify at-sea plastic debris, these attempts are difficult to make and yield only rough estimates. Dahlberg (1985), for example, found more than 80 percent of the debris sighted at sea to be plastic, with over 33 percent of this consisting of pieces of expanded polystyrene (cups, floats, boxes, etc.). His observations were limited to floating debris, however, which does not include plastic materials denser than sea water such as nylon nets. Because of the growing concerns about the aesthetic deterioration of our nation's coastline, a number of recent beach cleanup surveys have been conducted (e.g., Centaur 1986), but their findings tend to overemphasize floatable plastics while often excluding those plastics denser than sea water.

Incidental take. Plastics kill, debilitate or injure marine vertebrate (and some invertebrate) organisms in one of three ways, including active fishing, passive means and ingestion. Those nontarget animals captured in active fishing nets, seines, trawls or related equipment are termed ***incidental take*** or ***bycatch***. Numerous observations have been made and estimates of nontarget kills are often astounding. Scientists from the Point Reyes Bird Observatory, California, estimated that a minimum of 29,700 common murres (*Uria aalge*; > 17 percent of the area's population) died in 1983 in halibut gillnets (Center for Environmental Education 1984, Carter 1986). Although gillnet regulations were enacted to stop or reduce the mortality, the California Department of Fish and Game estimated that 6,000–8,000 murres died in 1984 and 1985. In addition to common murres, California's annual mortality from all gillnet types has included the drowning of at least 1,000 seal lions (*Zalophus californianus*), 100 harbor seals (*Phoca vitulina*), 25 elephant seals (*Mirounga angustirostris*), and 30 pilot whales (*Globicephala melaena*) (Miller et al. 1983). In the Danish salmon driftnet fishery, which operated off Greenland between 1965–1975, an estimated 500,000 thick-billed murres (*Uria lomvia*) were killed annually (Degange and Newby 1980). Between 350,000–450,000 seabirds were reported killed annually between 1975–1977 in Japanese gillnets in the North Pacific and Bering Sea; the majority of these were thick-billed murres (Bourne 1977).

Salmon, marlin and squid driftnets in the North Pacific today remain egregious in their take of mammals and birds; the Japanese nets apparently are inflicting the greatest losses. At least 111,600 miles (180,000 km) of gillnet are available for use by various foreign fisheries in the North Pacific fishery alone, an amount of net that would stretch 4.5-times around the world (Gerrodette et al. 1987). Each day during the five-month fishing season, some 20,500 miles (32,985 km) of driftnet are set by more than 700 Japanese, Taiwanese and Korean boats in international waters. Current season take of marine mammals could total ≥125,000, including Dall's porpoises (*Phocoenoides dalli*)—7,000–14,000 of this species alone may die—Northern fur seals (*Callorhinus ursinus*) and others. Since there are no restrictions on incidental take of marine mammals there, and U.S. observers are presently not allowed on board foreign vessels, mortality estimates are sketchy (Hinck 1986).

Considerably more is known about the incidental take of seabirds and mammals within our U.S. 200-mile fisheries conservation zone (FCZ). Estimates now indicate that from 250,000–750,000 seabirds die each year in salmon driftnets. In 1984 alone, more than 50,000 short-tailed shearwaters (*Puffinus tenuirostris*) and 20,000 tufted puffins (*Lunda cirrhata*)—27 percent annual mortality of this species—died in Japanese driftnets in our FCZ, according to National Marine Fisheries Service (NMFS) scientists. Although the Japanese claim that the annual take of Dall's porpoise in our FCZ has decreased from 3,000 in 1985, to 1,800 in 1986, many seriously question the reliability of these reported figures. A decision regarding the Japanese incidental take permit for Dall's porpoise, under legal appeal, was upheld in the Court of Appeals.

Biologists feel that the decline of the critically endangered vaquita (Gulf of California harbor porpoise) may be due in substantial part to exploitive take in totoaba (*Totoaba macdonaldi*) gillnets to which the porpoises are quite vulnerable. Although the totoaba is also endangered and protected by the Mexican government, illegal fishing continues, along with an incidental take of the porpoise (Brown 1987, Silber 1987).

Another incidental take issue involves the capture of endangered and threatened sea turtles in shrimp trawl nets in waters from North Carolina to Texas. According to estimates by the NMFS, Southeastern shrimp fishermen catch as many as 45,000 sea turtles annually, principally threatened loggerhead turtles (*Caretta caretta*). Some 12,600 of these turtle drown every year in the nets. Also at risk are the endangered Kemp's Ridley, hawksbill (*Eretmochelys imbricata*), and leatherback (*Dermochelys coriacea*) sea turtles, and the threatened olive Ridley (*Lepidochelys olivacea*) turtles (Weber 1987). The entire female breeding population of Kemp's Ridley turtles may number no more than 520 today, down from 40,000 in 1947. NMFS regulations now going into effect require shrimp fishermen to install nets or grates called "turtle excluder" or "trawling efficiency devices (TEDs)" in their offshore Gulf of Mexico trawl shrimp nets. The TEDs deflect virtually all sea turtles but allow shrimp to pass through unharmed. In addition, the TEDs are designed to reduce the tremendously large bycatch of finfish—approximately 10 pounds of fish for every pound of shrimp—presently estimated at 1.1 billion pounds (0.5 billion kg) of fish caught in federal waters from Texas to Tampa Bay, Florida (Fee 1988). Regulations for inshore TEDs use should go into effect in two years.

Entanglement. The term ***entanglement*** refers to the capture, entrapment and often death of numerous freshwater and large numbers of coastal and pelagic marine organisms in lost or discarded plastic debris. Among the most damaging are "ghost nets"—lost or discarded nets or net fragments—which can continue to fish for years. They sometimes sink from the weight of dead animals, seaweed or barnacles, and continue to catch fish on the oceans' bottoms. They also may ball up and continue to float, or they wash ashore. Packing bands, six-pack yokes, nets, net fragments and other plastics bind and/or strangle virtually every species of marine mammal, sea turtle, seabird, many varieties of fish and numerous invertebrates.

Perhaps the best documentation of the results of entanglement involves Northern fur seals. Extensive data, including the incidence of entanglement scars, were collected through 1984 from young male seals killed in the annual commercial seal harvest on the Pribilof Islands, Alaska. These and other data indicated an alarming trend. The population is declining annually at 4–8 percent; its numbers are now less than half of that 30 years ago. Entanglement, particularly in trawl net fragments, plastic packing bands, and other plastic trash is believed to be the primary contributing factor in the species' decline (Fowler 1982, 1987, Fowler and Merrell 1986), resulting in an annual estimated mortality of 30,000–50,000 seals. Reported incidents of observed seal entanglement in land-based salmon gillnets in the North Pacific also continued to be high for 1986 and 1987, with clear documentation that fur seals are attracted to driftnets during haulbacks (U.S. Coast Guard 1987). Previous research also indicated that captive seals demonstrated a tendency to swim toward plastic packing bands and net fragments and insert their heads. Some animals were able to free themselves, others were not (Yoshida et al. 1985).

The Japanese claim the problem of lost driftnets in the North Pacific is negligible, estimating that only 0.05 percent of their net sets are lost per operation (the NMFS estimate is 0.06 percent). When applied to the setting of more than 20,500 miles (32,985 km) of net per night (over 1,065,000 miles [1,713,585 km] per season), a 0.06 percent loss of net means at least 12 miles (19.3 km) of net are lost each night and 639 miles (1,028 km) of net each season (Hinck 1986). These figures do not account for discarded nets or net fragments.

Although documented evidence of entanglement is often anecdotal—most deaths are unobserved by man—there are rough estimates of annual mortality, including at least 100,000 marine mammals that are believed to die in nets, net fragments and plastic debris (especially packing bands, six-pack yokes, and related materials) either by drowning, from exhaustion or by starvation (MacKenzie 1987). Even endangered great whales fall victim to entanglement; 79 deaths were reported from entanglement off the coasts of North America during the past 6 years.

Plastic debris ingestion. Debris ingestion is a third major problem for marine organisms. Raw plastic particles including spherules, nibs, cylinders, beads, pills and pellets—the raw materials from which plastic products are manufactured—and the breakdown products of finished plastic items such as styrofoam cups are mistakenly ingested by numerous seabird, mammal, turtle and fish species (Wehle and Coleman 1983). A growing documentation of the fatal impact of plastic bag ingestion on threatened and endangered sea turtles emphasized that it is a matter of grave concern (Carr 1983). Sea turtle ingestion of plastics has been documented in leatherback, green (*Chelonia mydas*), olive Ridley, hawksbill and other turtle species. Floating plastic bags are probably mistaken for jellyfish, a favorite food of sea turtles (MacKenzie 1987).

More than 50 of the 280 species of seabirds are known to ingest plastics (Day et al. 1985, Bean 1987). A recent study of Laysan albatross (*Diomedea immutabilis*) in Hawaii found that 90 percent (45) of the 50 chicks had plastic in their gullets fed to them by their parents, apparently mistaking the plastic for food. In another study off Oregon's shores, stomach contents of nine sooty shearwaters (*Puffinus griseus*) contained 38 percent plastic particles by number of prey items (Matthews 1986). In addition to obstructing digestive tracts, plastic pellets cause ulcerations and often starvation.

A review of the literature indicated that at least 10 species of cetaceans, 2 species of pinnipeds and the Florida manatee had been shown to ingest plastics (O'Hara and Iudicello 1986, O'Hara et al. 1986). Fish also are not immune to plastics, as the literature indicated that at least eight species off New England ingested opaque polystyrene pellets. Bottom fish were reported to have the greatest concentrations of ingested pellets as noted in several species of bottom fish off Great Britain. At least 30 percent of the fish examined in another study were reported to have ingested plastics (O'Hara and Iudicello 1986).

So what's being done to deal with this massive problem?

Mitigation Through Citizen and Environmental Action

Activities of concerned citizens and environmental organizations are one of the major reasons why substantive steps have been taken recently to begin dealing with the massive plastics problem in the United States. These activities have included citizen involvement (e.g., letter writing campaigns, beach cleanup efforts, public workshops, etc.), direct and grassroots lobbying efforts, efforts to educate Congress and presentation of testimony. In 1983, at a time when there was little public involvement and essentially no federal government concern, Nancy Wallace organized a coalition of 14 environmental, conservation and animals welfare groups called the Entanglement Network Coalition (Network). She helped coordinate the first international conference ever held on the fate and impacts of marine debris, held in Honolulu, Hawaii in November 1984 (Wallace 1985). Wallace chaired the Network until early 1985 when she became inactive. In the summer of 1986, with apparent elevated public interest and awareness of the plastics problem—including some national media coverage—and interest from some Congressional legislators who were planning to introduce bills targeted at the plastics problem, I reactivated and took over chair of the Network. Several additional environmental organizations were then invited to join the Network, with membership today at over 38 organizations. We attempt to function as the voice of the environmental community concerning plastic pollution.

Network members/participants and many of the individual organizations' respective members and activists have done much to elevate concerns about plastic pollution. In August 1986, several groups in the Network testified before Representative Gerry Studds (Dem.-Massachusetts), then Chair of the House Subcommittee on Coast Guard and Navigation, Committee on Merchant Marine and Fisheries. This was the first hearing ever held on the issue of plastic pollution in the marine environment. In 1987, several members of the Network met with key Congressional staff, helping them design and draft future precedent-setting federal legislation dealing with marine and freshwater plastic pollution. The Network presented testimony for two hearings held on H.R. 940 (Manville 1987b), testifying before one of these hearings, and presented testimony before a Senate hearing on S. 559, S. 560 and S. 633 held on September 17. President Reagan ultimately signed the bill into law on December 30, 1987.

Other activities of the Network have included endorsing proposed amendments to NMFS fishery management plans for crustacean fisheries in the Western Pacific region and American lobster (*Homarus americanus*) fishery. We recommended the use of degradable panels in the American lobster fishery. In 1978, roughly 525,000 inshore and 18,000 offshore lobster traps were lost off New England, resulting in the estimated loss of more than 1.42 million pounds (0.64 million kg) of lobster (O'Hara et al. 1986).

In June 1987, the NMFS published final regulations phasing in requirements for the use of TEDs by some shrimp fishermen from North Carolina to Texas. The regulations state that all shrimp trawlers $\geq$ 25 feet (7.6 m) in length fishing in offshore waters are required to use TEDs during specified periods. Smaller trawlers and those boats fishing inshore are required to restrict net tow times to $\leq$ 90 minutes. The regulations, which the Network strongly endorsed, became effective in October 1987. On December 17, the House of Representatives defeated 273 to 136 an eleventh-hour move by Representative Solomon Ortiz (Dem.-Texas) to delay for two years regulations requiring shrimpers to use the TEDs in offshore waters. The Ortiz effort was offered as an amendment to the Endangered Species Act (ESA) Reauthorization bill during floor debate on H.R. 1467. Thirty-one members of the Network signed a letter sent to all House Members opposing the Ortiz amendment and many groups lobbied to oppose the effort. The House passed the reauthorization bill 399 to 16. Action on the ESA is now pending in the Senate.

In a lawsuit filed in May 1987, seven environmental organizations—including six from the Network—challenged a permit issued by the Commerce Department that allows the taking of marine mammals by the Japanese salmon driftnet fishery within our 200-mile U.S. FCZ. U.S. District Court Judge Norma Johnson issued a preliminary injunction against the permit which became effective July 13, 1987. On February 16, 1988, the U.S. Court of Appeals for the District of Columbia Circuit upheld Judge Johnson's decision, granting a permanent injunction against the permit. The original permit was issued in May 1987, establishing a three-year block quota on the incidental take of 6,039 Dall's porpoise. However, the permit prohibited the take of Northern fur seals because the Pribilof Island stock is depleted and there is uncertainty as to the status of the Commander Island stock. Under the Marine Mammal Protection Act (MMPA), permits may not be issued for the taking of depleted species. Significantly, the permit acknowledged that, despite the prohibition on taking Northern fur seals, harvest was inevitable, and observed violations would be subject to fines. But the permit left vessel observer coverage at only 6 percent, which members of the Network felt was inadequate and far below the 100 percent coverage required for every other foreign fishing fleet operating in U.S. waters. Although the permit represented a marked improvement over the original Japanese request for 5,500 take of Dall's porpoise annually, as well as 450 Northern fur seals, and 25 Northern sea lions, it allowed the continuation of a fishing technology that is ecologically devastating and economically wasteful (Wilkinson 1987).

Coastweeks, now in its sixth year, is an effort to focus public attention on our U.S. coastal resources and their importance as habitats for birds, mammals and fish. In the past, popular Coastweeks events have included, among other activities, beach cleanup efforts. These events have involved quite a number of groups in the Network, as well as their respective members and activists. Coastal cleanups were an important component of last year's activities with beach cleanups in 19 states, many on a statewide scale. Several of the environmental organizations as well as some of the state agencies involved in Coastweeks '87 plan to publish the data on the amounts and types of debris picked up during the cleanup efforts. Preliminary information indicated that more than 26,500 volunteers covered more than 1,800 miles (2,896 km) of U.S. coastline and collected nearly 700 short tons (635 metric tons) of trash (O'Hara 1987). Approximately 60 percent of the trash consisted of plastic.

In order to get information to Network groups on a timely basis, newsletters are periodically published, and sent too nearly 1,000 press and media contacts nationwide, all Congressional offices, key agency personnel, and individual Network members/participants.

Mitigation through Legislation and a Treaty

Federal authorizing action. Although some argue that further documentation of the impacts of plastics on fish and wildlife are necessary, recent actions by the U.S. Congress would indicate otherwise. By the fall of 1987, legislators in the 100th Congress had introduced 10 bills dealing with various aspects of the plastics pollution problem. Most comprehensive of these was H.R. 940—The Plastic Pollution Research and Control Act of 1987—introduced and later amended by Representative Studds. It was reported favorably out of the House Merchant Marine and Fisheries Committee on September 22, 1987. On October 13, the full House overwhelmingly (386 to 14) approved the legislation designed to reduce the growing environmental hazards posed by the widespread dumping of plastic refuse in the oceans. Most significantly, the bill calls for an outright prohibition on the dumping of plastic by all vessels within 200 miles of our coastline as well as in our navigable freshwaters. The bill further calls for studies on the effects of plastic pollution in the marine environment, as well as methods to reduce the amount of plastic debris. A "New York Bight Restoration Plan" will require the Environmental Protection Agency (EPA) to identify and assess the types, sources and impacts of plastic pollutants entering the New York Bight area as well as methods for controlling these pollutants. The EPA will be required to report on land-based sources of plastic, study recycling and look at the end products of degradability of plastics. The bill will require the U.S. Navy to comply with the plastics dumping provision within five years (which may be extended by Congress, if necessary), and will allow the U.S. Coast Guard to enforce the bill's provisions against foreign flag ships to the extent of our 200-mile limit. The bill also will require the use of log books and development of shipboard waste management plans by all captains of the U.S. vessels, with stronger penalty provisions for not using them. The bill lastly requires the Department of Commerce to participate in a public outreach program, including the formation of "citizen pollution patrols" to assist the monitoring, reporting, cleanup and prevention of ocean and shoreline pollution.

On September 17, Senator Mitchell (Dem.-Maine) held hearings in his Senate Subcommittee on Environmental Protection of the Environment and Public Works Committee on S. 559, S. 560, and S. 633, legislation comparable to H.R. 940. After being favorably reported out of the Senate Environment and Public Works Committee later in the fall, both House and Senate versions were appended as riders to the "United States-Japan Fishery Agreement Approval Act of 1987" (H.R. 3674). The bill was approved by the full House in December 18 (382–13), by the Senate on December 19, and signed into law by President Reagan on December 30 as Public Law 100–220.

Passage of H.R. 3674 implements a section of the International Convention for the Prevention of Pollution from Ships, known as Annex V of the Marine Pollution (MARPOL) Protocol. Annex V is the international counterpart to H.R. 940, which would ban the open-ocean dumping of all plastics worldwide by any nations party to the treaty. The MARPOL Protocol was unanimously reported out of the Senate Foreign Relations Committee on September 25, and was ratified by the full Senate, 96 to 0, on November 5. On December 30, the U.S. officially notified the International Maritime Organization (IMO) in London that the Senate had approved Annex V of MARPOL. The Annex will be put into force one year from that date since U.S. ratification resulted in approval by countries representing 50 percent of the world shipping tonnage. The Reagan Administration officially notified the IMO immediately after the President signed the U.S. domestic legislation, "The Marine Plastic Pollution Research and Control Act," P. L. 100–220, Title II.

Two bills—S. 62 introduced by Senator Ted Stevens (Rep.-Alaska), and the identical companion version, H.R. 537, introduced by Representative Charles Bennett (Dem.-Florida)—were designed to begin dealing with the North Pacific salmon driftnet problem. A hearing was held on April 30, 1987, in the Senate National Ocean Policy Study Subcommittee of the full Committee on Commerce, Science and Transportation. Several Network members presented testimony. Although both bills contained provisions to protect seabirds within 60 miles (97 km) radius of the Aleutian Islands, this seabird protection provision was opposed by the Reagan Administration, which claimed that the proposed zone violated existing treaties with Japan. As a compromise measure, Representative Studds introduced H.R. 3584, which called for negotiated agreements to monitor and control driftnet fishing in the North Pacific (Blockstein 1988). Like H.R. 940, H.R. 3584 was appended to the "United States-Japan Fishery Agreement Approval Act of 1987" (H.R. 3674), and signed into law by President Reagan on December 30. The law will require negotiations with foreign countries fishing outside our 200-mile limit; more extensive observer coverage; studies and reports on driftnet impacts; an analysis of net marking, registration and bounties; and a study of driftnet tracking. Noncompliance could mean Pelly Amendment certification.

Of the other bills introduced by legislators into the 100th Congress, most provisions were incorporated into P.L. 100–220. Although significant steps were taken by passing this legislation, Congress has not yet begun to deal with several major underlying issues: the proliferation of plastic in our society; need for a nationwide recycling effort; and the need to substitute biodegradable materials for nondegradable plastics.

Federal appropriations action. Four years ago, a fledgling marine entanglement research and education program was funded by Congress for $1 million for Fiscal Year 1985, in part due to lobbying by the Network. The program is run under the guidance of Jim Coe of the NMFS in Seattle, Washington. For the next three years, Congress funded the program at the $0.75 million level. Although Coe has had a small budget to work with, he has done much to disseminate important data on entanglement to the scientific community, and to educate Congress, industry and the public.

Other federal action. In response to a letter from 30 Senators, the White House established an interagency task force on plastics in July 1987. The group consists of 11 federal agencies, chaired by the National Oceanic and Atmospheric Administration. A task force report is scheduled for release in April 1988.

In an effort to get the U.S. Navy to comply with H.R. 940 (later P.L. 100–220), which will require no ocean dumping of any plastics fleetwide within five years, a staff member from Representative Jim Howard's (Dem.-New Jersey) office and I drafted language for House Resolution 183, referred to the House Armed Services Committee on September 14, 1987. The Resolution expressed the sense of the House of Representatives that the Navy should expedite an environmentally sound trash disposal system, including prohibition of the elimination of plastics. In part as a result of this Resolution, as well as a meeting I had with the Navy's key environmental liaison, an Ad Hoc Committee on Plastics was formed early in the fall. The Committee consists of 10 environmentalists (9 from the Network), key Congressional staff and Navy personnel. The Committee's goal is to present the Navy with a detailed series of recommendations regarding our perception of how the Navy might best solve its plastic waste management problem. Eight meetings as well as field trips on board Naval vessels, including the USS Forrestal while deployed on cruise in the Caribbean, should result in substantive and hopefully useful recommendations.

State legislation. To date, 11 states have passed laws banning nondegradable six-pack beverage yokes. These include Oregon (with a 120-day degradable restriction), Alaska (two-year degradable restriction), California, Connecticut, Delaware, Maine, Massachusetts, New Jersey, New York, Rhode Island and Vermont. These states all have approved the use of Hi-Cone ECO photodegradable yokes, their degradation dependent on a certain intensity and duration of exposure to ultraviolet light—an opportunistic situation. Senator John Chafee (Rep.-Rhode Island) reintroduced legislation in 1988 that would ban nondegradable beverage loops nationwide.

Louisiana recently passed a litter bill giving broad authority to the Department of Environmental Quality, while Michigan and Pennsylvania have degradable legislation pending. Maine and Connecticut recently passed laws requiring use of degradable lobster trap panels. Other states have plastics legislation pending, including: New Jersey, with a ban on polystyrene and other plastic packaging; Washington, with a statewide ban on plastic food packaging and disposable diapers; and Minnesota, with a ban on six-pack yokes and grocery and dry cleaning bags.

With the United States running out of space in which to put its solid waste, many state and local governments are considering additional measures to ban certain plastic products. More than half of the nation's municipal landfills are nearing saturation, and groundwater contamination has also become a major issue. New York State, for example, mandated the closing of all landfills on Long Island by 1990 (Lee 1987). The State also is working to eliminate all foam packaging used by fast-food chains and switch to paper packaging that could be recycled (Lee 1987).

City and county regulations. In Berkeley, California, foam plastic food containers made with chlorofluorocarbons (CFCs) were banned from 400 fast-food outlets and markets as of January 31, 1987. The ordinance was passed to reduce both nondegradable wastes and to protect the environment. CFC emissions deplete the earth's ozone layer, which protects us from excessive amounts of cancer-causing ultraviolet radiation.

In Suffolk County, Long Island, New York, legislation banning fast-food packaging made of polystyrene and polyvinyl chloride—two plastics with no developed recycling market—and convenience-store plastic bags, was passed in late March 1988. The intent of this precedent-setting legislation is to simplify packaging and encourage recycling.

Mitigation through Research

Degradable plastics. The accelerated deterioration of plastic occurs today in three different ways. The first is by ***photodegradability***, which occurs as a result of adding a photosensitive polymer. The rate and extent of photodegradation are governed by the amount of light energy absorbed by the plastic (Andrady 1987). If the plastic is buried in a landfill, in ocean sediments, or under thick ice or snow, it will degrade no faster than ordinary, nondegradable plastic. Hi-Cone ECO plastic now required for use in six-pack rings in 11 states is photodegradable. The Coca-Cola Company used Ecolyte plastic in its beverage cups at the 1988 Winter Olympics in Calgary, Alberta, Canada. Webster Industries, Peabody, Massachusetts, is one of a few other companies in the United States that markets photodegradable products, including trash and garbage bags.

Biodegradation is defined as the breakdown of a plastic polymer—ultimately to small molecules—by the action of microorganisms such as bacteria and fungi. Although few such products are sold in the U.S. today, one such product is made from a cornstarch-polyvinyl alcohol material developed into water-soluble laundry bags by Mono-Sol Corporation of Gary, Indiana. Although the material is fairly weak, it has additional promise as a fast-food wrap and agricultural mulch film (Portnoy 1987).

Another biodegradable plastic with great potential is that made from chitin, the material which makes up the exoskeletons of lobsters, crabs, shrimp, insects, mollusks, and other organisms. Industrial exploitation of chitin is today virtually at a standstill in this country due to difficulties with reliability, convenience and quality control of chitosan, a chief derivative of chitin from which the plastic is made. One patent-pending process for production of pure chitosan from shellfish waste holds great promise. The plastic has high tensile strength (>20,000 psi), and degrades by common bacteria. More research and development are needed, however.

Flexell Chemical Company sells a biodegradable cellophane made of 100-percent plant fiber cellulose, the material marketed by Earth Care Paper Company of Madison, Wisconsin. Their main products are sandwich and bread food storage bags.

The third type of degradability is termed ***physical biodeterioration***. Plastic materials are physically broken down into fine powder, rather than actually being attacked by microorganisms. Polyethylene is broken down in such a manner by the forces of nature.

Conclusion

To deal with this plastics problem will require a multifaceted approach, including recycling, waste reduction, use of degradable plastics, return to biodegradable non-plastic alternatives, improvement in the laws and enforcement on dumping. Industry and the general public must become more conservation-conscious, overturning our current "use it and discard it" mentality. To begin to deal seriously with this problem the Plastics Institute of America, for example, has scheduled a symposium in May 1988 on the business opportunities in plastics recycling. One recommendation regarding recycling is to take a closer look at Japan's waste management scheme. Over half of all discards are recycled there, with most of the remainder burned for energy recovery. Landfilling is reserved only for treated residues and inert wastes (Hershkowitz and Salerni 1987). A few states have begun to take some action, including Oregon, Rhode Island and New Jersey, which implemented legislation making some recycling mandatory.

Solutions will require new technologies, new initiatives and different directions. Although Americans may seem wedded to a throw away lifestyle, we are capable of change.

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Special Session 4. *Implementing Conservation Provisions in Federal Agricultural Programs*

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Institutional Challenges in Implementing Conservation Compliance

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There is a new era emerging in American agriculture, an era that promises to re-establish a constructive relationship between farming and wildlife. This new era has been ushered in by the conservation provisions contained in the 1985 Food Securities Act (or Farm Act).

Probably the most significant of the several historic conservation features of that Act, over the long run, will be the "conservation compliance" provision. Under these new rules, farmers who cultivate highly erodible land will need to have an approved conservation system on their land, or at least to have developed an accepted plan and implementation schedule in order to qualify for federal farm program payments after 1990. By 1995, they will be expected to have those plans implemented. In other words, farmers will soon be expected to meet minimum conservation standards in order to receive federal benefits. That changes the "bargain" between the federal government and farmers in a substantial way, and the impact will have significant impacts on the agencies and programs involved.

This new reform in the relationship between the federal government's farm programs and the nation's farm and ranch operators should, if it works the way it is envisioned, result in major improvements in the use and treatment of agricultural land. That could result in reduced soil erosion, water runoff, pollution and permanent land degradation. There is little doubt that, at the same time, it will improve wildlife habitat markedly.

But the transition into conservation compliance does not promise to be an easy one, and there is certain to be strong and vocal resistance on the part of some farmers as they begin to understand what is expected of them. This will translate into political controversy, both at the local and national levels.

At the national level, it is reasonable to anticipate efforts to overturn the conservation compliance provisions in the 1985 Farm Act, or at least extend the period of transition before the new rules take effect. That will no doubt begin during the upcoming debate over the 1989 Farm Bill. The coalition of conservationists and organizations who helped support the enactment of the 1985 Act will need to fight to prevent its emasculation in Congress.

The issues are likely to be more clear-cut than they have been in the past eight years. In both 1981 and 1985, the Reagan Administration proposed to phase out most or all of the price supports, loans and other farm programs that provide economic support to farmers. If those programs were to vanish, farmers could ignore conservation compliance requirements with little or no immediate cost or penalty. Obviously, that did not happen. The economic collapse of American agriculture forced policy makers to create more farm subsidies, not fewer, and conservation compliance became a very important aspect of farm policy.

Its a little early to guess right now, but it seems certain that the economic situation in agriculture will force the 1989 Farm Bill to contain a continuing program of production controls associated with price supports. If that is the case, those programs will be very important to most farmers, and conservation compliance will be equally critical. Therefore, the battle in 1989 probably will center around attempts to weaken or eliminate the compliance provisions or, at least, to stretch the deadlines. Again, its too early to tell, but the current mood of Congress suggests that it will be possible for conservationists to defeat those attempts. Congress is out of patience with farmers who want federal largess but refuse to farm their land in a socially responsible way.

What may be more difficult—and dangerous—however, will be the last-ditch efforts of the program's opponents. If they lose in the attempt to water down the bill, they will turn attention to the funding of the agencies that administer it. Cutting funding for federal agencies is a popular political cause, and assuring that the conservation provisions cannot possibly function is possible if the budget-cutters succeed.

At the local level, however, the issues will be less clear-cut. Both the Soil Conservation Service (SCS) and the Agricultural Stabilization and Conservation Service (ASCS) face a heavy workload as they prepare conservation plans and certify farmers' performance. They have begun much of the work already, and in some states most if not all of the farmers who will need to develop farm plans have been identified, located and informed of their options. This is, of course, happening at a time while federal agencies face budget cuts, personnel limits and reduced staffs.

SCS has never had a role that approximates regulatory enforcement as closely as this one. Historically, they have succeeded in being accepted by rural people because their field technicians were seen as supportive helpers, not policemen. The agency now faces significant institutional change, and challenge, as farmers who have long accepted soil surveys and other technical information as helpful but largely inconsequential now begin to question each detail closely, because its interpretation means many thousands of badly needed dollars in their pocket.

But USDA has given this program its highest priority support, and Congress has responded with supplemental funding that has allowed these agencies to maintain fairly well their staff levels, so the USDA effort to implement conservation compliance is going about as well as might be expected at the moment. The real institutional crunch lies ahead, but that is a fact not lost on the administrators of the agencies, and they are doing everything possible to gear up for the inevitable challenges that will mark the decade of the '90s.

One example is the intense effort being made by SCS to get as many farmers into the process of developing a plan as possible. In a small informal sample of SCS field offices recently, I came away with the impression that somewhere around 10 percent of the farmers needing plans have already prepared them, or are fairly far along in the process. That sounds encouraging, but not too surprising. There has always been a fair percentage of farmers who have been conservation-conscious, and who have been fairly cooperative with the voluntary programs of the past. If these percentages begin to approach 50 percent somewhere in early 1989, it should indicate that the agency has moved about as well as could be expected.

Local conservation district supervisors and ASC committeemen are faced with the job of establishing and enforcing local standards, based on SCS technical guides. That also seems to be going along fairly well at the moment, since farmers facing 1990 and 1995 deadlines are reasonably easy to deal with. Seven years is a long time, and few farmers are feeling the urgency of the matter at this time.

As those deadlines come closer, however, it will be necessary to reach farmers who have never cooperated with conservation programs, and who would probably rather fight than switch now. It will also catch those who have had the bad judgment (or bad fortune) to be farming particularly difficult land. For the most part, that land has never been too profitable, so the farmers who have the most serious (and probably expensive) land-use changes to make, or conservation practices to install, are those who can least afford it. These farmers will test the system severely.

Both SCS technicians and conservation district officials will be pressured by neighbors for more time and leeway in meeting conservation standards. These pressures will be particularly difficult in areas where marginal lands or economic conditions cause serious hardship in changing farming methods. Entire communities may face the possibility that the farm economy, as they have known it in recent years, could collapse. The local political pressures will be intense, and personal. This will not be a particularly easy time to work for USDA, or to serve on one of the local conservation organizations.

The USDA rules for meeting these situations were clarified in the *Federal Register* on February 11, 1988. In this final rule, the procedure for "alternative conservation systems" were set out. These systems will be designed locally to provide options that will help achieve a substantial reduction of existing soil losses, but at the same time be cost-effective.

Now, what does this mean? To many, it will sound like an easy cop-out—a way to let farmers continue the old ways and ignore excessive levels of soil erosion. Maybe, but I don't think so. If the rule is followed, and local groups and people are involved in establishing the conservation systems, then the systems are reviewed by SCS at both the regional and state office levels, the outcome should be pretty good. It won't be perfect everywhere, but it will be a giant step in the right direction. And it may defuse a potentially deadly political backlash.

Under the rule, for highly erodible croplands that were in production prior to December 1985, the farmer can use any system that is contained in the SCS technical guide. Some of those systems may result in lowering soil erosion rates to the tolerable level; some may not. Those that do not will still reduce erosion significantly, but fall short of reaching the ultimate goal because gaining the last few increments of erosion reduction is unacceptably expensive (a concept we'll return to shortly).

Farmers who have converted highly erodible land into crops since December 1985 will have no such economic leeway. They must adopt systems that bring soil erosion within the tolerable range, no matter what the cost. The net effect is sort of an ''economic common sense'' grandfather clause.

The basis for the concept of ''alternative conservation systems'' is farily straightforward. Consider this example, which is fictitious but not uncommon—a field currently is growing corn and soybeans, with clean cultivation, and suffering soil losses of 25 tons per acre per year. Installation of conservation tillage and contour farming will lower soil loss to an estimated 7-ton level, at a cost to the farmer of fairly modest levels. The 7 tons, however, still exceed the 5-ton estimate of allowable soil loss (or ''T'' level). Moving from 7 tons to 5 tons will reduce the farmer's options significantly, and drive costs dramatically higher. Terraces might cost $500 per acre—a level that cannot be paid back with corn/soybean profits in today's world. Or, the farmer could plant the land to grass or trees which, without supplemental government payments, would not pay the taxes and holding costs for the land, let alone provide annual income to support the family. What to do?

Letting this farmer go to the 7-ton level means a reduction of significant proportions in terms of soil loss, while allowing him to stay in business and probably not inciting him to such anger that he decides to fight the program. Forcing him to 5 tons may either put him out of business, or convince him that his most cost-effective option is to begin writing his congressman and donating funds to a national ''anti'' group. Which option is best, both for conservation and for the long-term public interest? My vote goes to the ''alternative'' proposal. Getting something is better than losing everything.

A logical question is: ''How much are we giving away when we allow alternative conservation systems?'' This, of course, is virtually impossible to predict, but a recent SCS exercise attempted it. Its best estimates suggest that highly erodible croplands are contributing 1.8 billion tons of soil loss to the national erosion statistics. With currently foreseen alternative conservation systems applied, the predicted annual loss will drop to around 400 million tons—a significant reduction. Now, with that estimated accomplishment, we would still have some 24 million acres eroding in excess of 5 tons per acre per year. The problem would still not be totally solved, but the gains would be historic indeed.

What is happening, to be sure, is the most significant opportunity for positive institutional change since the creation of SCS and soil conservation districts in the 1930s. But, as we all know, institutional change usually is evolutionary in nature, and somewhat slow. Not all district officials are ready for the kind of responsibilities that are being placed on them. They will, if we are patient and persistent, either grow into their new tasks or be replaced by people who find the new roles challenging. Either way, the system improves.

Another view, expressed to me by some young soil conservationists, is that this is really a high-stakes game for the whole conservation district movement. Farmers are starting to realize what is at stake, and the intense media effort by USDA will broaden that realization. Districts that cave in under local political pressures and try to press for alternative conservation systems that do not accomplish adequate conservation will be scorned as ineffectual by the very farmers on whom they depend for their success. In addition, they will create conflict with SCS technicians, who are likely to press for more demanding standards. In other words, conservation districts have a historic chance to grow in stature. But if they fail to grasp the opportunity responsibly, they could be cast aside by both their supporters and their critics as ineffectual relics of a past era.

That raises a serious institutional problem. Many may welcome the passing of the old order. But students of institutional changes may ask "can we replace these institutions?" Does anyone believe that a unit of local special-purpose government with the broad powers and capabilities of conservation districts could be re-created in the political climate of most states today? I am convinced it could not happen. Better to reform the institutions we have, even if slowly, than to throw them out hoping for something better to emerge. The risks of being left with nothing are far too great.

Watching this historic scenario unfold, and acting in ways that are supportive and helpful, will be a challenge for other conservationists, as well. There will be calls for strong, no-compromise regulations that force farmers into compliance as rapidly as possible. Some professionals will be appalled at the lack of technical specificity in the SCS technical guides, the latitude given to develop alternative conservation systems, or to the degree of local latitude and judgment that USDA will allow conservation districts and ASC committees. Such local control is a prescription for avoiding the letter of the law, it will be argued.

While fully understanding the desire of conservationists to press for conservation compliance as soon as possible, it is also important to realize that there is much to be lost from taking too hard a line on implementation of the conservation compliance program. There are very real problems in meeting conservation standards in some parts of the country. The technical data on which those standards are based are not equally valid in every area. In those areas where virtually every farm faces radical changes or bankruptcy, the calls for cost-effective "alternative conservation systems" will be intense. In those places, the best strategy to promote soil conservation will be to take part in public meetings and technical conferences to help assure that the resulting "alternative systems" contain as much "conservation" as possible.

We face a delicate situation, in which some local latitude is needed. We also know for certain that limits to local latitude must be established and maintained, or there will be no end to delay and confusion. So we need to support a reasonable degree of "slippage" in implementing the conservation compliance provisions while, at the same time, holding forth the expectation that farmers and USDA agencies will move with reasonable haste to meet the spirit as well as the letter of the law.

It is a situation in which USDA and the local conservation districts will need constructive critics, but those critics will have to be cautious not to be too strident. If the pressures mount so high that farmers feel too threatened, the result will be an intensive national political campaign to destroy the law, or cripple the agencies that administer it. If that were to happen, and be successful, conservationists would lose much more than they would gain, and the nation will lose its best opportunity in 50 years to bring some sense to the way that national agricultural policy drives the use and management of our precious farmlands.

Implementation of Conservation Compliance: Implications for Soil, Water and Wildlife

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The conservation compliance portion of the 1985 Food Security Act (FSA) requires that farmers producing commodity crops on highly erodible land develop and begin implementing an approved conservation plan by 1990 to remain eligible for most U.S. Department of Agriculture (USDA) farm program benefits. The plan must be fully operational by 1995. Compliance will help make USDA subsidy programs, and soil and water conservation programs, more consistent. It will also encourage participation in the Conservation Reserve Program (CRP).

In many areas across the country, compliance is going to speed adoption of low-till and no-till farming methods, and increase use of conservation structures such as terraces. If the provision is rigorously enforced, some areas that are too difficult or costly to farm with proper erosion controls will revert to pasture or be enrolled in the CRP.

Conservation compliance, along with its companion FSA provisions, including the CRP, sodbuster, swampbuster and conservation easements, has potential for enhancing the quality and quantity of habitat for fish and other aquatic animals, for waterfowl, game and nongame birds dependent on undisturbed grasslands, and also for many species of mammals and the raptors that feed on them. It is likely, however, that compliance itself will have a relatively small impact on terrestrial wildlife species compared with CRP and swampbuster, since much of the approximately 121 million acres of cropland subject to compliance will continue to be row-cropped or used for hay production.

Compliance's main contribution to wildlife improvement will probably come in the area of water quality, leading to better habitat for fish species and other aquatic animals.

Conservation compliance and the other FSA conservation provisions represent significant improvement in farm policy in relation to natural resources. They will not end the country's erosion problems or the agricultural practices that pollute water and destroy wildlife habitat. This would be true even if the compliance provision protected all land that has serious erosion problems, which it does not. Conservation compliance works to the extent that we have farm programs that are attractive to farmers. Moreover, it still is true that the commodity programs, and the way they are implemented, discourage conservation.

Potential to Reduce Erosion

Conservation compliance is needed to protect highly erodible lands that are cropped or enrolled in commodity set-aside programs. As it now stands, the program affects 121 million acres of land most subject to water or wind erosion (G. Root personal communication: 1988). It targets federal attention on land with the greatest potential for erosion, but the definition for highly erodible land still leaves many problem lands unprotected.

About 40 percent of all cropland, or approximately 173 million acres, is eroding at levels above what is considered tolerable, or "T," based on the estimated rate at which soils are supposed to be able to maintain long-term productivity. About 23 percent of cropland is eroding at twice the tolerable rate (USDA 1982, 1987a).

According to the 1982 Natural Resources Inventory, about 4 billion tons of soil were moved by sheet, rill and wind erosion on privately owned rural land, but close to half of all actual erosion is concentrated on relatively few acres. Less than 10 percent of the nation's cropland accounts for nearly 45 percent of soil losses. One reason the country still has such serious erosion problems after decades of attention is that much soil conservation effort has been directed at lands suffering from only moderate-to-low erosion.

Sediment and related pollutants are the greatest contributor to nonpoint water pollution. A recent report estimates that the off-site costs of erosion add up to $3.2–13 billion each year, with at least one-third of the costs attributable to agriculture. This accounting includes: reduced water quality for drinking and recreational use; increased maintenance costs at water treatment and hydroelectric facilities; clogged navigation channels; and reduced water-holding capacity of streams and reservoirs, leading to more frequent and more severe floods (Clark et al. 1985). This tally does not include costs related to biological damage to aquatic animals and ecosystems.

Under the first, interim rules written by USDA, compliance would require conservation plans designed to bring erosion down to T, usually from 2–5 tons per acre. The interim rules allowed that, in hardship cases, farmers would only have to bring erosion down to 2T, or twice the tolerable level. USDA estimated that implementing these rules would bring an erosion reduction of about 1.2 billion tons annually by 1995 (USDA 1986). As a result of political pressure from those who felt that getting erosion levels down to T or 2T was too restrictive, USDA dropped T as the requirement for conservation plans under compliance. SCS offices were instructed to use the local Soil Conservation Service (SCS) Field Office Technical Guide (FOTG), to determine alternative systems that would "significantly reduce erosion, but be economically feasible and socially acceptable" (USDA 1987b).

Since then, USDA has not revised its environmental assessment. According to Gerald Root, assistant director of the SCS Conservation Planning Division, a review of data from field offices leads the agency to believe that the level of erosion reduction will still fall within the range of the original assessment. Root believes there is widespread misunderstanding about the "alternative systems" approach as it is being implemented by USDA. He stated that the FOTG alternative systems will only apply to certain crops and soils on a total of about 4 million acres.

Potential to Enhance Wildlife

A USDA (1985) brochure, "Going Wild with Soil and Water Conservation" states that "wildlife can benefit from many cropland conservation practices, especially those for erosion control." Among these practices are conservation tillage, cover and green manure crops, strip-cropping, grass waterways, narrow-base bench terraces, field windbreaks and field borders. Whether such practices usually benefit wildlife has been widely disputed (Harmon 1974, Carlson 1985, Berner 1987, Brady and Hamilton 1987).

Birds and Other Terrestrial Species

Some research indicates that as soil-conserving measures increase, upland wildlife habitat quality also improves (Lines and Perry 1978, Miranowski and Bender 1982). However, the positive impacts that soil conservation practices have on wildlife are largely secondary and very dependent on actual vegetative composition of cover, strip crops and "edge" (Harmon 1974, Langner 1985).

If carefully managed, some erosion control structures and practices can enhance wildlife habitat. If farmers are aware of opportunities for improving terrestrial wildlife habitat, there is evidence that many will manage conservation practices for the dual purpose of controlling erosion and providing habitat (Brady and Hamilton 1987, Etter 1987). One study of grassed backslope terraces found 35 species of vertebrates using the terraces, and calculated that pheasant nest success was 22.5 percent (Beck 1982).

Conservation tillage (CT) includes a range of practices that leave crop residue on the land to protect soil from the force of wind and water. These practices have been gaining in popularity since the late 1970s, and conservation compliance is expected to provide a strong impetus for more widespread adoption. Preliminary studies show that conservation tillage has potential for reducing or eliminating bird nest disturbances in small grains and row crops (Rodgers and Wooley 1983). Warburton and Klimstra (1984) found that no-till corn fields offer more food and cover than do conventionally tilled corn fields, leading to a greater diversity of invertebrate species and a more stable population of small mammals.

Although expansion of conservation tillage will probably benefit many animals, the increased use of herbicides that often accompanies these practices poses some risks (Baker and Laflen 1983, Warburton and Klimstra 1984). Again, careful management can help wildlife. Chemical contamination can be decreased in several ways—by "knifing" the pesticide into the soil, by splitting applications, by timing pre-emergence herbicides prior to nesting or by selecting less toxic chemicals (Baker and Laflen 1983, Rodgers and Wooley 1983). Some "organic" farmers, who use little or no pesticides, are reporting success with such conservation tillage practices as ridge-till. Their experience deserves attention from researchers and others concerned with wildlife and environmental quality.

Overall, changes in land use have a greater impact on habitat quality than do changes in management practices (Miranowski and Bender 1982). By comparing Illinois data, a report by Brady and Hamilton (1987) shows a 46-percent decline in farmland game harvest at the same time as a 48-percent increase in "cropland adequately treated" to control erosion. The proportion of cropland used for row crops increased almost 80 percent during this 15-year period. A study of eight grassland bird species in Illinois during approximately this same time showed that their numbers had declined by 80–95 percent and more (Graber and Graber 1983).

Compliance, by itself, will result in a negligible amount of actual land-use changes to less intensive agricultural practices, except as the threat of compliance encourages participation in the CRP. In fact, USDA's express purpose in weakening the requirements for conservation plans was to avoid forcing farmers to change land use, i.e., to have more pasture and less row crops. This reduces the provision's potential benefits for wildlife.

Fisheries

Fisheries literature on the expected impacts of the FSA conservation provisions is virtually nonexistent. Even generic information relating erosion-control practices and fisheries impacts is limited. Yet, it is in the area of aquatic habitat improvement that compliance probably has the most potential for wildlife.

Conservation compliance should significantly decrease sediments and associated pollutants that run off cropland, thus improving water quality and habitat for fish and other aquatic species. USDA originally estimated that conservation compliance could prevent about 1.2 billion tons of soil from eroding off farmlands each year after 1995. Agency officials report that they believe the provision will still bring nearly that level of erosion reduction, despite the rule change previously discussed (G. Root personal communication: 1988). It is probably more realistic, however, to expect that the provision will be able to achieve something less than the amount of erosion reduction originally predicted—maybe about 1 billion tons. While it is impossible to calculate how much this will reduce the amount of sediment being dumped into streams, lakes, potholes and rivers, it is obvious that the measure will contribute to improvements in aquatic ecosystems.

Eroded soil, or sediments, deposited on the bottom of lakes and streams put fish under chronic stress. Heavy soil deposits can completely eliminate aquatic plants that provide cover for fish, and provide habitat for many invertebrates that fish eat. Sediments reduce numbers of bottom-dwelling organisms that young fish depend on for food. Spawning fish deposit their eggs on the bottom where heavy sediments can smother eggs and newly hatched fry.

Soil particles degrade habitat while suspended in water and after settling out of it—in both cases, sediment harms aquatic life all along the food chain, from microscopic algae to valuable game fish (Smith 1971, Berkman and Rabeni 1987). For example, a study of long-term changes in fish populations in Illinois streams identified excessive siltation as the principal cause for the disappearance of native fish species (Smith 1971). Research on fingernail clams, a widely distributed, important food source for ducks and many fish, shows that these clams respond to turbid, muddy water by closing their shells, greatly reducing their ability to filter food from the water flowing by. Many other types of clams, once abundant in midwestern waters, have also been impacted by siltation and turbidity (Ellis 1936, Lewis 1984).

Sediments that blow or wash off land frequently carry along nutrients such as nitrogen and phosphorus that otherwise are limited in aquatic systems. These nutrients cause one of the most serious water quality problems—eutrophication, excessive nutrient enrichment of a body of water, stimulating high rates of biological productivity. This is particularly a problem for lakes. In Lake Erie, for instance, a marked decline in the commerical fishing industry has accompanied its serious eutrophication problem (Clark et al. 1985). Besides carrying nutrients, cropland runoff also carries pesticides and other contaminants to streams and lakes.

Reducing sediment inputs to already damaged streams or lakes may not immediately result in improved fishing. Many factors are involved, making the link between erosion reductions and fisheries difficult to pinpoint (McSweeny and Kramer 1986).

Acknowledging this, one must still conclude that policies that reduce erosion have great potential for improving fish habitat. A study of Black Creek in Illinois found that erosion control measures had measurable benefits for fish (Morrison 1982). Terraces or retention basins, designed to hold water on the land and direct it through a subsurface draining system, proved quite effective in reducing sediment and phosphorus to the waterway. Conservation tillage was somewhat less effective, but still of significant benefit. Grassed waterways reduced the sediment and phosphorus entering the stream, but due to their small total area, were not as effective as either terraces or conservation tillage in improving water quality.

More research needs to be done on the aquatic habitat benefits of erosion-control practices. In the meantime, fisheries scientists, the commercial fishing industry and sport fishing organizations need to take increased interest in agricultural policy as it relates to conservation. Good policies could have big payoffs for fish.

Implementing Compliance

USDA agency representatives responsible for carrying out the Food Security Act generally express strong support for the conservation provisions. These agencies include SCS, Agricultural Stabilization and Conservation Service (ASCS), Farmers Home Administration (FmHA) and the Cooperative Extension Service (CES). According to reports from agency personnel, media, farm organizations, legislators and from farmers themselves, there is considerable support from the farm community for the CRP, for sodbuster and, to a lesser extent, for conservation compliance and swampbuster.

As could be expected, the level of support for the provisions differs greatly among states. For example, most farmers in Iowa and Pennsylvania are reportedly adjusting to the provisions without great alarm (Baloun personal communication: 1987, Heidecker personal communication: 1987, Peterson personal communication: 1987). Sentiment against swampbuster is running high in North Dakota (Grindberg 1987), and against sodbuster and compliance in the South of Texas, in areas where cotton is a major crop (Mitchell 1987).

SCS representatives report that because of conservation compliance and the CRP, they are seeing many farmers who have not previously cooperated with SCS programs. Farmers are becoming more knowledgeable about compliance, thanks to the media and public information efforts by USDA agencies. In many states, including Illinois, Minnesota, Mississippi, Pennsylvania and Wisconsin, increased awareness has been enhanced by the efforts of interagency committees or task forces set up to promote implementation of the FSA. A similar committee for information and education has been set up at the national level.

Interagency coordination is an important element in the success or failure of the FSA, since fragmented responsibilities between SCS, ASCS and conservation districts (and, in some cases, FmHA) is a major obstacle to the successful implementation of compliance and the other FSA conservation provisions. No one agency is fully responsible. Perhaps more importantly, ASCS and its state and county committees have much of the final control in dispensing or denying farm program benefits. This agency has a long history of supporting practices and programs more oriented to production than to conservation (Harmon 1974, USGAO 1977, Berner 1984, Steiner 1987).

According to a study of USDA personnel in the SCS, ASCS and CES, 75 percent of those interviewed felt their constituents did not fully understand conservation compliance (Nowak and Schnepf 1987). About 27 percent of the respondents considered this lack of understanding to be a very important barrier to implementation. Other barriers perceived as important by agency personnel were farmers' tendency to avoid agencies they consider regulatory and the complexity of conservation compliance rules.

An informal survey of SCS personnel from five upper Midwest states (Illinois, Iowa, Minnesota, Missouri and Wisconsin) by the author in spring 1987, indicated that general good will toward the conservation provisions did not seem to translate necessarily into expectations that compliance would be implemented and monitored adequately.

Informal telephone interviews by the author in late 1987 and early 1988 with SCS and ASCS personnel from the Midwest region and a sampling of other states (including Pennsylvania, Wyoming, Washington, Arkansas and Mississippi), indicated that agency representatives seem to be more positive about implementation of the compliance feature of FSA than they had been earlier. This seemed to be largely the result of two elements: (1) SCS agents were more optimistic about their ability to provide the conservation planning required under compliance; and (2) SCS agents were more positive about the final rules than they had anticipated. These points will be discussed in the next two sections.

Conservation Planning

The nation's SCS employees have much of the responsibility for carrying out FSA's mandate. Nationally, an estimated 2.8 million farms are being checked for highly erodible land. Probably half of these will need to develop conservation plans by 1990 under compliance (NACD 1987a). In addition, SCS employees must provide technical assistance for the CRP and continue to administer other programs. This amounts to a tremendous workload for SCS staffs, which have been steadily dwindling due to budget cuts over the last 20 years. A nationwide analysis estimated that, ideally, $95 million for 2,900 additional full-time positions was needed to manage the workload related to FSA's conservation provisions (NACD 1987a).

One survey found that personnel shortages were the most common concern expressed by all those in agencies responsible for the FSA, especially by SCS and CES staff (Nowak and Schnepf 1987). Originally, it was feared that staff shortfalls would lead to poor morale, poor farmer/agency relations, shoddy conservation plans and inadequate monitoring to ascertain cooperation. These are still concerns, but it appears the situation has eased somewhat, partly because Congress allotted $20 million in supplemental funding to assist SCS and ASCS with conservation programs (NACD 1987b). SCS's 1988 budget will probably be higher than the original 1987 appropriation by $50 million (NACD 1987c).

Other reasons for this improved outlook include efforts to do more group planning in high workload states and areas, and a high level of cooperation among USDA agencies, conservation districts and in some states, with federal and state natural resource agencies (Nowak and Schnepf 1987, Lange personal communication: 1987, Peterson personal communication: 1987).

Group planning is being viewed skeptically by some conservation oragnizations, as well as by some SCS personnel, because of concern about the level of quality that will result from the group-planning process. The group approach usually combines a certain amount of "self" planning on the farmer's part. There are good reasons for concern, particularly if farmers are given powers to approve their own plans or "self-verify" compliance.

On the other hand, group planning has positive aspects and is reported to be working well in some areas. Pennsylvania is using group planning with farmers who already have conservation plans, but may need to change or upgrade their plans to meet compliance (Heidecker personal communication: 1987). Illinois, a state with a history of group small-watershed planning, has developed a national pilot for group conservation planning. Some who are familiar with the group program there have stated that this approach—wherein the farmer is given more hands-on responsibility—is turning out to be an excellent tool to educate farmers about their erosion problems and conservation options, and make them feel more personally involved than have traditional planning approaches (Darden personal communication: 1987, Farnsworth personal communication: 1987, Riggle personal communication: 1987). Similar attitudes have been expressed by SCS employees in Iowa and Missouri (Peterson personal communication: 1987, Simpson personal communication: 1987).

Attitudes Toward the Final Rules

During the months leading up to promulgation of the final rules, there had been considerable controversy over the level of erosion control that would be required for compliance. Many in the agencies, in conservation districts and in the conservation community felt strongly about keeping T as the standard for compliance (Horvath personal communication: 1987, Muhm 1987, Nowak and Schnepf 1987, Peterson personal communication: 1987). Reasons given for preserving T included that the change was based on politics and not science, and that it replaced a defensible (if imperfect) standard with vague criteria that would be inconsistent between states and even among areas within a state, leaving SCS personnel vulnerable to criticism and local political pressure. This attitude reportedly was strongest in the Midwest.

There was, however, powerful opposition to a T or 2T standard in some regions with high erosion levels, such as the cotton-producing areas of the South and Great Plains. As previously noted, this opposition lead USDA to scrap T as a requirement, and instead, allow each state or local area to use FOTG to determine systems that would significantly reduce erosion, taking into consideration economics and local acceptability (USDA 1987b).

Since the FOTG criterion became policy in September 1987, SCS personnel seem to have become more positive about the weakened rule. SCS offices in many of the states and local districts have set up a coordinated approach, reviewed in state training meetings, that should indeed bring major reductions in erosion. In many cases, the level of erosion permitted under conservation plans will still approximate T. In areas with steep slopes or particularly vulnerable soils, the "alternative" conservation systems required by SCS will probably reduce erosion substantially. This is good news.

Even so, the alternative systems will still allow levels of erosion up to 3T and more in some areas. The optional systems outlined in the FOTG may require changes in methods (such as a switch to higher residue cropping systems or adding a year of small grain in a rotation), but farmers will still have a choice of practices that fall short of requiring a change of general crop or livestock scheme, or extensive terracing.

The weakened guidelines for compliance may be necessary to make the measure palatable to farmers and politicians, and to prevent widescale flight from the commodity programs, but the final rule reduces compliance's potential to improve habitat for both terrestrial and aquatic wildlife. Originally, many groups hoped the law would work to reduce row crop production on lands with severe erosion problems or potential, turning it back to less intensive, diversified uses more beneficial to a variety of wildlife. The impetus for such a change is definitely reduced. The weakened rule also reduces farmers' incentive to enroll problem land in the CRP.

Many pro-compliance groups in the conservation community have temporarily accepted the weakened standard for compliance, waiting to see if the promised "significant erosion reductions" are realized. There still is a solid consensus among conservation groups, many farm groups and SCS employees that this weakening of the rules should not be allowed for sodbuster, which covers "new" land coming into commodity production. The compromise has also intensified feelings that the definition of highly erodible for sodbuster and compliance should be changed to bring more problem land under conservation plans.

Conclusions and Recommendations

If compliance is to fulfill its promise for improving the conditions of our soil and water resources, and offer wildlife habitat benefits, the goal of farmer's conservation plans must ultimately be T. Even this goal may have to be revised, based on the scrutiny of the T standard taking place among soil scientists, many of whom think that current T levels do not adequately protect at least some soils (Wischmeier 1976, Johnson 1987).

It is not in Americans' best interests to continue mining our soils until production is severely disrupted and lakes and streams filled with silt and agricultural runoff. Politically speaking, it may be that the current criteria for compliance that allows erosion levels above 2T will have to stand until possibly 1995, the deadline for fully implementing the plans that are being developed now. By then, perhaps farmers will take conservation more seriously and many will have achieved significant erosion reductions. Those whose farming practices still continue to cause excessive erosion should make the final increment of improvement within a reasonable amount of time, or expect penalties that may go beyond loss of USDA benefits.

It is difficult to predict whether farm subsidies as we know them will even continue to exist at a level high enough to provide an incentive for conservation (Kaplan-Wildmann 1983, Reichelderfer 1984, Steiner 1987). Though the cost of farm programs has risen sharply during the last decade, the current administration's stated goal is to reduce the farm program budget, and there have been some decreases in support prices the last few years for dairy and other crops. In the meantime, conservationists should consider trying to get the criterion for defining highly erodible land changed so that more eroding land will be protected, including more lands coming out of CRP 10-year contracts.

Definition of Highly Erodible Land

Under the current rules for compliance and sodbuster, land with an erodibility index (EI) of 8 or greater is considered highly erodible. (The "EI" system indexes the sensitivity of soil to erosion damage.) The EI of 8 definition applies to approximately 121 million acres of private cropland, with estimated total erosion of 1.8 billion tons. This criterion excludes approximately 20 million acres eroding at levels greater than 2T, and 8.4 million acres eroding beyond 3T (USDA 1986). Under the EI of 8 criterion, for example, only 12 percent of midwestern cropland is defined as highly erodible land (HEL), but 48 percent is reported to need erosion control (Brady and Hamilton 1987).

If the criterion was changed to include lands with an EI of 5 or greater, about 30 percent more land would come under compliance, with estimated total erosion of 2.3 billion tons. About 486 million acres of land would be defined as highly erodible, including about 188 million acres of existing cropland. The proposed change would address about 73 percent of all cropland erosion, reducing erosion by approximately 1.5 billion tons annually or 54 percent of all cropland erosion in excess of T (USDA 1986).

While it is valuable to target erosion control at acres with the most severe problems, the EI of 8 criterion probably is too tightly targeted, leaving many lands with severe erosion problems unprotected. One important reason for changing the criterion, would be to help solve the problem that is going to arise when land in the CRP comes out of 10-year contracts in the 1990s and is not protected by conservation compliance or sodbuster. Due to the different criteria between the CRP and the highly erodible land conservation provisions, some of the land in the CRP is not highly erodible enough to be protected under compliance or sodbuster. It will be scandalous if this land is allowed to go back into the commodity programs without adequate conservation protection, giving taxpayers little long-term conservation in return for their 10-year investment.

Two other major concerns of conservationists must be the related issue of the annual set-aside program, and the county ASCS committees which have so much power to implement federal agricultural programs at the local level.

Commodity Programs

The annual set-aside portion of the commodity program, in a variety of forms, has been used most years since 1961 to control production of annual commodities. This part of the agriculture budget is very costly, but lenient rules for managing the set-aside acres often leave the land exposed to wind and water erosion, and are frequently detrimental to wildlife (Harmon 1974, Berner 1984, McSweeny and Kramer 1986). Funding levels for this program are high enough to outcompete effectively the CRP and other conservation programs for acres.

A broad framework of rules for managing set-asides are made at the federal level, but many details are left to the discretion of state and county ASCS committees. These committees are made up of producers and elected by producers only, though the large amounts of money they dispense come from all taxpayers. In many areas, the ASCS committees have been so concerned with issues such as weed control and convenience for their farmer constituents, that they have neglected the "conservation" portion of their charge. Surveys in a number of states indicate that their concern for soil and water conservation has been minimal (Harmon 1974, Mekelburg 1983, Berner 1984, Berner 1987).

This is not so surprising, considering that there is no representation on the ASCS committees by natural resource professionals, or others concerned with the off-farm environmental impacts agricultural programs have. Though some states require the committees to "consult" with resource professionals, there is no obligation to use this information. As we have become more aware of the water quality and wildlife impacts of farm programs, it has become clear that we need broader voting representation on the ASCS committees to improve management of programs like the annual set-asides.

Annual set-asides have been the cornerstone of USDA farm policy since 1961, continuously emphasizing administrative flexibility in commodity control to the detriment of soil and wildlife (Berner 1984). These programs work against soil and wildlife conservation in many cases, and even penalize farmers who practice sound conservation techniques. Acreage histories determine a producer's "base" for crops, and thus, farmers who plant fence row to fence row get a larger base acreage to use in calculations for commodity program benefits. On the other hand, farmers who use soil-building crop rotations, who leave windbreaks or install conservation structures such as terraces, are penalized when it is time to figure their crop base.

The set-aside programs have typically had a limited effect on crop production, which is their main purpose (American Farmland Trust 1984). Indeed, their year-to-year nature hampers their effectiveness at bringing supply into balance with demand, as well as making them bad for natural resources. Critics of the current set-aside programs have developed recommendations for improving these programs for wildlife and soil conservation (Berner 1984, Hicks 1986, Taff and Runge 1986, Berner personal communication: 1987, Brady and Hamilton 1987). Some of the major features recommended are: to extend the period a field is kept in set-aside from one year to three or five years; to ban practices such as fallowing; to require cover to be seeded before May 15; and to prohibit destruction of annual cover until after September 1.

Suggestions have also been made to improve commodity programs by using a land-classification system to determine eligibility (Hicks 1986, Taff and Runge 1986). This recommendation would basically target USDA benefit programs to lands most suited to accomplish different goals. Lands with high erosion potential and low productivity would only be eligible for a conservation reserve, and would not compete for higher paying commodity programs. Other proposals for improving the commodity programs, that have potential conservation benefits, include the controversial concept of "decoupling" specific crops and crop bases from farm program benefits (Boschwitz 1987).

Conservation compliance will almost certainly result in considerable erosion reductions. We can take satisfaction in this as long as we do not become complacent. We need to protect what we have gained here, monitoring to see that compliance is implemented on schedule. The conservation provisions represent significant improvement in farm policy in relation to natural resources, but the detrimental aspects of some ongoing farm programs still work against conservation. Keeping this in mind, we must look ahead to see where our next gains can come in devising a wise, workable set of agricultural programs that protect soil, water and wildlife.

Author's Note: Subsequent to presentation at the 53rd North American Wildlife and Natural Resources Conference, USDA policies for implementing compliance changed sufficiently to warrant increased doubts about the measure's potential effectiveness. Despite SCS' earlier statement that the relaxed Field Office Technical Guide (FOTG)/alternative systems approach would still bring erosion levels down to T or 2T on most highly erodible lands, only allowing higher levels in areas with particularly problematic conditions, agency sources now indicate that staff have been told to make the weakened list of alternatives available to all farmers. The erosion reductions required under this new administrative mandate could be negligible. Farmers with high erosion levels may not necessarily be required to make any changes in farming practices to meet compliance (AYR—May 15, 1988).

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Opportunities for Enhancing Wildlife Benefits Through the Conservation Reserve Program

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The 10-year enrollment aspect of the current Conservation Reserve Program (CRP) makes it particularly attractive for enhancing wildlife values. United States Department of Agriculture (USDA) agencies are responsible for assisting landowners to enroll in the CRP. State wildlife agencies are in the best position to influence and assist USDA agencies and landowners in improving wildlife habitat on CRP land. Opportunities for wildlife enhancement begin with cooperation among agencies and wildlife interest groups, then continue through information and education programs and direct assistance to landowners in planning, establishing and managing vegetation on CRP land and adjacent areas.

Introduction

The Conservation Reserve Program provides an unparalleled opportunity to improve wildlife habitat on the more fertile private lands of the United States. Other aspects of the Food Security Act of 1985 may benefit specific habitats, such as wetlands and grasslands, or generally improve wildlife habitat conditions nationwide; but the Conservation Reserve represents a unique opportunity for wildlife enhancement on the specific land enrolled.

The purpose of this paper is to review the CRP, including data from the first five sign-ups (March 1986 through August 1987), and offer recommendations as we enter the third year of the five-year sign-up period. We hope to leave you with suggestions for improving the program in your respective states—or simply inspire you to become involved with the CRP.

Background

The CRP is not the first program of its kind to be administered by the USDA. The Soil Bank, created by the Agriculture Act of 1956, was the first national program to retire farmland under long-term contracts (USDA 1956). Soil Bank was divided into two programs—the Conservation Reserve and the Acreage Reserve. The Conservation Reserve provided the owner or operator an option of either 3-, 5- or 10-year contracts. The Acreage Reserve idled cropland on an *annual* basis for the first time since the concept was introduced briefly by the Agricultural Adjustment Act of 1933 (USDA 1939).

The primary purpose of Soil Bank was to reduce agricultural production. Therefore, the 1956 Conservation Reserve did not require that enrolled acres be highly erodible cropland—all cropland or hayland was eligible; pastureland was not. Permanent vegetative cover establishment was required on enrolled acres and cost-shared at rates of up to 80 percent of the total cost. However, a "minimum cost" permanent cover was encouraged, which often resulted in pure stands of perennial grasses. Interestingly, this original Conservation Reserve included cost-shared options for tree planting, wildlife management, marsh development and even for fish ponds.

After Soil Bank enrollments ended in 1960, long-term programs were reintroduced with the Cropland Conversion Program (CCP) of the Food and Agriculture Act of 1962 and continued in the Cropland Adjustment Program (CAP) of the Food and Agriculture Act of 1965. The 1956 Conservation Reserve retired 28.6 million acres, CCP converted 0.6 million acres and CAP idled 3.9 million acres (Harmon and Nelson 1973). CAP was the last of these long-term programs to expire, in 1976. It also included bonus USDA rental payments for allowing public access.

The Feed Grain and Wheat Program initiated in 1961 reintroduced the *annual* idled acres concept. Variations of this program have continued to the present using Set-Aside, Diverted Acres, Acreage Conservation Reserve, Conservation Use Acreage, and other similar terms to designate short-term idled land.

The Conservation Reserve Program (1985)

The Conservation Reserve has been revived by the Food Security Act of 1985.[1] The Act authorizes the Secretary of Agriculture to enter into contracts with owners and operators for enrolling highly erodible cropland to conserve and improve soil and water resources. The contracts, which are administered by the Agricultural Stabilization and Conservation Service (ASCS) of USDA, provide for annual rental payments to owners and operators in exchange for retiring their land for 10 years. A 10-year contract is the only option being offered at this time, even though the Act provides for up to 15-year contracts.

It is the intent of Congress for CRP to retire 40–45 million acres from commodity crop production. Because 10-year contracts are being initiated over a 5-year period, the peak acreage will only occur from 1990 to 1995. However, significant acreages nationwide will be in CRP through 1999. If the authorized 15-year contracts are used by the Secretary of Agriculture, some land could be enrolled through 2004.

The CRP has *two* primary purposes—(1) reducing soil erosion and (2) reducing the surplus of agricultural commodities. The soil conservation goal makes it substantially different from the earlier Soil Bank program. Furthermore, CRP has significant secondary goals, such as increasing forest resources and improving environmental quality.

CRP requires that eligible land be highly erodible cropland. By retiring only highly erodible cropland, CRP is significantly reducing soil erosion nationwide. This requirement can also increase the diversity of vegetation when only portions of cropland fields are eligible and enrolled.

Even more important to those concerned with wildlife management is the requirement that grass *and legume* cover, or prairie grass cover alone, be established along

[1]Public Law 99–198, Title XII, Subtitle D.

with any other necessary erosion-control practices. CRP not only requires establishment of at least one legume with nonprairie grasses, but it requires that all seedings must meet the standards and specifications of the Soil Conservation Service (SCS) of USDA. The successful establishment of cover must also be certified by SCS. ASCS will cost-share up to 50 percent of the total costs of establishing eligible CRP practices (USDA 1986).

Congress also expressed an intent to have CRP land managed for wildlife, forestry or water quality if the landowner is interested. Six of the 13 vegetative cover establishment and management practices specifically address wildlife, forestry or water quality; 5 of those 6 include additional cost-share items (Table 1). Congress even established a specific goal for the tree-planting practice—one-eighth of each year's enrolled acres will be devoted to trees.

It is interesting to note and certainly no mere coincidence that most of the recommendations by Harmon and Nelson (1973) are incorporated in the current Conservation Reserve. Some of their recommendations were: (1) retire approximately 40 million acres for a minimum of three years; (2) require perennial grass-legume cover; and (3) provide participants cost-share payments for establishing the required

Table 1. Conservation Reserve Program conservation practices (CP).

ASCS code	Title and description
CP1	ESTABLISHMENT OF PERMANENT INTRODUCED GRASSES AND LEGUMES—Seeding mixtures of perennial, non-native (cool season) grasses and legumes (or forbs).
CP2	ESTABLISHMENT OF PERMANENT NATIVE GRASSES—Seeding perennial, prairie (warm season) grasses and optional legumes or forbs.
CP3	TREE PLANTING—Planting a stand of trees to provide multipurpose forest benefits.
CP4	PERMANENT WILDLIFE HABITAT—Seeding perennial grasses and legumes or forbs, and planting trees or shrubs.
CP5	FIELD WINDBREAK ESTABLISHMENT—Planting strips of trees or shrubs to reduce excessive wind erosion.
CP6	DIVERSION—Constructing a low ridge to divert surface water runoff.[a]
CP7	EROSION CONTROL STRUCTURE—Constructing various types of structures to repair or prevent soil erosion from concentrated surface water runoff.[a]
CP8	GRASS WATERWAY—Shaping and seeding a shallow drainageway to guide surface water runoff.[a]
CP9	SHALLOW WATER AREAS FOR WILDLIFE—Developing or restoring a shallow water area (wetland or watering facility).
CP10	VEGETATIVE COVER—GRASS—ALREADY ESTABLISHED—Eligible land with adequate grass cover established before being enrolled.[b]
CP11	VEGETATIVE COVER—TREES—ALREADY ESTABLISHED—Eligible land with an adequate stand of trees established before being enrolled.[b]
CP12	WILDLIFE FOOD PLOT—Allows the establishment of annual wildlife food plots.[b]
CP13	VEGETATIVE FILTER STRIPS—Seeding grasses and optional legumes or forbs in strips adjacent to streams, lakes, or wetlands. In some situations, a portion of the strip may be planted to trees or shrubs.

[a]These practices are constructed so that permanent vegetative cover can be established on adjacent areas of CRP land.
[b]These practices are not eligible for ASCS cost sharing.

cover. They also recommended that contracts of 10 or more years provide additional incentives to establish trees and shrubs, water impoundments, or multiple-row windbreaks.

Conservation Reserve Wildlife Practices

The six vegetative cover practices of particular interest to wildlife agencies and groups are: Permanent Wildlife Habitat (CP4); Shallow Water Areas for Wildlife (CP9); Wildlife Food Plot (CP12); Vegetative Filter Strips (CP13); Tree Planting (CP3); and Field Windbreak Establishment (CP5) (Table 1). The food plot practice was introduced in July 1987, and the filter strip practice was added in January 1988.

The Permanent Wildlife Habitat (CP4) practice establishes a vegetative cover that will control soil erosion and enhance the wildlife habitat of the enrolled CRP acreage and surrounding areas. Practice-establishment items that are eligible for ASCS cost-sharing are lime, fertilizer, seeds (grasses, legumes and forbs), seedlings (tree and shrub), temporary cover crops, and the activities necessary to apply or plant them. Fencing, roads and minerals (lime and fertilizer) for enhancing production are not eligible for ASCS cost-sharing.

The Shallow Water Areas for Wildlife (CP9) practice develops or restores a wetland or wildlife watering facility. Practice-establishment items that are eligible for ASCS cost-sharing are earthmoving and component measures and permanent plantings within the floodable area. Temporary food plots and fencing are not eligible for ASCS cost-sharing.

The Wildlife Food Plot (CP12) practice allows the establishment of annual wildlife food plots within other permanent vegetative cover practices. The food plots must: (1) meet SCS standards and specifications, (2) be included or added to an approved Conservation Plan of Operations, and (3) reduce or prevent excessive soil erosion. If the food plots are abandoned or relocated, the landowner must seed the area to an approved permanent vegetative cover. There are no items eligible for ASCS cost-sharing in this practice—including subsequent seedings of permanent vegetation.

The Vegetative Filter Strips (CP13) practice establishes a corridor 66–99 feet wide adjacent to a stream, lake or wetland to improve or protect water quality. Practice-establishment items that are eligible for ASCS cost-sharing are lime, fertilizer, seed and the activities necessary to apply them. Clearing, streambank stabilization, fencing and minerals (lime and fertilizer) for enhancing production are not eligible for ASCS cost-sharing. This practice also encourages consideration of wildlife needs in selecting seed varieties and in other practice specifications.

The Tree Planting (CP3) and Field Windbreak Establishment (CP5) practices establish a stand of trees and shrubs that will control excessive soil erosion and improve air and water quality. Practice-establishment items which are eligible for ASCS cost-sharing are tree planting, herbicides and temporary cover crops. Some of the items not eligible for ASCS cost-sharing include fencing, roads, and orchard, ornamental or Christmas tree plantings.

Practices such as the shallow water area, filter strip and field windbreak are usually applicable only to specific sites within the eligible acreage, while the wildlife habitat and tree-planting practices are usually applicable to the entire acreage enrolled.

In order to be cost-shared by ASCS, eligible practices must be included in an approved Conservation Plan of Operations. Cost-shared practices must be maintained for the duration of the CRP contract and vegetative cover practices must provide adequate erosion control. CRP contracts require that all plantings be protected from haying, grazing and destructive fire.

Conservation Reserve Responsibilities

Responsibilities for implementing CRP are divided among: ASCS, landowners, SCS, conservation districts, and wildlife and forestry agencies. As stated earlier, ASCS has primary responsibility for CRP. They process applications and administer contracts on behalf of the Secretary of Agriculture and monitor landowner compliance during the life of the contract.

Landowners offer land, submit bids, and establish and maintain vegetation (and other necessary erosion-control structures) for the life of the contract. Using ASCS guidelines, they also decide what the land-use objectives will be and how enrolled land will be managed.

Basing its decision on cropping history and soil-erosion conditions, SCS helps ASCS determine which offered land is highly erodible cropland. SCS assists the landowner in developing a plan for the establishment and management of vegetation within 30 days after the sign-up ends. This Conservation Plan of Operations becomes part of the ASCS/landowner contract. SCS also certifies that adequate vegetation for erosion control has been established, and provides technical assistance for any other necessary erosion-control practices. The local conservation district approves the landowner's management plan.

Wildlife agenices participate in ASCS Conservation Review Groups, which develop minimum specifications and cost-share ceilings for eligible CRP practices, particularly Permanent Wildlife Habitat (CP4) and Shallow Water Areas for Wildlife (CP9). Forestry agencies have the same duties for the Tree Planting practice (CP3) and are responsible for helping landowners develop the tree establishment and management plans on land enrolled in that practice.

Wildlife agenices are also given the opportunity to assist in developing SCS standards and specifications that are used for planning CRP wildlife practices. And state wildlife agencies may be called on for additional input when SCS is helping landowners develop individual cover establishment and management plans.

Status of the Conservation Reserve

The acreages presented in Table 2 are cumulative through the fifth sign-up, August 1987 (USDA 1988). Please note that even the combined totals of the last four columns (forestry and wildlife practices) is only slightly more than 9 percent of the total CRP acreage enrolled nationwide. Data were not available for the food plot (CP12) and filter strip (CP13) practices.

Ninety percent of the total CRP acreage is enrolled as either grass and legume seedings (CPl—57 percent), prairie grass seedings (CP2—28 percent), or established grasses (CP10—5 percent). More than 99 percent of the prairie grass seedings (CP2) is being established west of the Mississippi River, with nearly 92 percent in only six states, and more than 72 percent in just three states (Colorado, Kansas and Texas).

Table 2. Conservation Reserve Program acreage summary for selected conservation practices (CP) by state, through August 1987.

State	Eligible cropland	Total enrolled	Trees (CP3)	Wildlife (CP4)	Windbreaks (CP5)	Water (CP9)[a]
Alabama	1,286,100	362,101	172,448	3,689	0	18
Alaska	[b]	24,374	0	710	0	0
Arizona	196,800	0	0	0	0	0
Arkansas	684,100	121,030	55,465	7,346	0	325
California	767,500	150,582	53	2,962	16	28
Colorado	5,469,400	1,591,788	636	70,276	416	23
Connecticut	52,600	0	0	0	0	0
Delaware	25,200	155	0	37	0	0
Florida	445,200	67,313	58,020	1,959	0	0
Georgia	998,300	335,119	296,246	3,839	0	0
Hawaii	114,800	85	0	0	0	0
Idaho	2,330,400	618,410	716	111,365	16	3
Illinois	4,017,500	330,981	5,672	5,623	5	17
Indiana	2,133,600	183,470	3,145	6,860	602	1
Iowa	8,846,100	1,386,788	5,487	2,366	40	18
Kansas	7,032,000	1,911,334	1,485	11,243	73	411
Kentucky	2,054,600	325,526	1,319	10,950	0	37
Louisiana	244,600	58,479	20,171	900	0	0
Maine	132,000	20,673	1,129	0	0	0
Maryland	439,500	3,688	388	564	0	4
Massachusetts	48,000	26	10	0	0	0
Michigan	828,800	99,987	3,814	3,074	42	6
Minnesota	2,327,000	1,402,784	26,895	4,690	1,049	379
Mississippi	1,575,300	473,101	242,143	17,780	0	0
Missouri	5,226,800	1,155,226	1,758	39,393	4	0
Montana	8,601,400	1,702,299	143	22,062	633	15
Nebraska	5,034,200	929,621	1,279	159,173	744	85
Nevada	196,900	0	0	0	0	0
New Hampshire	23,800	0	0	0	0	0
New Jersey	193,100	322	0	0	0	0
New Mexico	871,600	454,819	0	0	18	0
New York	1,225,300	34,215	1,834	575	0	0
North Carolina	1,527,800	80,842	42,998	110	0	0
North Dakota	2,790,500	1,297,888	482	138,264	556	12
Ohio	1,529,800	129,018	3,970	2,772	20	7
Oklahoma	2,949,300	855,486	63	1,388	12	0
Oregon	1,212,500	467,641	375	1,787	0	1
Pennsylvania	1,980,800	44,922	467	2,128	1	11
Puerto Rico	242,500	240	25	0	0	0
Rhode Island	3,300	0	0	0	0	0
South Carolina	364,600	162,354	122,357	3,568	4	0
South Dakota	2,038,300	746,492	253	103,330	210	2
Tennessee	2,023,800	302,558	14,786	9,266	0	3
Texas	13,932,400	2,747,873	7,793	86,397	15	15
Utah	463,900	209,453	0	17,421	10	0
Vermont	68,600	171	0	0	0	0

(continued)

Table 2. (*continued*)

State	Eligible cropland	Total enrolled	Trees (CP3)	Wildlife (CP4)	Windbreaks (CP5)	Water (CP9)[a]
Virginia	910,800	36,120	14,605	2,420	0	0
Washington	2,464,000	790,662	703	13,402	0	34
West Virginia	232,400	388	13	15	0	0
Wisconsin	2,994,500	332,363	20,251	1,711	42	8
Wyoming	383,500	200,772	8	33,412	21	3
Totals	101,535,800	22,149,539	1,129,407	904,829	4,549	1,467

[a]The *number* (how many) of a given practice is not available.
[b]Estimate not available.

Discussion and Recommendations

The following recommendations are a composite of the various efforts of several conservation agencies and groups throughout the United States to promote wildlife management on CRP land. Specific agencies or groups are mentioned only as examples. Recommendations are grouped into six subjects: cooperative relationships; information and education programs; direct assistance; management of permanent vegetation; food plots; and annual idled acreage programs.

Cooperative Relationships

Wildlife agencies and special interest groups need to continue expanding their cooperation with USDA agencies responsible for implementing CRP. In states where the wildlife benefits of CRP are being maximized, wildlife agenices or groups have designated an individual to coordinate with USDA agencies at their respective levels. This appears to improve understanding and cooperation in developing CRP wildlife projects.

The recent addition of the Vegetative Filter Strips (CP13) practice is an example of how quickly changes can take place in CRP. This new practice was introduced just two weeks before the sixth sign-up (February 1988). Wildlife agencies and groups that are familiar with the changing nature of CRP, and have developed effective communication with USDA agencies, will be able to react and take advantage of opportunities as they develop. In the case of the Vegetative Filter Strips (CP13) practice, wildlife agencies had very little time to recommend seed mixtures or encourage USDA agencies to allow tree or shrub plantings.

Information and Education Programs

Wildlife agencies and groups have existing information networks reaching audiences that include landowners with eligible cropland or land already enrolled in CRP. These landowners can be encouraged to enroll their eligible cropland for wildlife purposes or manage previously enrolled land for wildlife. Texas has produced an excellent publication on establishing and managing wildlife habitat with several of the CRP practices (Schramm et al. 1987). The Missouri Department of Conservation (MDC) has also published information sheets specifically for CRP (MDC 1987a, 1987b). Nationwide, there is a need for more publications to inform landowners of *regional* wildlife management techniques that are applicable to CRP land.

Direct Assistance

Wildlife agencies and special interest groups may also encourage landowner participation in CRP wildlife practices by offering direct assistance with establishment and maintenance or supplementation of annual rental payments. A landowner's decision to choose a CRP wildlife practice during the enrollment process may be influenced by the potential for additional assistance in establishing the practice or maintaining it during the contract period. The Secretary of Agriculture is encouraging state and private organizations to provide "piggyback" funding to landowners for CRP enrollment or cover establishment.

The MDC (1987b) is providing 25 percent additional cost-share to establish selected CRP practices. Colorado, Idaho, Illinois and North Dakota also have supplemental cost-share programs for establishing specific CRP practices (N. Bushwick personal communication: 1988). In Pennyslvania, CRP landowners who also are Game Commission cooperators are eligible for free tree and shrub seedlings, and Game Commission food and cover crews may perform free habitat improvement work on their land (J. Byerly personal communication: 1988). Private wildlife groups, such as Quail Unlimited and Pheasants Forever, have provided planting equipment and seed at no cost to landowners, and members have provided free labor for wildlife habitat establishment and maintenance.

Wildlife agencies in Oklahoma and South Dakota are initiating programs that will supplement the annual rental payments to landowners who establish and manage their CRP land to benefit wildlife and provide public access (S. Tolly and C. M. Vicuna personal communications: 1988). The Fish and Wildlife Service (FWS) of the United States Department of the Interior is providing annual rental payments to some Waterfowl Easement Program (WEP) landowners in North Dakota, South Dakota and western Minnesota who have enrolled their WEP acres in CRP. The supplemental payments are for allowing FWS to practice waterfowl management (D. V. Kleven personal communication: 1988).

FWS is also implementing a program on *existing* CRP land in Indiana, Iowa, Michigan, Minnesota and Wisconsin. It will pay 100 percent of the cost of restoring wetlands. Their goal is to restore 300 wetlands in Minnesota and 100 wetlands in each of the other four states (D. C. Hudak personal communication: 1988).

Management of Permanent Vegetation

In such states as New York, Virginia and Oklahoma, natural resource agencies and conservation groups have encouraged local ASCS and SCS personnel to recommend cover establishment and management options that are beneficial to wildlife, even on acreages *not* enrolled for wildlife purposes (R. E. Myers, G. H. Moser and S. Tolly personal communications: 1988). Examples are: recommending specific grasses and legumes or forbs beneficial to wildlife; encouraging conservation tillage or no-tillage seedings; encouraging the use of companion or nurse crops with seedings; and recommending rotational strip and/or delayed mowing or timely burning.

SCS is concerned about establishing adequate grass cover for erosion control, and ASCS is concerned about controlling noxious weeds (as defined by local laws and ordinances). However, rotational strip and/or delayed mowing or timely burning can be practiced on most CRP land once cover is established, and will benefit wildlife as well as reduce landowner maintenance costs.

Food Plots

As large or isolated acreages are enrolled in CRP, food plots may become important for some wildlife species normally associated with cropland. This is another example where conservation agencies or groups may have an opportunity to encourage both establishment and maintenance, since food plots are specifically exempt from ASCS cost-share. Both free food plot seed and free permanent cover seed could be provided.

Annual Idled Acreage Programs

As mentioned earlier, there are also *annual* idled acres of cropland created by other ASCS programs. These acreages alone may provide some wildlife food or cover. However, a greater potential for wildlife enhancement exists when these short-term idled acres adjoin long-term CRP areas. Wildlife agencies and groups may encourage: (1) CRP landowners to consider this option through their information programs; and (2) ASCS and SCS field personnel to recommend it to CRP landowners.

Conclusions

All of these methods of achieving a better Conservation Reserve Program for wildlife may be accomplished with expanded communication and cooperation between USDA agencies and other interested agencies and groups. Some of the above examples do require new sources of funding, but most of these programs are being initiated through redirection of existing staffs and funds.

Even though only slightly more than 9 percent of enrolled CRP land is devoted to wildlife or forestry practices, the other 90 percent of the CRP acreage surely is providing some wildlife benefits. And there are still opportunities to improve the wildlife habitat on those other acres. The vegetative cover already is established in most cases, but the management can be changed to benefit wildlife further without landowners violating the requirements of their CRP contracts. Low-level, extensive wildlife habitat improvement on a larger percentage of this ''other'' CRP land may be a greater opportunity to enhance wildlife benefits of the CRP than would be intensive management on the relatively small acreages being enrolled for wildlife or forestry purposes.

With the CRP having a relatively long life and dwarfing all the current efforts of wildlife interests both public and private (in the private lands arena), the opportunities provided by CRP should not be overlooked. Chester McConnell (1981) pointed out that the land-use problem is ''simply too massive for wildlife agencies to solve alone with their [limited] funds and personnel. [They] must use all the tools available. . . .'' If they choose to use it to its fullest potential, the Conservation Reserve Program of the Food Security Act of 1985 is an excellent tool readily available to wildlife managers.

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Effects of the Conservation Reserve Program on Wildlife Habitat: A Cooperative Monitoring Study

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The Food Security Act of 1985 authorized a Conservation Reserve Program (CRP) that provides payments to farmers for planting permanent cover on highly erodible cropland. To date, about 23 million acres have been put into the Conservation Reserve, and this figure could increase in future years to the authorized limit of 45 million acres. Normally, up to 25 percent of the total cropland in a county can be enrolled, and some counties have been allowed to exceed 33 percent.

The CRP could produce substantial benefits for some wildlife species. Several studies documented the effects of earlier farm programs on wildlife (Bartman 1969, Berner 1984, Edwards 1984, Erickson and Weibe 1973). However, these earlier studies might have limited applicability to the CRP because farm environments have changed drastically in recent years (Berner 1986). Consequently, there are widely differing views about potential wildlife benefits of the CRP. On the positive side, the CRP should be beneficial to wildlife because, as Berner (1986) pointed out, the Food Security Act contains the strongest conservation provisions of any recent farm legislation. Harmon (1988), however, contends that benefits from the CRP remain to be seen because of uncertainties about management practices (e.g., haying, grazing) on CRP lands.

Study Objectives

Recognizing the need to document the effects of the CRP program, the International Association of Fish and Wildlife Agencies (IAFWA) and the U.S. Fish and Wildlife Service began this monitoring study in 1987. The objectives are as follows: (1) describe trends in vegetation succession on CRP lands; (2) describe trends in wildlife habitat caused by the CRP; and (3) summarize the results for presentation to Congress in 1990 and 1994, including recommendations for enhancing the CRP for wildlife.

The purposes of this paper are to describe how the monitoring study will be conducted, report on its current status and outline a schedule of future activities.

Study Design

The design of a successful monitoring study required that we devise a systematic way to do the following:

1. Perform an analysis that clearly describes changes in wildlife habitat caused by the CRP.
2. Identify the data that must be collected on sampled CRP fields in order to perform the above analysis.

3. Determine the sample size (i.e., the number of CRP fields to be sampled) and select the specific fields to be sampled.

Of course, the sampling effort has to be feasible given the number of people and funding available.

Performing Habitat Analyses

Initially, the country was divided into four to eight ecological regions and, in each, habitat trends were to be monitored for three wildlife species, including at least one nongame species. Location of the regional boundaries, and thus the number of regions, was dependent on several criteria. First, the regional boundaries were dependent on the species chosen for the study; species chosen to represent a region should be distributed across the entire region. Second, boundaries were defined to provide regions that were relatively homogeneous with respect to ecological variables (e.g., soils, climate) that control agricultural practices and rates of plant succession on CRP fields. Third, each of the regions encompassed significant CRP acreage (or erodible soils eligible for CRP).

A preliminary regional map was developed based on ecoregions described by Bailey (1980) and Major Land Resource Areas defined by the U.S. Department of Agriculture (1981). However, these regional boundaries were later realigned to correspond with the distribution of two key species selected by the Midwest, Southeast and Plains regions—the ring-necked pheasant and the bobwhite quail. Study regions, as currently defined, are shown in Figure 1, but additional revision is anticipated as planning is completed for remaining areas.

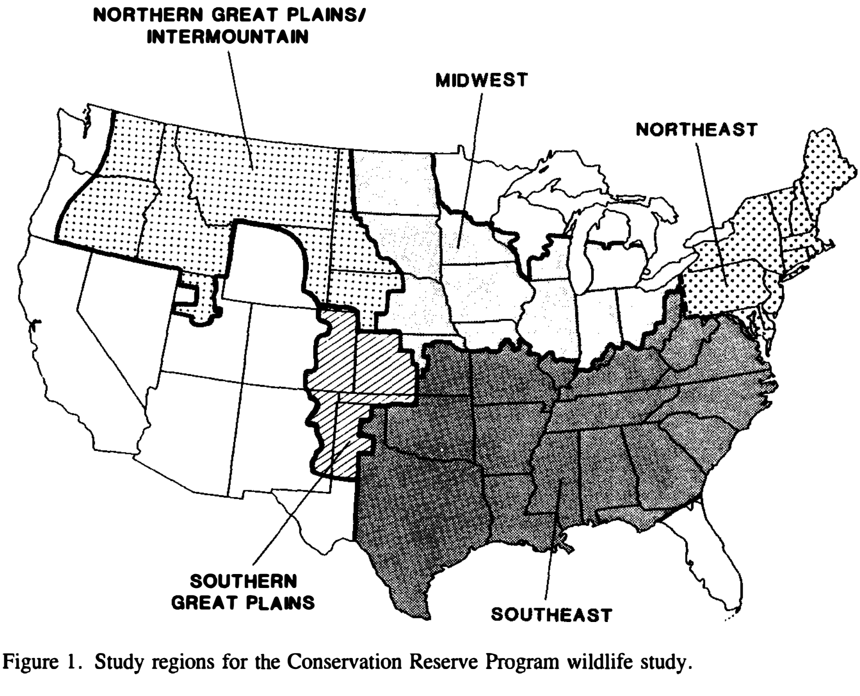

Figure 1. Study regions for the Conservation Reserve Program wildlife study.

Habitat trends for the species in each region will be analyzed using the habitat unit (HU) defined by the U.S. Fish and Wildlife Service (1981) as follows:

$$HU = (HSI)(AREA)$$

where:

$$\begin{aligned} HU &= \text{Habitat Units (acres)} \\ HSI &= \text{Habitat Suitability Index (unitless)} \\ AREA &= \text{the surface area of habitat (acres)} \end{aligned}$$

The AREA is simply a measure of the surface acreage in a CRP field, whereas the HSI is computed using a model that relates easily measured habitat characteristics (e.g., vegetation structure) to the species' life requisites. Habitat trends will be reported in terms of change in the area and change in habitat suitability. Habitat units will be computed for each sampled field based on the area of the field and the habitat characteristics that existed before the field entered the CRP. Every two years, habitat characteristics will be measured in the field and the habitat units recomputed. Comparisons between years will show trends in habitat units, and the observed trends will be reported annually and in major reports in 1990 and 1994.

Identifying Required Data

The data to be collected for each sampled CRP field are the area of the field (available from the contract) and the habitat measurements required by the HSI models for the three species. The list of habitat measurements for the Midwest region is given in Table 1.

Although the data requirements follow directly from the HSI models, some judgment must be exercised during model construction so that the data are feasible to collect. We will hold a workshop within each region, attended by biologists from participating states, to review HSI models for the selected species. The models resulting from these workshops will reflect the best compromise between two perspectives—biological realism and feasibility of data collection.

Determining Sample Size

The CRP fields within a region are highly variable in habitat value due to the different types of cover (i.e., the Conservation Practice) that can be planted and

Table 1. Habitat variables to be measured in sample fields in the Midwest region.

Variable	Pheasant	Rabbit	Meadowlark
Is there a potential source of winter food on or within ¼ mile of the CRP field?	x		
Is there a source of winter food and cover within 2 miles of CRP field?	x		
Robel reading of vegetation (pregreenup).	x		
Robel reading of vegetation (nesting period).	x		
What is the quality of winter cover for pheasant?	x		
Herbaceous canopy cover (pregreenup).		x	
Herbaceous canopy cover (summer).			x
Proportion of herbaceous canopy cover that is grass.			x
Height of herbaceous canopy.			x
Canopy cover of shrubs.		x	x

different times that fields entered the CRP. Therefore, for efficiency, we decided on a stratified sampling strategy. Each field was put into a sampling stratum, or population, based on its habitat characteristics. Three characteristics thought to have the most influence on habitat value were used to define the populations: (1) the Conservation Practice employed on the field (this determines the future habitat suitability); (2) the retired crop base (this should be correlated with soil and climate and determine the past habitat suitability); and (3) the year the CRP contract was initiated (determines the stage of plant succession). There are about 220 different populations (11 conservation practices times 10 crop bases times 2 contract years [1986 and 1987]).

Most of the CRP fields within a given region fall into just a few of the possible populations. Our evaluation of the CRP will be based on these dominant populations. The populations within a region will be rank-ordered on the basis of acreage, and those populations contributing approximately the top 95 percent of CRP acreage, plus populations of special policy interest, will be sampled. For example, the top 95 percent of CRP in the Midwest region occurred in tame grass (CP #1) for five base crops, native grass (CP #2) for five base crops and "already in grass" (CP #10) for one base crop. Because of their special appeal, wildlife plantings (CP #4) and tree plantings (CP #3,5) also will be included. These 14 populations were further subdivided by year, to give a total of 28 populations for the Midwest.

A sufficient number of fields will be selected to provide a specified level of statistical reliability for each population on a regional basis. Given a regional sample, it is doubtful that we will be able to perform equally reliable analyses for individual states. However, some states have expressed a desire to attain state-level reliability, and we will assist them by drawing a state sample of contracts large enough for this purpose.

We have tentatively chosen to sample randomly from each population, selecting enough fields to achieve a 95-percent probability that the sample mean for each habitat variable, plus or minus 10 percent, will include the population mean. This is an arbitrary decision—any other level could have been used—but the chosen reliability level approximates that traditionally used in wildlife research. Moreover, it seems that this level is feasible to attain, at least in the Midwest region. Preliminary data indicate that about 20 sample fields per population will be sufficient for the Midwest. This turns out to be 560 sample fields (20 samples times 28 populations), and the distribution of samples by state is shown in Table 2.

In summary, the sample for each region will be determined as follows:

1. Populations of CRP fields will be classified into different populations based on three characteristics—conservation practice, crop base and year of contract.
2. The populations will be rank-ordered on the basis of most acreage; populations contributing the top 95 percent of CRP area and those of special policy interest will be sampled.
3. Each population will be sampled randomly to attain a 95-percent confidence of ± 10 percent accuracy.

Participants

This study is a cooperative effort between the IAFWA, state fish and wildlife agencies, the U.S. Fish and Wildlife Service, and the U.S. Department of Agriculture. The IAFWA is the focal organization in the study. Through its Washington, D.C.

Table 2. Distribution of Conservation Reserve Program sample fields by state for the Midwest region.

State	Number of sample fields
Illinois	8
Indiana	4
Iowa	68
Kansas	36
Michigan	10
Minnesota	198
Missouri	57
Nebraska	99
Ohio	8
South Dakota	35
Wisconsin	38
Total	560

office and its committees, the IAFWA has helped set the study direction and defined the information needed from the study. It has been instrumental in enlisting the help of state wildlife agencies, without which the data could not be collected. It will also be the conduit through which study results will be passed on to Congress and others.

The U.S. Fish and Wildlife Service's Division of Federal Aid provided the funding for the study. The Service will coordinate the development of HSI models and field procedures with the participating states. The Service also has the lead role in statistical design of the study and will perform national-level analyses and prepare written reports of the study results. And it will serve as a data clearinghouse, which means that it will maintain a computer database of all regional data and make these data available to cooperating agencies.

The states will provide the principal biological expertise for constructing HSI models and will assist in developing field procedures. They will have the lead in collecting field data and may prepare state-level analyses and reports. Several states will do more intensive work in order to get higher reliability in their data or to initiate such supplemental studies as monitoring wildlife populations.

The U.S. Department of Agriculture provided a copy of the computer database on CRP contracts for use in the statistical design of the study. This agency has offered to help by providing economic data and other information. It has also expressed interest in using our results in its analyses of the success of the Food Security Act.

Study Schedule

The study schedule requires data collection in each region every two years, through 1994. Therefore, regions that begin data collection this year will collect data again in 1990, 1992 and 1994. Reports summarizing the habitat changes since initiation of the CRP will be prepared annually. In 1990 and 1994, we will report on additional analyses, forecasting trends in habitat and identifying potential modifications to improve the CRP from a wildlife perspective.

During 1988, four study regions will become operational and begin collecting data—Midwest, Southeast, Northern Great Plains/Intermountain and Southern Great

Plains. These four regions cover more than 80 percent of all CRP acreage. During the last quarter of 1988, data summaries and computerized data from the 1988 field season will be available for distribution. In early 1989, the first analysis will be completed, based on a comparison of 1988 results with estimates of pre-CRP habitat values.

Only the Northeast region will not be included in 1988 fieldwork. Before March 1989, we will hold workshops with the Northeast region to develop models and field procedures. This region should begin collecting field data in 1989.

During 1989, additional field sampling for the first four regions will occur. Fields with crops will be sampled using the standard procedure in each region to establish estimates of habitat values for the CRP fields before they were enrolled in the CRP. We may have to obtain additional samples if the 1988 sample proves to be too small or if supplemental information is required.

During 1990, a major focus will be to project the future habitat value of the CRP fields through the end of the contracts (and perhaps beyond for tree plantings). This will involve major input from state biologists and may include sampling new fields in later stages of succession than the CRP fields. This report also will include recommendations for modifications in the Act or administrative guidelines to improve the program for wildlife. The final report is likely to be in 1994 and will contain information similar to the 1990 report.

Interested agencies will be kept apprised of progress on the study. In addition to the annual reports, three other types of reports will be periodically produced. Every quarter, the Service will mail a status report to the state "Farm Bill" coordinators. A one-page summary of the status report will be distributed by the IAFWA to directors of state wildlife agencies. Finally, information of interest will be published periodically in the newsletter "Linking Agriculture and Resource Conservation Programs," produced by the Wildlife Management Institute.

Future Extensions

Several supplemental studies have been suggested by participants. The studies that have the most support and should be conducted are:

1. *Model validation and population studies*. The HSI models that are used to describe habitat trends have not been field-tested, so we are not sure if they will give reliable results, i.e., if populations will respond to CRP as projected by the habitat trends. We are currently developing study plans for testing the bobwhite model at Virginia Polytechnic Institute and State University and the pheasant model at Iowa State University. Models for the other species will need testing as well.

2. *Economic studies*. Wildlife benefits measured in dollars may have more influence on farmers and legislators than do biological measures of habitat. Currently, the U.S. Department of Agriculture does not plan to undertake economic analyses of wildlife resources; we must take the lead if this is to be accomplished. The Service has devoted an economist for about six months in 1988 to design studies that might begin in 1989, subject to obtaining the needed funding. Two levels of focus are planned—regional analyses that address broad economic changes, and on-farm management

to determine the economic implications of likely wildlife response to alternative plantings and management.

3. *Community measures*. The current study is based on three wildlife species per region, which will not give an accurate picture of all wildlife effects of the CRP. Two regions to date have decided to collect information about the diversity of cover types at the edges of the CRP fields. There is a need to develop and test a model relating the relation of the wildlife community diversity to differences in the cover type diversity.

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Potential Implications of Sodbuster on Wildlife

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Introduction

"Sodbuster" is the common name applied to part of the highly erodible land (HEL) provision of the Food Security Act (FSA) of 1985 (PL 99–198). Sodbuster withholds U.S. Department of Agriculture (USDA) farm program benefits from farmers who produce agricultural commodities after December 23, 1985, on fields newly converted to cropland in which a predominance of HEL occurs. Exemptions are granted to producers who have in place an approved conservation system before they produce agricultural commodities. This provision will apply to most farmers, as about 75–85 percent of them traditionally have participated in USDA commodity support programs (USDA 1986). Sodbuster is considered in this paper as it may affect wildlife habitat.

Sodbuster

Sodbuster Lands

Land-use and erosion data for the nonfederal rural lands in the United States (excluding Alaska) are found in Table 1. There are 225 million acres (91.3 million ha) of HEL with potential for conversion to cropland in the U.S. representing about 23 percent of the total range, pasture, forest and other land (USDA SCS 1987). About 28 percent of the cropland is HEL, but nearly 48 percent of it is eroding at rates greater than the tolerable (T) soil loss limits. Soil erosion rates are accelerated under cropping but generally quite low under permanent vegetation.

Figure 1 depicts the proportion of the total nonfederal HEL with potential for conversion to crops by farm production region. Figure 2 depicts the proportion of each land use within each region that is HEL with potential for conversion. Rangeland in the Mountain Region accounts for 17 percent of the total land affected by Sodbuster (Figure 1), while 20 percent of the Mountain Region rangeland is HEL with potential for conversion to cropland (Figure 2). The farm production regions are identified along with Sodbuster data by state in Table 2.

Sodbuster Process

The Soil Conservation Service (SCS) is responsible for determining if a field has a predominance of HEL. If the field does have a predominance of HEL, the producer is subject to Sodbuster and may retain his eligibility by deciding not to convert the HEL to cropland or by applying an approved conservation system to the field before planting crops. Approved conservation plans prepared for the FSA will generally reduce soil erosion rates down to T. However, the FSA provides for an exception—the alternative conservation system (ACS), which will reduce soil erosion rates down

Table 1. Land use, estimated average annual erosion rates, proportion eroding above tolerable limits, land with potential for conversion to cropland, area and proportion of highly erodible land of the nonfederal, rural land in the United States (excluding Alaska) in 1982 (USDA SCS 1987).

	Land-use Category				
	Crop	Range	Forest	Pasture	Other
Total area					
ac × 10^6	421.0	405.9	393.2	132.4	59.6
ha × 10^6	170.4	164.3	159.1	53.6	24.1
Erosion rate					
t/ac	7.3	2.9	1.0	1.4	11.5
t/ha	16.4	6.5	2.2	3.1	25.8
Percentage eroding > T	47.8	4.4	3.1	4.6	11.4
Potential cropland					
ac × 10^6		180.1	188.2	109.3	16.0
ha × 10^6		72.9	76.2	44.2	6.5
Percentage		44.4	47.9	82.5	26.9
Highly erodible[a]					
ac × 10^6	117.7	98.7	74.1	47.5	5.3
ha × 10^6	47.6	39.9	29.9	19.2	2.1
Percentage	27.9	24.2	18.8	35.9	8.8

[a]With the exception of cropland, these data represent land that is highly erodible and has potential for conversion to cropland.

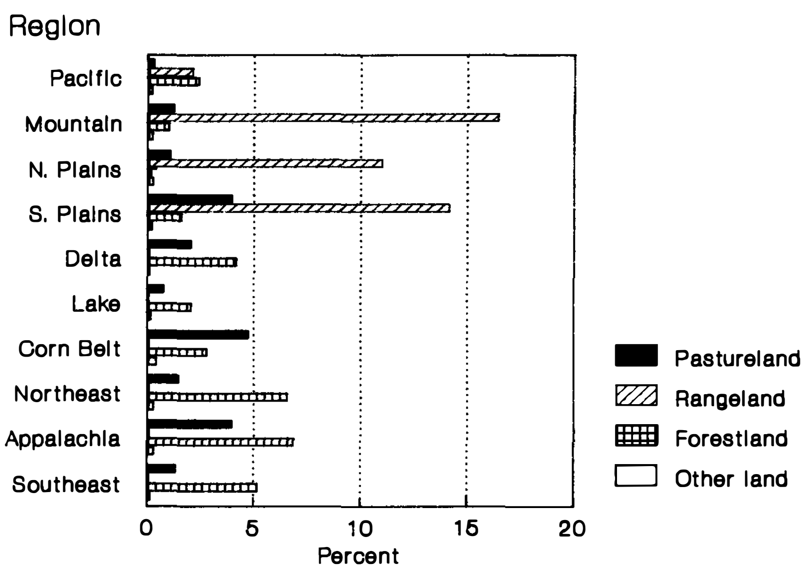

Figure 1. Land use and distribution in 1982 of the nonfederal highly erodible land with potential for conversion to cropland in the 10 farm production regions of the United States (USDA SCS 1987).

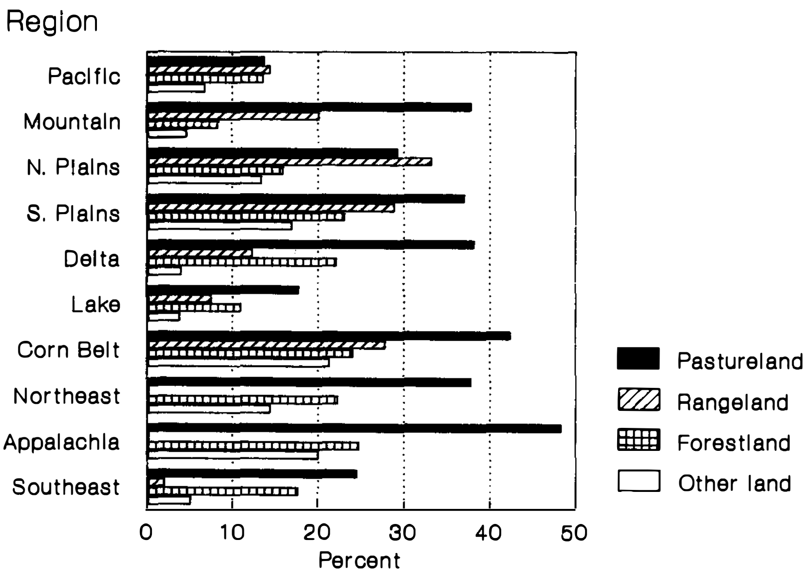

Figure 2. Percentage of the nonfederal rural land by land-use category in each region in 1982 that is highly erodible and has potential for conversion to cropland (USDA SCS 1987).

Table 2. Nonfederal, highly erodible land with potential for conversion to cropland in 1982 by land use and by state (USDA SCS 1982 National Resources Inventory file data).

		Acres (in thousands)				
Region	State	Range	Forest	Pasture	Other	Total
Se	AL	0.0	4,671.3	1,354.8	124.3	6,150.4
Mt	AZ	4,455.6	699.3	33.3	49.7	5,237.9
De	AR	47.8	3,897.2	2,717.9	57.0	6,719.9
Pa	CA	2,667.1	1,386.9	157.5	282.2	4,493.7
Mt	CO	7,177.9	266.2	468.6	106.4	8,019.1
Ne	CT	0.0	306.5	38.7	28.6	373.8
Ne	DE	0.0	65.1	12.5	8.3	85.9
Se	FL	76.9	573.1	175.0	35.7	860.7
Se	GA	0.0	4,460.9	1,041.5	130.4	5,632.8
	HI	0.0	183.8	259.4	17.6	460.8
Mt	ID	1,236.2	510.4	421.0	90.4	2,258.0
CB	IL	0.0	891.3	1,195.6	142.4	2,229.3
CB	IN	0.0	848.5	836.7	151.1	1,836.3
CB	IA	0.0	414.0	2,052.7	237.6	2,704.3
NP	KS	4,843.5	84.9	594.9	141.9	5,665.2
Ap	KY	0.0	1,626.6	2,745.8	128.7	4,501.1
De	LA	2.3	3,310.4	692.3	67.4	4,072.4
Ne	ME	0.0	4,616.7	186.7	87.9	4,891.3
Ne	MD	0.0	702.0	234.8	45.1	981.9
Ne	MA	0.0	321.4	58.2	26.3	405.9

(*continued*)

Table 2. (*continued*)

Region	State	Acres (in thousands)				
		Range	Forest	Pasture	Other	Total
La	MI	0.0	1,347.4	450.5	104.5	1,902.4
La	MN	14.9	1,120.9	444.0	141.9	1,721.7
De	MS	0.0	2,168.9	1,225.8	48.9	3,443.6
CB	MO	46.7	2,469.9	5,445.6	199.7	8,161.9
Mt	MT	10,678.0	415.4	1,308.7	122.4	12,524.5
NP	NE	11,646.1	141.8	863.5	202.1	12,853.5
Mt	NV	690.0	1.7	55.4	11.9	759.0
Ne	NH	0.0	731.5	45.1	15.9	792.5
Ne	NJ	0.0	213.2	50.9	28.4	292.5
Mt	NM	5,501.9	224.8	49.8	102.6	5,879.1
Ne	NY	0.0	3,282.9	1,401.4	109.6	4,793.9
Ap	NC	0.0	4,284.6	1,002.5	239.9	5,527.0
NP	ND	2,698.6	111.3	354.1	153.5	3,317.5
CB	OH	0.0	1,672.8	1,158.9	233.1	3,064.8
SP	OK	5,187.9	1,363.5	2,705.1	112.2	9.368.7
Pa	OR	1,231.4	1,603.6	265.1	58.0	3,158.1
Ne	PA	0.0	3,448.5	1,111.5	269.3	4,829.3
Ne	RI	0.0	112.3	7.8	3.5	123.6
Se	SC	0.0	1,914.0	437.9	36.1	2,388.0
NP	SD	5,591.4	38.0	627.8	125.9	6,383.1
Ap	TN	0.0	3,180.8	2,717.6	103.5	6,001.9
SP	TX	26,673.5	2,290.8	6,257.4	367.4	35,589.1
Mt	UT	794.4	125.7	120.0	37.5	1,077.6
Ne	VT	0.0	962.9	190.4	13.3	1,166.6
Ap	VA	0.0	4,085.9	1,592.0	135.3	5,813.2
Pa	WA	887.0	2,433.5	227.0	101.6	3,649.1
Ap	WV	0.0	2,251.9	869.9	81.0	3,202.8
La	WI	0.0	2,198.2	865.2	115.6	3,179.0
Mt	WY	6,514.2	55.8	332.1	41.2	6,943.3
	PR	0.0	55.8	197.4	5.8	259.0
Total		98,663.3	74,144.8	47,658.3	5,280.6	225,747.0

to some other specified level. ACS are authorized only for specific soil map units and crop combinations where erosion reduction to T is impractical and would result in an economic hardship to producers.

Progress in implementing Sodbuster cannot be tracked separately from Conservation Compliance in the SCS reporting system, but in the first one and one-quarter years since the rules for the HEL provisions have been in use, SCS has made HEL determinations on 956,000 farms and has found 554,000 farms with 57.7 million acres (23.4 million ha) of HEL. Conservation plans have been developed on 33.1 million acres (13.4 million ha) and conservation treatment has been applied on 8 million acres (3.2 million ha).

Wildlife and Cropland

Conversion of native lands to crop production is one of several interrelated factors that have historically influenced wildlife resources in the U.S. Harvests of ring-necked pheasant (*Phasianus colchicus*), northern bobwhite quail (*Colinus virginianus*) and cottontail rabbit (*Sylvilagus floridanus*) in Illinois during the years 1956–1985 (J. A. Ellis personal communication: 1984, Ellis and Mahan 1987) were evaluated against key agricultural land-use factors (Illinois Coop. Crop Report. Serv. 1987) for the purpose of this discussion. Regression analysis revealed the following: declining harvests of pheasants were significantly correlated ($R^2 = 0.53$, $F = 32.1$, $P < 0.0001$) with increasing acres of row crops; declining harvests of bobwhites were significantly correlated ($R^2 = 0.67$, $F = 57.5$, $P < 0.0001$) with increasing acres of row crops; and declining harvests of cottontails were significantly correlated ($R^2 = 0.86$, $F = 172.9$, $P < 0.0001$) with decreasing acres of hay and small grains.

Baxter and Wolfe (1973) suggested that a threshold exists for intensive agriculture and pheasant numbers, below which an increase in cultivation would bring about an increase in pheasants and above which pheasant numbers would decline. Higgins (1975) reported that nest and nest densities of three game birds and five shorebirds in nontilled upland habitats were about three times greater than those on annually tilled croplands in east central North Dakota. Taylor et al. (1978) reported a statistically significant relationship between declining pheasant densities and an interspersion index reflecting increasing intensity of cropland use in Nebraska during the years 1955–1976.

Based on stepwise multiple-correlation analyses, Edwards et al. (1981) reported that declines in the abundance of cottontails appear to have been particularly associated with decreases in number of farms and the acreages of hay and oats (*Avena sativa*) during the years 1957–1977 in Illinois. They considered land use to be the principal factor determining the base level of abundance of endemic species in agricultural environments.

Graber and Graber (1983) reported that eight species of grassland-nesting nongame birds suffered catastrophic population declines (84–98 percent) in central and northern Illinois during the years 1957–58 through 1979. This was a period of major land-use shifts from tame hay and pasture to row crops. Henslow's sparrow (*Ammodramus henslowii*), upland sandpiper (*Bartramia longicauda*) and long-billed curlew (*Numenius americanus*) population declines are thought to have been caused by loss of preferred field nesting habitat to agricultural conversion (USDI FWS 1982). Loggerhead shrikes (*Lanius ludovicianus*) have declined in all parts of their range apparently as a result of a combination of factors that includes loss of pastures and hedgerows, and lark buntings (*Calamospiza melanocorys*) were reported as declining where grazing land was rapidly being converted to cropland (Robbins et al. 1986).

Whitcomb et al. (1981) reported the absence or major decline of several bird species from an archipelago of forest islands surrounded by agriculture in Howard County, Maryland. Samson (1980) also reported that habitat for nongame birds has become increasingly isolated by agricultural or other human activities, thus more insular in character. There is reason for concern that increasing forest fragmentation will eliminate some species as functioning members of certain regional faunal communities.

A few species of wildlife have shown an increase in population numbers in response to expanded production of agricultural commodities. Dolbeer and Stehn (1979) reported significant positive annual rates of change on a continental scale for red-winged blackbirds (*Agelaius phoeniceus*), brown-headed cowbirds (*Molothrus ater*) and starlings (*Sturnus vulgaris*) during the years 1966–1976. They reported that common grackles (*Quiscalus quiscula*) indicated no significant continental change, but had increased in parts of the Midwest and lower and upper Plains regions. They noted that the intensification of agriculture, particularly expanded corn acreage, is a major reason for these increasing populations and/or enhanced overwinter survival rates.

Agricultural sources of pollution are reported to affect adversely the fish community in 29 percent of all waters (Judy et al. 1984). Many fish species adapted to clear-water conditions have been decimated and are being replaced by species tolerant of higher turbidity. From an economic standpoint, the declining species have tended to be those most valuable to the sport and commercial fisheries, while the ascendent fishes are of lesser value (Menzel 1982).

The previous point is illustrated with the Illinois River. During the first 75 years of this century, the Illinois River catch of freshwater fish dropped from 10 percent to 0.3 percent of the nation's total catch, and full-time commercial fishermen on the river dropped from 2,000 to just 2 (Havera and Bellrose 1982). During this period, a large commercial shellfish fishery and 25 mussel species were exterminated by sediment from eroding croplands and other pollution including that from organochlorine pesticides (Starrett 1971). The attendant decline in waterfowl use of the Illinois River Valley is directly related to the loss of aquatic food plants from sedimentation and associated turbidity—primarily the result of poor farming practices (Bellrose et al. 1979).

Future Land-use Projections

USDA (1987) made "projections of future scenarios" based on a broad set of assumptions. It projected that cropland will decline dramatically after 1990, especially in the Plains and Mountain states, primarily because crops could be produced elsewhere at lower cost (Figure 3).

In those farming regions where future cropland is reduced, the result is likely to be reduced soil erosion and sediment deposition and expanded habitat diversity for wildlife. The intensity of the new use of the idled cropland will determine the quality of the habitat and the magnitude of the impacts. However, Sodbuster plus reduced cropland acres would likely result in a stabilized or expanded base of noncrop land uses. The unfavorable trends in wildlife abundance of recent decades previously discussed should be expected to change favorably, especially in those regions where cropland will continue to decrease through 2030.

There was widespread concern about world resource degradation in the 1970s, reflecting the sharp upward trends of commodity demands and resource degradation that begin in 1972. Based on those trends, the National Research Council's (1982) report suggested expanding agriculture and increasing intensity of use will result in continued or accelerated resource degradation. If this scenario develops, and commodity prices rise, the need for and participation in USDA farm programs would decline, reducing the influence of Sodbuster on cropland conversions. Sodbuster

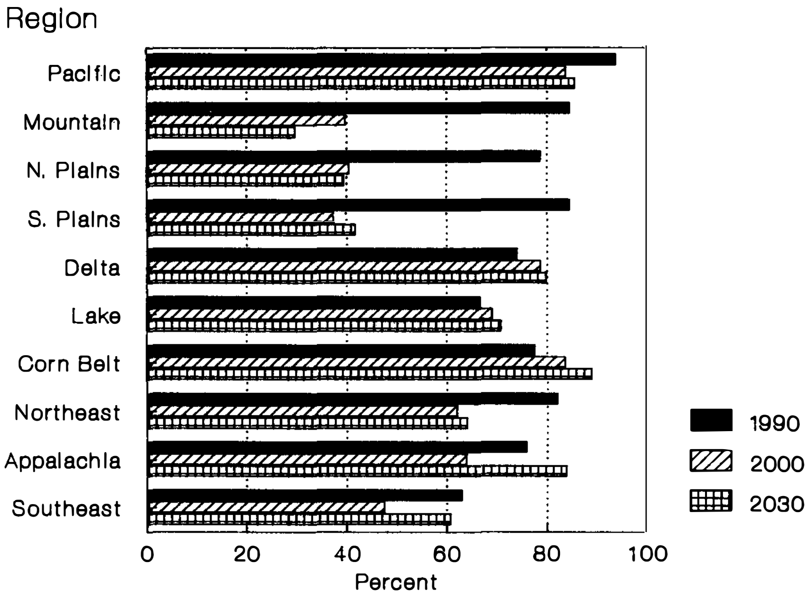

Figure 3. Projected cropland in each farming region as a percent of 1982 cropland (USDA 1987).

might encourage some producers to apply soil conservation systems to the land as it is converted. The abundance and diversity of habitat types now present would be reduced and the unfavorable trends in wildlife abundance previously described would continue.

Impact of Sodbuster

If fully implemented, the relative impacts of Sodbuster on reducing conversions to cropland are greatest in the Northern and Southern Plains, Appalachian, and Corn Belt regions, and least in the Lake States, Mountain, Pacific and Caribbean regions (USDA 1986). Data from Klopatek et al. (1979) indicate that the percentage of natural vegetation is highest in the Mountain and Pacific regions, lowest in the Lake States, Northern Plains and Corn Belt regions, and intermediate in the other regions. This would suggest that Sodbuster's influence will generally be felt most in the regions with relatively low proportions of natural vegetation and least in regions with relatively high proportions of natural vegetation, a generally favorable impact in regard to wildlife habitat. If the 225 million acres (91.3 million ha) of HEL with potential for conversion to cropland are currently eroding at the average annual rate for their respective land uses, and if they erode at the same average annual rate as highly erodible cropland if converted to that use (15.2 t/ac or 33.4 t/ha), then about 2.9 billion tons (2.6 billion tonnes) of eroded soil annually would be prevented by keeping the land in permanent cover (USDA 1986).

The Sodbuster provision is not operating in a vacuum and its conservation impact can really only be evaluated in concert with the other FSA conservation provisions.

Conservation Compliance and the Conservation Reserve Program (CRP) will serve to reduce erosion from highly erodible cropland or to convert it to permanent vegetation. USDA (1986) estimated that the two programs will eliminate 75 percent of the soil erosion in excess of T which occurs on cropland if CRP enrollment reaches 35 million acres (14.2 million ha). This proportion will be reduced where alternative conservation systems are installed, but overall, the reduction in soil erosion rates and offsite sediment and pollutant delivery will be substantial.

Sodbuster complements the CRP by reducing the likelihood of farmers substituting other erodible land for land they have enrolled in the reserve. Thus, a major impact of the Sodbuster provision is likely to be achieved indirectly through supporting the production-adjustment elements of the CRP. Additionally, CRP land is only enrolled for 10 years, but afterwards much of it will also be subject to the HEL provisions, thus adding a large additional base of habitat to the lands they influence.

A major benefit of Sodbuster will be to support the conservation gains of Conservation Compliance and CRP by discouraging additional conversions of HEL. These provisions will collectively result in significant improvement to aquatic ecosystems from reduced sediment deposition and its associated pollutants. This could likely be the most significant environmental impact of the FSA. HEL that is spared from conversion to cropland will help maintain a diversity of habitat types, although its quality will vary widely. The rate of fragmentation or isolation of habitat islands should decrease. The result is a greater likelihood that biotic resources can maintain their diversity and abundance.

Recommendations

Decisions that involve changes in land use may have a greater effect on habitat quality than do changes in land management practices (Miranowski and Bender 1982). Therefore, a decision to avoid sodbusting will generally be best for wildlife habitat. However, if the decision to sodbust has been made, it should be accompanied by conservation decisions. Some form of conservation tillage practice (such as no-till, mulch-till or ridge-till) should be used in all cases and all forms of post-harvest fall tillage should be discouraged. Crop rotations that include small grains and hay or contour strip farming should be encouraged to reduce the impact of expanding monocultures of row crops. Residual cover, such as in fencerows, brushy draws and "odd areas," should be protected. Specific management practices to enhance agricultural production and wildlife habitat are well-known by professional resource managers. If they effectively transfer those technologies to land-users in the form of custom-designed resource management system alternatives, better resource decisions are likely.

While Sodbuster's influence will be exerted on a field-by-field basis there are landscape scale recommendations that should also be considered. Attention should be focused on characteristics of the field that could preserve some of its biotic integrity. Forman and Baudry (1984) concluded that hedgerows (including fencerows and shelterbelts) perform diverse functions for society and the farmer that are both economically and ecologically significant. In addition to providing desireable habitat on the farm, they could function to link isolated islands of habitat, the result of fragmentation. Special attention should also be given to protecting riparian vegetation. Management of riparian greenbelts on a regional basis for their multiresource values would enhance our ability to achieve many off-site benefits. Where headwaters of streams occur in agricultural watersheds, they should receive priority status for protection because they are the primary sites of sediment input from the land surface (Karr and Schlosser 1978).

Conclusion

If fully implemented, and so long as significant numbers of farmers continue to participate in USDA farm programs, Sodbuster will discourage the conversion of HEL to cropland. USDA (1987) projections suggest a reduced need for cropland in future years. Because less HEL will be converted to cropland, the undesirable impacts (increased erosion and sedimentation, reduced water quality, and reduced wildlife diversity, abundance and habitat) associated with the more intensive use are avoided. Sodbuster does not create additional habitat, but will help to maintain or reduce the rate of loss of existing habitat, including much of that developed by the CRP. A major impact of Sodbuster is likely to be achieved indirectly through supporting the production adjustment elements of the FSA. The greatest environmental impact of Sodbuster from supporting these FSA provisions will likely be the reduced sediment delivery to aquatic ecosystems.

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Effects of Swampbuster Implementation on Soil, Water and Wildlife Resources

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Introduction

The alarming rate of wetland loss in the continental United States, particularly due to agricultural conversion, has become a matter of increasing concern. Congress addressed this concern in wetland conservation provisions of the Food Security Act of 1985 (FSA), which have been dubbed "Swampbuster" (P.L. 99–198, codified at 16 U.S.C. 3801 *et seq*). One of the purposes of Swampbuster was to reduce wetland conversion to agriculture by denying federal farm benefits to producers who drain and crop wetlands. The purpose of this paper is to assess the potential impact of Swampbuster in conserving wetlands and associated soil, water and wildlife resources, particularly in the Prairie Pothole Region and the Lower Mississippi River Valley.

Swampbuster Limitations as a Wetlands Protection Law

Swampbuster is not a statute that prevents wetland destruction. It simply provides that the federal government will not continue to extend a broad range of federal farm subsidies to a producer who drains, fills or otherwise manipulates a wetland *and* plants an agriculture commodity, i.e., a crop produced by annual tilling, on that converted wetland (16 U.S.C. 3801(a)(1)(A); 16 U.S.C. 3821). Congress passed Swampbuster not as a wetland protection statute per se, but to simultaneously remove federal subsidies for wetland conversion to agriculture, discourage agricultural expansion onto marginal farmlands, discourage the continued overproduction of commodity crops, and reduce federal budget outlays for farm subsidies generally (see, e.g., H.R. Rep. No. 99–271, 99th Cong., 1st Sess. 86–87 (1985)).

As a wetlands protection statute, Swampbuster has several critical limitations. First, it does not penalize a farmer for draining or otherwise manipulating a wetland. Only *in a year* when a producer plants an *agricultural commodity*, does the producer risk losing benefits (16 U.S.C. 3821). In those years in which the producer wants to ensure receipt of benefits, he can either forego planting in the converted wetland or he can plant a perennial crop such as alfalfa there.

Another fundamental limitation is that Swampbuster only discourages farmers who participate in federal farm programs. Therefore, farm operations that do not produce crops with commodity price supports or rely on other federally subsidized loan and insurance programs can ignore Swampbuster altogether. Similarly, as crop prices rise or farm subsidies are cut in the future, farmers will have less to lose by cropping converted wetlands in violation of Swampbuster.

Finally, Congress enacted certain exemptions to Swampbuster that further limit its effectiveness in reducing wetland conversion. The most significant exemption is for wetland conversion that "commenced" prior to passage of the FSA in December

1985. If a producer actually began "moving dirt," or committed significant funds for conversion through a contract or purchase of conversion supplies, prior to December 23, 1985, the wetlands converted through that activity or investment can continue to be cropped without triggering Swampbuster sanctions (see 16 U.S.C. 3822 (a)(1); Final Regulations, 52 Fed. Reg. 35201, 35203, to be codified at 7 CFR 12.2(a)(6) and 12.5(d)).

Other exemptions that can limit Swampbuster's effectiveness are the "third-party" exemption, which immunizes a producer who crops a wetland converted by activity beyond his control (52 Fed. Reg. 35203), and the "minimal effect" exemption (16 U.S.C. 3822(c)), which permits minor wetland conversion activity that will have only a deminimus effect on wetland function.

Wetlands Affected by Swampbuster

The Wetlands Definition and Congressional Intent

Wetlands potentially affected by Swampbuster are those that meet the following wetlands definition: "[L]and that has a predominance of hydric soils and that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions" (16 U.S.C. 3801(a)(16)).

Some wetlands that meet this definition, but which have been partially drained or otherwise manipulated prior to December 1985 to produce an agricultural commodity, are not subject to Swampbuster because they are defined as "converted wetlands." Potholes, playas and other wetlands "seasonally flooded or ponded for extended periods" are expressly excluded from this converted wetland status, despite some prior manipulation, and are thus covered by the Swampbuster sanctions (Final Regulations, 52 Fed. Reg. 35194, 35208, codified at 7 CFR 12.32(3)). As discussed in more detail below, the definition of "extended periods" will have a significant impact on the role of Swampbuster in protecting previously cleared and planted bottomland hardwood wetlands and certain other wetland types.

In summary, all wetlands that meet the accepted statutory definition, and which are not excluded as converted wetlands, should be subject to Swampbuster sanctions.

Overview of Wetland Types, Functions and Acreages Potentially Affected by Swampbuster

The remaining wetlands most vulnerable to agricultural conversion are palustrine (upland, generally freshwater) wetlands in private ownership. According to the 1982 Natural Resources Inventory (NRI) conducted by USDA Soil Conservation Service (SCS), approximately 80 percent of wetlands not federally protected are privately owned (Heimlich and Langner 1986b). Of the 70.7 million acres of nonfederal palustrine wetlands, 5.1 million were rated by NRI as having moderate-to-high potential for conversion to cropland in 1982 (Table 1). However, approximately 16 million acres of wetlands would have earned short-run positive returns if converted, assuming 1985 crop prices and subsidy program participation rates (Heimlich and Langner 1986a, 1986b). Therefore, the 5.1-million acre estimate of wetlands vulnerable to agricultural conversion may actually be very conservative.

Table 1. United States wetlands with a moderate-to-high potential for agricultural conversion

Region	Nonfederal wetland acreage	Acreage of medium-to-high conversion potential
Southern Florida palustrine	4.5 million	382,500
Northern Prairie Pothole	4.9 million	588,000
Nebraska Sandhill	859,000	128,850
Lower Mississippi	4.3 million	387,000
North Carolina pocosins	1.0 million	380,000
Western riparian	1.4 million	35,000

Agricultural conversion is a major threat to wetlands in six of the nine critical wetland areas in the continental U.S. that were identified by the U.S. Fish and Wildlife Service (FWS) in its 1984 Wetlands Status and Trends Report (Tiner 1984). Those areas are the palustrine wetlands of southern Florida, the Prairie Pothole Region of the Dakotas and Minnesota, the Nebraska Sandhills and Rainwater Basin, the Lower Mississippi River bottomlands, the pocosins of the North Carolina coastal plain, and western riparian wetlands (Heimlich and Langner 1986b). Two of these wetland areas—the Prairie Pothole Region and the Lower Mississippi River Valley—will be discussed in detail in the next section.

Southern Florida's palustrine wetlands provide freshwater runoff that maintains the salinity balance in the coastal estuaries which support 85 percent of Florida's offshore fishery (Tiner 1984). These wetlands also provide breeding and wintering habitat for many bird species, and support a number of endangered species (Tiner 1984). Swampbuster is expected to have little influence in reducing conversion, however, because the farm program participation rate in southern Florida is particularly low (Heimlich and Langner 1986b).

Nebraska's Sandhills and Rainwater Basin areas are critical migration stopovers for waterfowl and sandhill cranes in the Central Flyway (Tiner 1984). Agricultural conversion and irrigation-related wetland losses have concentrated migratory birds on remaining sites, resulting in increased potential for disease (Tiner 1984).

The North Carolina pocosin wetlands are principal groundwater recharge areas and, like southern Florida wetlands, provide freshwater runoff essential to maintaining the salinity balance of the coastal estuaries (Tiner 1984). Conversion may be profitable on a much larger acreage in the pocosins, due to economies of scale in expansive wetland conversions (Heimlich and Langner 1986b).

Western riparian wetlands also provide important food and cover for resident and migratory species of fish and wildlife in what are otherwise arid regions (Tiner 1984).

Prairie Pothole Wetlands

Functions and acreages potentially affected. Prairie pothole wetlands of the Upper Midwest are glaciated emergent wetlands, often small in size and less than two feet deep, which cover an area of approximately 100,000 square miles in the Dakotas, Minnesota and Montana (Tiner 1984). Agricultural conversion has been responsible for loss of almost 50 percent of the original wetlands in this region (Tiner 1984). Given the vulnerability of these wetlands to conversion, and the high rate of farm program participation in these states (Heimlich and Langner 1986b), Swampbuster could play a significant role in reducing the rate of prairie pothole wetland loss, and conserving the soil, water and wildlife resources associated with them.

Wildlife habitat. The Prairie Pothole Region is commonly referred to as North America's "duck factory." Comprising only 10 percent of North America's waterfowl breeding area, it produces 50 percent or more of the continent's ducks (Tiner 1984). About 87 percent of duck species found in the lower 48 states breed in the Dakotas, Minnesota and Montana (Wittmier 1985). Waterfowl production in one South Dakota study area averaged 140 ducks per square mile per year (Stewart and Kantrud 1974).

Small, shallow potholes are important to breeding waterfowl because they thaw early in the spring and provide abundant invertebrates and aquatic plant food (Krapu 1974, Swanson et al. 1974, Tiner 1984, Wittmier 1985). The large number of these small wetlands also facilitates waterfowl production by permitting breeding pairs to disperse and claim breeding territory, and by reducing the risk of disease that is increased when waterfowl are concentrated on shrinking habitat (Tiner 1984, Wittmier 1985).

Prairie potholes are valuable to other wildlife as well. Those with dense stands of emergent vegetation provide important winter cover for white-tailed deer (*Odocoileus virginianus*) and important cover and breeding habitat for ring-necked pheasants (*Phasianus colchicus*) (Higgins et al. 1987). The South Dakota Wetlands Coalition (1987) reported that 138 bird species utilize prairie pothole wetlands in North Dakota. It also found an average avian population density in these wetlands of 337 pairs per square kilometer, or about 1.3 pairs per acre.

Prairie potholes, especially the smaller, shallower ones that are generally the most vulnerable to agricultural conversion, clearly are important to wildlife, particularly breeding waterfowl. A strictly enforced Swampbuster law could slow the loss of these wetlands and the wildlife habitat they provide.

Soil and water conservation. Prairie potholes of the Dakotas are very important in recharging surficial groundwater in this region (Hubbard and Linder 1986). In one study of 213 wetland basins covering 1,600 acres in northeastern South Dakota, a total minimum recharge of about 12 acre-feet was estimated. This volume could irrigate 160 acres with 1.4 inches of water, or supply water for 1,699 head of cattle for a year (Hubbard and Linder 1986).

Because prairie wetlands are hydraulically connected with the watertable, their drainage should eventually result in declines in watertable elevation (Sloan 1972, Hubbard and Linder 1986). Maintenance of watertable elevation is important to both agricultural and biological productivity on the subhumid and semiarid prairies (Hubbard and Linder 1986).

Prairie wetlands are also important in storing spring snow melt and retarding storm runoff, and thereby moderating flooding in the Dakotas. The 213 wetlands in the forementioned 1,600-acre South Dakota study area retained an estimated minimum of 158.7 acre-feet of water during the spring thaw. Drainage of these wetlands would contribute to flooding at lower elevations in the watershed under certain conditions (Hubbard and Linder 1986). Prairie potholes in the Devils Lake Basin of North

Dakota have a maximum storage capacity of 657,000 acre-feet, and retain 72 percent of the total runoff of a two-year event. These potholes would retain about 41 percent of the total runoff of a 100-year event (Ludden et al. 1983). Drainage of these wetlands could significantly affect flooding in the Devils Lake Basin. Wetland drainage was identified as a significant factor aggravating flooding in the southern Red River Valley in North Dakota (Brun et al. 1981).

Finally, prairie wetlands can help maintain water quality by retaining sediment and fertilizer and pesticide residues on the land. Wetland drainage in the Dakotas is often accomplished through extensive surface drainage ditches financed and constructed by local drainage districts. These ditches concentrate runoff from farmed pothole areas. They deliver water and chemical residues at increased velocities to outlets at lower elevations in the watershed. These higher water velocities can cause significant soil erosion and contribute to poor water quality downstream (Tiner 1984, Malcolm 1979).

The Swampbuster statute and regulations hold individual producers accountable for wetland drainage accomplished through drainage district projects. By discouraging both small- and large-scale drainage projects in the Prairie Potholes Region, a strictly implemented Swampbuster should help to maintain groundwater levels, flood water storage capacity, and water quality in the Dakotas and Minnesota.

Lower Mississippi Valley Wetlands

Functions and acreages potentially affected. Bottomland hardwood forests of the Lower Mississippi floodplain are forested wetlands characterized by such tree species as gum and cypress in the lowest areas, and water-tolerant oaks and water hickory on slightly higher ground.

Only about 20 percent of the original 4–5 million wetland acres remain (MacDonald et al. 1979, Clark and Benforado 1981, Taylor et al 1987). This wetland type is one of the most rapidly diminishing in the United States, with an estimated 2 percent (or more than 100,000 acres) being lost annually (Tiner 1984). Past losses have been principally due to clearing and drainage for crop production. Most remaining bottomland hardwood forests are in Louisiana, Arkansas and Mississippi (Tiner 1984).

About 9 percent of nonfederal wetlands in this area are considered to have a moderate-to-high potential for conversion (Heimlich and Langner 1986b) (Table 1). Although commodity program participation is not as high in the soybean-dominated agricultural economy of the Lower Mississippi River floodplain as it is in the Prairie Pothole Region, it is significant. In addition to soybean commodity credit loans, many farmers have diversified into commodity crops such as cotton and wheat and are dependent on those subsidies (Feierabend and Zelazny 1987). Consequently, strict implementation of Swampbuster can slow the rate of loss of bottomland hardwood forests in the Lower Mississippi River floodplain.

Wildlife habitat. Bottomland hardwood forests provide highly valuable fish and wildlife habitat. The structural diversity of woody plant communities, presence of surface water and abundant soil moisture, diversity and interspersion of habitat features—particularly due to the soil moisture gradient—and linear nature of bottomlands, which intensifies the ''edge effect'' and provides corridors for wildlife movement, all contribute to this ecosystem's high species abundance and diversity (Brinson et al. 1981).

Low-lying bottomland areas, swamps and semipermanently flooded zones are used extensively by migrating waterfowl as staging and overwintering areas. Wooded swamps are important for wood duck nesting (Fredrickson 1979, Brinson et al. 1981, Wharton et al. 1981, 1982, Taylor et al. 1987). Two and one half million of the 3 million mallards of the Mississippi Flyway and virtually all of the 4 million wood ducks use these wetlands as overwintering grounds (Tiner 1984).

Furbearers, such as mink (*Mustela vison*), otter (*Lutra canadensis*) and beaver (*Castor canadensis*), inhabit these low-lying bottomland zones, as well. They feed on the fish, crayfish, and frogs abundant in these zones (Taylor et al. 1987, Harris et al. 1984). Indeed, the Louisiana bottomlands produce a larger annual fur harvest than any other state—up to 65 percent of all U.S. production (Harris and Gosselink 1986).

Flooded bottomlands also provide spawning and feeding habitat for some 50 fish species, including largemouth bass (*Micropterus salmoides*), catfish (*Ictalurus spp.*), perch (*Perca spp.*), alewives (*Alosa pseudoharengus*), and blueback herring (*Alosa aestivalis*). (Taylor et a l. 1987, Harris et al. 1984, Tiner 1984). Fish populations in these wetlands are not only diverse, but very abundant; the wetlands support some of the highest fish populations of any habitat (Harris et al. 1984).

Bottomland hardwood forests, particularly in the drier zones, support a great abundance and diversity of both resident and migratory birds. During peak winter months (November-February) migratory bird density is about 35 birds/hectare in bottomland hardwood wetlands (Harris and Gosselink 1986). One acre of bottomlands may provide overwintering habitat for summer breeding birds from six acres of northern forest (Harris and Gosselink 1986).

White-tailed deer, beaver, rabbit (*Sylvilagus* spp.), squirrel (*Sciurus* spp.), raccoon (*Procyon lotor*), fox (*Vulpes fulva, Urocyon cinereoargenteus*) and bobcat (*Lynx rufus*) are also prevalent in these wetlands (Harris and Gosselink 1986, Taylor et al. 1987, Tiner 1984). Bottomland hardwood forests also provide critical remaining habitat for a number of threatened and endangered species (Brinson et al. 1981, Harris et al. 1984).

Soil and water conservation. Bottomland hardwood wetlands are effective nutrient filters, particularly in converting inorganic nitrogen and phosphorus to organic forms. These nutrients are absorbed in bottomland soils and taken up by forest vegetation (Taylor et al. 1987, Harris and Gosselink 1986). Toxic substances, such as pesticide residues, and other heavy metals and chlorinated hydrocarbons, may also be removed from streamflows by adsorption onto suspended sediments, followed by incorporation and stabilization in the sediment (Taylor et al. 1987, OTA 1984, Tiner 1984). This filtering function of the remaining bottomlands is particularly important in light of the high rate of conversion to agriculture and the associated increases in agricultural runoff in the Lower Mississippi River Valley.

Bottomland hardwoods also provide an important erosion-control function, simultaneously conserving soil and enhancing water quality. These wetlands reduce water velocity and retain soil in two major ways: first, the broad flat floodplain provides for meanders and overbank flooding, allowing the water to spread out; second, the wetland vegetation acts in several ways to hold the soil (Taylor et al. 1987, Harris et al. 1984). Bottomland trees, shrubs and vines reduce wave and current velocity by friction, and extensive, shallow root systems bind the sediments and stabilize the shoreline (Taylor et al. 1987, Adamus and Stockwell, 1983, Wharton et al. 1982, Harris et al. 1984).

Bottomland hardwoods provide flood storage and modify storm flows by temporarily storing surface water volume on the wetland, by recharging surficial aquifers, and by reducing flood water velocities (Taylor et al. 1987, Carter et al. 1979, Harris et al. 1984). Numerous studies have shown lowering of flood hydrograph peaks associated with bottomland hardwood floodplains (Taylor et al. 1987, Wharton 1980, Leitman, 1978, Mitsch et al. 1977, Harris and Gosselink 1986).

Bottomland hardwood wetlands may also store groundwater and contribute baseflow to streams during dry periods (Taylor et al. 1987, Brinson et al. 1981, Wharton et al. 1982, Wharton 1970).

The remaining bottomland hardwood wetlands of the Lower Mississippi River Valley provide extremely valuable fish and wildlife habitat, as well as serving important water quality and quantity control functions. Strict enforcement of Swampbuster can discourage the loss of these wetlands and thus help to preserve wildlife, water and soil resources of national importance.

The Current State of Swampbuster Implementation

Progress Since Enactment in 1985

When Congress enacted Swampbuster in 1985, it directed the Secretary of Agriculture to promulgate regulations by June 1986 (16 U.S.C. 3844). To meet that deadline, the Department of Agriculture published ''interim'' regulations—51 Fed. Reg. 23496 (June 27, 1986)—which were then supplemented by guidance in field manuals and oral communications to local officials in the Agricultural Stabilization and Conservation Service (ASCS) and SCS charged with administering the law.

Farmers learned in early 1986 that they had to certify any drainage plans on USDA forms (AD-1026) in order to receive federal farm benefits. At the same time, local ASCS committees and SCS personnel were put in the unfamiliar position of *requiring* compliance from farmers whom they had assisted with voluntary programs before. Neither the newly appointed ''regulators'' nor the regulated agricultural community were happy in their new roles and they tended to give the new law little attention.

Political pressure to weaken the law, notably that from North Dakota Senator Mark Andrews, in the fall of 1986, was translated into field guidance which interpreted the rather vague interim rules in a manner which exempted significant wetland conversion from the intended impact of the law (ASCS 1987). Where the law could not be side-stepped through agency interpretation, local officials and farmers simply ignored it. (see, e.g., FWS 1987a). Consequently, Swampbuster implementation during the 1986 and 1987 growing seasons was extremely variable and generally very lax. Open disdain for implementation was, and continues to be, most apparent in the Prairie Pothole Region (FWS 1987a, 1987b).

This picture of administrative inertia changed—at least superficially—when the final rules were published in September 1987 (52 Fed. Reg. 35194 (September 17, 1987)). These rules were the product of considerable interagency haggling between ASCS, SCS, FWS, the Office of Management and Budget and, to some extent, the Environmental Protection Agency. Conservation groups supported FWS in pushing for strong final rules.

The final rules were more detailed and more stringent, and seemed to send a signal that USDA genuinely intended to implement Swampbuster, that the law was here to stay, and that the field representatives and the agricultural community should comply.

Since issuance of the final rules, SCS and, to some extent, ASCS, seem to have made a concerted effort to provide uniform training in Swampbuster implementation to their field personnel. Initial indications are that this training has reinforced the strong message sent by the final rules (Robert Misso, Robert Lange and Lloyd Wright personal communications: 1987). As of January 1988, this training had been received by state-level officials. The agencies are relying on those officials, in turn, to train county-level staff. The speed and effectiveness of such trickle-down training will be a critical factor in assessing Swampbuster implementation over the next few years.

By April 1988, both ASCS and SCS field manuals were updated and revised to reflect the requirements of the final rules. These manuals should also provide more uniform and stringent guidelines for Swampbuster implementation in the field.

With the administrative house in order, the real test of Swampbuster effectiveness will come with field implementation in the 1988 growing season and thereafter. The track record to date, however, looks rather dismal. Though ASCS and SCS have not accumulated any records or statistics evaluating the program through December 1987, the available information is disturbing.

Wildlife professionals and local landowners have documented increased wetland drainage throughout North Dakota, South Dakota and Minnesota during 1987. Drainage proponents have admitted that drainage this year has increased (FWS 1987b).

In South Dakota, over 272 potential Swampbuster violations have been reported, yet no benefits have been withheld. In North Dakota, more than 150 potential Swampbuster violations have been reported, with the same result. In Minnesota, SCS personnel admit to nearly 3,000 potential Swampbuster violations. Only one producer in that state is known to have had benefits withheld under Swampbuster. ASCS has made only two known findings of noncompliance nationwide—one in Minnesota and one in Georgia. In the two years since Swampbuster was passed, the law clearly has not served as the wetland conversion deterrent conservationists had hoped for.

Implementation in the Prairie Pothole Region

While numerous Swampbuster violations continue to be ignored in Minnesota, implementation there appears to be improving slightly, due to increased coordination between ASCS, SCS and FWS. In the spring of 1987, FWS regional and state Swampbuster coordinators began documenting potential Swampbuster violations and implementation gaps in Minnesota, and then working with ASCS and SCS to resolve them. Some of the changes that have resulted are as follows:

1. ASCS agreed to forward to SCS for wetland determination every Form AD-1026 Certification on which a producer has indicated intent to impact any wet area. Previously, ASCS county offices were advising producers that wet areas on crop records need not be reported, and many wetlands were being drained without ever reaching SCS for a wetland determination (Robert Lange personal communication: 1987).

2. ASCS agreed to consult with FWS at the county and state levels on all "commenced" and "third-party" exemption determinations. Although the final regulations require consultation, they do not dictate consultation at the critically important county level, where the ASCS determinations are actually made (see 52 Fed. Reg. 35204, to be codified at 7 CFR 12.6(b)(3)) (Robert Lange personal communication: 1987).
3. Similarly, SCS agreed to consult with FWS at the district, area and state levels on controversial wetland determinations and "minimal effect" exemption determinations (Robert Lange personal communication: 1987). Again, these determinations are critical to whether a given wetland is protected by Swampbuster, and FWS consultation at the local level should result in increased wetland protection.

SCS district offices in Minnesota made more than 12,000 Swampbuster wetland determinations in Fiscal Year 1987, all of which were referred to them by ASCS through the Form AD-1026 certification process. This figure represents more than two-thirds of all such wetland determinations made nationwide (Robert Lange personal communication: 1987).

Furthermore, Minnesota appears to be only one of two states in which ASCS has found a producer in violation of Swampbuster and has denied benefits. Finally, SCS in Minnesota has also ruled favorably in a Swampbuster appeal brought by a drainage district—dismissing it as unavailable to any entity other than an individual producer denied benefits.

Swampbuster implementation is more discouraging in North Dakota, where wetland drainage is reported to have escalated (FWS 1987b). Though weather conditions contributed to this increase, it is largely blamed on farmer antagonism toward the Swampbuster restrictions, and fears that wetlands not drained now when implementation is lax will be impossible to drain as implementation is tightened up in the next few years.

In November 1987, North Dakota Congressman Byron Dorgan held meetings in North Dakota to discuss problems with Swampbuster. Farmers and farm organizations turned out for these meetings in large numbers, expressing a general antagonism toward implementation of final Swampbuster regulations.

By December 1987, North Dakota Senators Quentin Burdick and Kent Conrad had promised to hold Senate committee hearings on Swampbuster in early 1988 (Deutz 1988, FWS 1988). A primary goal of these groups is to exempt seasonally flooded potholes (type I wetlands—see Shaw and Fredine 1956) from Swampbuster sanctions (see, e.g., North Dakota Farmers Union et al. 1987).

The reaction of ASCS and SCS personnel to this type of pressure has been to compromise on enforcement, if not ignore it altogether. The rationale has been that strict enforcement will result in pressure to amend or repeal the law.

Information being compiled by the National Wildlife Federation (NWF) in North Dakota confirms the absence of implementation (Christman 1987). While FWS alone reported more than 150 potential Swampbuster violations to local ASCS offices in 1987 (Jones 1987), ASCS acknowledges receipt of only 83 reports from all sources, including neighboring farmers (Christman 1987). Some county offices have simply ignored these FWS reports. Although a minimum of 23 county offices received reports of potential violations, only 3 made any attempt to field-check them. In four counties and at least 15 instances, ASCS contacted farmers with potential violations and were told that the drainage was simply to clean out existing drains. ASCS county offices have not field checked any of these drains, apparently accepting the producer's determination at face value (Christman 1987).

The one reported finding of noncompliance in North Dakota did not result in the withholding of farm benefits. Instead, the producer was notified, the drain was closed and the crop planted on the wetland was destroyed. No federal farm benefits had been withheld in North Dakota as of the end of calendar year 1987 (Christman 1987, Jones 1987, Wayne Baron personal communications: 1987).

Indeed, ASCS has seriously pursued only two other reported potential violations in North Dakota; both demonstrate ASCS's abuse of the "commenced" exemption to avoid Swampbuster sanctions (Christman 1987, Jones 1987, Baron 1987). While the ASCS State Committee acknowledged that the county committee's initial "commenced" determinations were improper, it subsequently upheld the determinations and refused to declare the producers ineligible for benefits (North Dakota State ASCS Committee 1987). The track record through 1987 demonstrates that ASCS county committees in North Dakota have permitted the piecemeal conversion of prairie potholes *with federal money*, either by ignoring Swampbuster violations altogether or by exempting producers from Swampbuster sanctions.

Despite this dismal outlook, there is some reason for optimism. For example, ASCS, SCS, and FWS state and regional officials met in November 1987, and agreed to some of the same interagency procedures in North and South Dakota that have been applied in Minnesota. In addition, SCS has agreed to send a team of professionals to North Dakota in January 1988, to identify all of the wetlands in the Red River Valley—an area in which considerable frustration and controversy over Swampbuster implementation has been sparked. This comprehensive wetland delineation effort ought to reduce delays, uncertainties and frustrations with Swampbuster in this part of North Dakota. The Swampbuster training and field guidance finally being provided by ASCS and SCS nationally should also reduce farmer frustration, by making implementation more consistent and efficient.

In summary, Swampbuster implementation in the Prairie Pothole Region has been extremely lax, but shows some improvement, particularly in Minnesota. Whether implementation becomes a reality in North and South Dakota will depend in large part on whether Congress and ASCS and SCS in Washington, D.C. stand firm in signaling their commitment to strict Swampbuster implementation in 1988. Absent such a commitment, coupled with diligent oversight, farmers and ASCS county committees are likely to continue to ignore the law and press for its repeal.

Implementation in the Lower Mississippi River Valley

While the Prairie Pothole Region has been a Swampbuster battlefield, implementation in the Lower Mississippi River Valley may best be characterized as a sleeping giant. The consensus seems to be that, while there has been little in the way of Swampbuster implementation, there also has been little bottomland hardwood conversion due to the depressed agricultural economy.

ASCS, SCS and FWS are not being subjected to the same political pressure in Louisiana and Mississippi that they are in North Dakota, in part because of economic conditions and because of a more widespread realization among producers that many of the converted bottomlands never should have been cleared and cropped. FWS coordination with ASCS on ''commenced'' determinations, and with SCS on minimal effect determinations, has improved with issuance of the final rules.

There is evidence that Swampbuster is protecting some bottomland hardwoods in the Lower Mississippi River Valley. At least two substantial bottomland clearing operations proposed or actually initiated by corporate entities in Louisiana appear to have been stopped to avoid loss of agricultural commodity payments. In both these cases, FWS made determinations that the operations would convert wetlands covered by Swampbuster, and the clearing plans were dropped, at least for the time being.

The most concrete impact of Swampbuster in the Lower Mississippi River Valley may be an indirect one, however. Federal flood-control projects have been identified as a major factor in bottomland hardwood conversion. These projects have historically been justified in large part on the basis of economic benefits derived from increased ability to expand agriculture by clearing and planting bottomland hardwood forests, and to intensify agricultural production on wetlands that already have been cleared but continue to be seasonally flooded.

If the U.S. Army Corps of Engineers can no longer claim these agricultural benefits because they are erased by Swampbuster and because they contradict federal wetlands conservation policy, many of these flood projects can be challenged on both economic and policy grounds. FWS has already challenged at least one Corps-sponsored flood-control project in Louisiana on this basis.

The role of Swampbuster in protecting bottomland hardwood wetlands in the Lower Mississippi River Valley will depend in part on the extent to which Swampbuster will apply to previously manipulated, seasonally flooded floodplain wetlands, including those that already have been cleared of their bottomland hardwood forests for the purpose of agricultural production. These areas clearly meet the statutory definition of wetland and have considerable present and future value for wildlife, soil and water resources. Little effort has yet been made to apply Swampbuster to these cleared wetlands. If these wetlands are covered by Swampbuster, additional drainage to improve crop production would result in loss of benefits, and at least some of the ecological values of these wetlands would be retained.

SCS, in consultation with FWS, has been developing technical guidance defining the critical ''seasonally flooded for extended periods'' language in the final rules. SCS guidelines recommend defining this term as flooding for 10 percent of the growing season (Lloyd Wright and Billy Teels personal communications: 1988). This criteria requires about 30 days of inundation in the Lower Mississippi River Valley, and probably includes no more than 10 percent (the lowest and wettest) of previously cleared bottomland hardwood wetlands in this region.

The SCS 10-percent guidance is inconsistent with the statutory wetlands definition, and has apparently been adopted as a compromise between USDA and FWS interpretations of the term ''converted wetlands.'' SCS guidance does provide for alternative definitions of ''extended period,'' which more accurately represent the duration of flooding that produces hydric soils and hydrophytic vegetation. However, any such deviation from the 10-percent guidance must be justified on the basis of demonstrated wetland value to wildlife, and must be supported by the appropriate SCS state conservationist. SCS adoption of alternative definitions that extend Swampbuster protections to more wetlands is expected to be rare. If the 10-percent rule stands, it will significantly narrow the scope of Swampbuster protection for previously cleared bottomland hardwood wetlands in the Lower Mississippi River Valley.

One tangential benefit of Swampbuster, particularly regarding the issue of previously cleared, seasonally flooded bottomlands, is that much more information will be generated on the distribution and importance of these cleared wetlands. Existing National Wetlands Inventory maps do not identify these areas as wetlands. FWS field personnel believe this new information will benefit many other wetland conservation efforts, including the North American Waterfowl Plan.

Conclusion

The greatest contribution of Swampbuster to wetland conservation probably is that it ensures greater consistency between federal wetland protection policies and programs, on one hand, and federal farm and flood protection programs on the other. And, in general, the concensus seems to be that a strictly enforced Swampbuster law can make wetland conversion more costly, thereby discouraging some wetland loss.

At least 5 million acres of wetlands in the continental United States are vulnerable to agricultural conversion and could benefit from strict implementation of Swampbuster. At least 500,000 acres of prairie potholes and 300,000 acres of Lower Mississippi River bottomlands could receive better protection through Swampbuster. These two wetland types have been severely depleted by agricultural conversion. Remaining prairie pothole and bottomland acres provide wildlife habitat of national and international importance and are valuable in maintaining water quality and controlling water levels.

During the two years since Swampbuster was passed, the law has not been implemented and has contributed little to wetland conservation. Indeed, it actually may have accelerated wetland conversion, particularly in the prairie pothole states.

Now that ASCS and SCS finally have published final regulations, begun to develop uniform training and procedures for their field personnel, and begun to educate producers about the Swampbuster program, the real test of Swampbuster's effect on wetlands conservation will depend on how strictly is implemented at the local level in the 1988 growing season and beyond. Strict implementation will, in turn, depend on diligent oversight by Congress, USDA, FWS, state wildlife and water quality personnel, and the conservation community.

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Conservation Easements: Farmers Home Administration Inventory Lands and Debt Restructuring

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In complying with federal environmental laws, regulations and Executives Orders, and in assessing the potential environmental impacts of its actions, including the making of loans and disposal of lands or interests in such lands, the Farmers Home Administration (FmHA) consults with appropriate federal, state and local agencies on the technical aspects of environmental planning, including impact analysis and mitigation alternatives. In addition, the Food Security Act of 1985 (FSA) provides important new opportunities for strengthening the farm economy and contributing to fish and wildlife resource conservation and wetlands protection and restoration. The Memorandum of Understanding between the FmHA and the U.S. Fish and Wildlife Service (Service) establishes procedures for interagency coordination on fish and wildlife resource issues affecting farmer programs. A similar Memorandum of Agreement among the Soil Conservation Service, the Missouri Department of Conservation and FmHA State Offices in Missouri provides for coordination at the state level and further defines fish and wildlife habitat of state importance. Section 1318 of the Act stipulates a role for the Service to assist FmHA in selecting real property in which the Secretary of Agriculture may grant easements for conservation, recreation and wildlife purposes, and formulate the terms and conditions of such easements. Section 1314 provides an opportunity for easements, restrictions, development rights or the equivalents of these items to be granted or sold, for conservation purposes, to units of state or local governments (such as the Missouri Department of Conservation [MDC]) separately from the fee title to farm properties in FmHA's inventory.

At the time a farm property is acquired by FmHA, the FmHA county supervisor notifies, by letter, both MDC and the Service of the acquisition. Along with the letters of notification, the FmHA county supervisor provides MDC and the Service with the legal description of the property and a photostat copy of the page(s) of the county plat book, if available, identifying the location of the property. Often there is an accompanying aerial photo or other documentation.

Soil Conservation Service (SCS), Service and FmHA field personnel are involved in developing resource inventories and determining whether wetlands or highly erodible lands are present on FmHA farm inventory property in Missouri. Service biologists, either through review of available information or field inspections, examine the properties for important resources. The list of important resources is reviewed at the time the wetland and highly erodible land assessment is being made to ensure all concerns are addressed properly. Should an important resource be identified, during the assessment, that merits consideration for a fish/wildlife deed restriction or easement, then coordination with the FmHA state office is initiated by the FmHA county supervisor.

Important Resources

1. *Riparian zones:* An area at least ≤66 feet wide from high bank (both sides) on all streams classified as stream order 2 or greater.
2. *Wetlands:* Those areas meeting FSA definition of wetland. "The term 'wetland' . . . means land that has a predominance of hydric soils and that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions."
3. *Prairies:* Any naturally occurring stand of native grasses will be identified and appropriate management recommendations incorporated into the conservation plans.
4. *Woodland:* Forested tracts ≤5 acres for those inventory lands located in sections where woodland is less than 10 percent of acreage in that section.
5. *Ponds:* Identify water bodies greater than 3 acres. Protect the complete pool as part of the conservation plan. Protection is to prevent sedimentation and/or cattle damage to banks, etc.
6. *Threatened and endangered species:* Critical habitat; known occurrence—perch sites, feeding areas, migration stop-over sites, etc.
7. *Area of high water quality or scenic value*, including wild and scenic rivers and wilderness areas, as identified by federal or state agencies.
8. *Fish and wildlife habitat of state importance:* FmHA inventory lands can provide habitat for the greater prairie chicken and ring-necked pheasant. For both of these species, nesting and brood-rearing cover are limiting populations in Missouri. The MDC prepared comprehensive management plans for both species. Sixteen counties with remnant prairie chicken populations were identified as the most important locations for greater prairie chicken management on private land. Thirteen counties were identified as containing the best opportunities for enhancing ring-necked pheasant populations.

If important resources are identified during the SCS or Service resource inventory, it is the responsibility of the FmHA state office (after contact from the FmHA county supervisor) to coordinate further with the Service and MDC for a possible deed restriction or easement. It should be recognized that planning on these inventory farms is not constrained by prospective buyers decisions. As properties are sold by FmHA, the FmHA state office will notify both MDC and the Service of the sales. The FmHA state office will also provide both MDC and the Service with copies of any deeds issued which contain restrictive easements relating to fish and wildlife resources and/or wetlands.

Presently there is no standardized easement language that has been accepted. To date, the FmHA in Missouri has inserted the following language into deeds for properties which identified resources: "Pursuant to 42 U.S.C. 1480; 7 C.F.R. 1940; and Executive Orders 11988 and 11990, Public Law 99–198; 7 C.F.R. Part 1940, Sub-part G, Exhibit M, the purchaser(s) of the above described real property covenant(s) and agree(s) with the Government that the purchaser(s) will not change the natural value and function of the wetlands or floodplain by draining, dredging, channelizing, filling, diking, impounding, converting wetlands to produce an agricultural commodity, constructing buildings on the wetlands or floodplain, or similar activities and restrictions set out in the cited authorities."

In the near future, the Washington office of FmHA is expected to issue standardized language. This will require more specific identification and delineation of areas possessing fish and wildlife resource values.

Farm Debt Restructure

Section 1318 of the FSA authorized the Secretary of Agriculture to ". . . acquire and retain an easement in real property, for a term of not less than 50 years, for conservation, recreational, and wildlife purposes." These easements were to be acquired in lieu of the repayment of portions of the indebtedness of the landowner. Wetlands, uplands or highly erodible land were eligible for consideration.

Depending on factors considered, the estimated number of farmers in Missouri participating in off-farm employment varies from 50 to 80 percent. Thus, a debt restructure program that would ease the debt repayment, increase the availability of off-farm income, and allow the landowner to retain fee title and certain uses of his/her land would seem to have some attractiveness. Unfortunately, USDA has chosen not to implement this section of the FSA.

Instead, USDA has proceeded under other authorities to write down loans and to promote the movement of these lands into programs requiring annual payments. As a result, the opportunity offered in Section 1318 to return conservation value to the public in exchange for debt relief is being lost. It is hoped that this, or a similar authority, will be made available in future farm bills.

In Missouri, the cooperating agencies have accepted the conservation philosophy inherent in the FSA that land should be used in accordance with its capabilities, and not abused in accordance with the available subsidies.

Special Session 5. *New Dimensions in Water Resources Planning, Development and Management*

Chair
JACQUELINE E. SCHAFER
President's Council on Environmental Quality
Washington, D.C.

Cochair
DON L. LOLLOCK
California Department of Fish and Game
Sacramento, California

Opening Remarks

The Honorable Jacqueline E. Schafer
Council on Environmental Quality
Executive Office of the President
Washington, D.C.

When the President of the Wildlife Management Institute, Larry Jahn, invited me to chair a session at the 53rd North American, I was so flattered that I accepted the assignment on the spot. I had never attended one of these Conferences, but I was familiar with its long tradition and honorable reputation as *The* gathering of wildlife administrators and managers in North America. Then I remembered what I knew about wildlife management (not enough) compared with what my audience would know (too much for my own good), and contracted a mild case of anxiety. But when I consulted with some of the "regulars," I was assured that this would not be difficult, so long as I did three things: (1) pick good speakers and let *them* do all the work; (2) make sure they stop talking on time; and, (3) quote Aldo Leopold a lot (everyone at the North American likes to quote Aldo Leopold a lot). I was relieved somewhat. At least I knew who Aldo Leopold was.

Indeed, one of the great pleasures of this assignment was the opportunity to read Leopold's essays again and to reflect on what progress, if any, had been made in the quality of the nation's environment since the enactment of the National Environmental Policy Act, signed by President Richard Nixon on January 1, 1970. That was the year I first got into this business. It was also the year that Council on Environmental Quality and the Environmental Protection Agency were created, the year Earth Day was celebrated, and the year Sierra Club published its paperback edition of Leopold's *Sand County Almanac* and other essays. By now, my own copy was brittle, yellowed, marked up and coming unglued, but otherwise quite readable.

This morning's session on "New Dimensions in Water Resources Planning, Development and Management" will give all of us an opportunity to reflect on this question of progress and change in the management of water in the United States. It is sometimes difficult to know what is progress, or to recognize that anything has changed. Some problems just never seem to go away, even after 40 years. In his essay on "Wilderness for Wildlife," Leopold struck a decidely contemporary chord: "The National Parks do not suffice as a means of perpetuating the larger carnivores; witness the precarious status of the grizzly bear, and the fact that the park system is already wolfless . . . . The reasons for this are clear in some cases and obscure in others."

And today, as then, equally conscientious citizens hold opposite views of what should be done. To paraphrase Leopold, "Such factions commonly label each other with short and ugly names when, in fact, each is considering a different component of [the same problem.]"

During the past seven years, there has been a number of new policy developments that are expected to have a profound impact on the future direction of water resources planning, development and management. We cannot expect to observe the full consequences of these changes in the course of this one administration (the longest in 25 years), or even the next administration, or longer. And equally conscientious citizens may hold opposite views of what has been done. These new policies have both adherents and skeptics, and a few new "short and ugly names" have been added to the lexicon of political epithets.

Being a partisan of the Regan Administration, I prefer to label these policies as "progress." But I will settle for Leopold's word, "striving." I will recount them briefly, because, to varying degrees, they have propelled all of the developments you will hear this morning. I believe they are all beginning to have a salutary effect on environmental quality generally and on water management particularly. They promise to have long-lasting effects because they work through fundamental institutional rearrangements of the relationships between the federal government and the states and local governments, and through economic incentives that are changing the behavior of institutions and individuals.

First, tax reduction and tax reform. Lower taxes and a fairer tax structure have operated to reduce distortions in the economy generally, and the recent reforms are expected to reduce artificial (nonmarket) incentives to, for instance, second-home developments that so often have their impact on sensitive environments.

Second, cost-sharing requirements that this administration has made a precondition of new federal water-development projects as embodied in the 1986 Water Resources Development Act and in policies applicable to Bureau of Reclamation projects. Some, who may have preferred no new water project legislation at all, may regard this as second-best policy; but that would ignore the fact that Congress was authorizing new projects all along, through the back door of pork barrel appropriations. Now there is a policy on which Congress and the administration have agreed will give local sponsors an incentive to assure greater responsibility for determining if a proposed project is really needed in their community and, if so, its proper scale. This policy has already led to a number of cases of project redesign with less cost and less adverse environmental impact. It has also begun to have a profound impact on how water resources agencies view themselves and their missions, and led to new institutional arrangements to make water more efficient—in other words, less wasteful.

Third, the "swampbuster" and conservation reserve provisions of the 1985 Food Security Act. These provisions remove the perverse economic incentives of otherwise popular farm subsidies to convert wetlands or highly erodible soils into crop production. Some farmers are looking to alternative uses of these marginal lands, including the production of wildlife habitat and the diversification of farm income through fee hunting.

Fourth, gone are the days of ever-expanding federal budgets for water development, including capital-intensive wastewater treatment plants. This is leading to more resourceful, creative methods to finance and engineer the really needed, not the speculative, developments. Many of these have been done with related benefits in mind, such as boosting recreational fisheries for community and tourism benefits, and to assure the continuation of commercial fisheries as well. Not only innovative projects, but innovative policies are being devised, partly as a response to limited government budgets. A proposed national fisheries policy, for instance, has aimed at defining the proper role of each level of government and each user of the resource, and better integrating their respective activities, to make more efficient and effective use of their individual contributions.

What does each of these policies—lower and fairer taxes, cost-sharing, curtailing farm subsidies, and control over federal spending—have in common? In my own view, they all have led to diversifying the ways in which the nation goes about solving its everyday problems of securing enough water, food, energy and housing. And this diversity is leading to more innovation than we could ever expect to see when we were so dependent on federally funded programs. The papers prepared for this session will explore some of these innovations in greater detail. Clearly, the returns on these new policies are not all in yet. It will be some decades before we can be certain if they have had the expected benefits. I do not foresee, however these efforts turn out, a return to a dominant federal role in water management and development.

One final point—there is more at work than economic efficiency (and its twin, resource conservation), although that is an important aim of new policies that change the structure of economic incentives. There also is the question of values. That is, more efficient, but *to what end*? As these policies necessarily increase the involvement of states and communities and local interests, by relying more on their creative powers and other resources, the solutions are increasingly likely to reflect local values. Tradeoffs are more obvious than when costs are obscured. I think the American people do value environmental quality more highly today than at any time in the past, and will see to it that adverse environmental impacts will be minimized when they can deal with issues on a smaller, more manageable, that is, "local" scale.

The personal values that have led ordinary Americans to cherish environmental quality, wildlife and their own natural surroundings are more consciously widespread today, compared within Leopold's time. Witness the enormous popularity of nature programs on television. Education about the outdoors and wildlife is far more commonplace in elementary schools today than when I was a kid. Ordinary people, not philanthropists, are the foundations on which most of the nation's organizations dedicated to fish and wildlife and environmental protection causes are built today. The most successful efforts may be localized, and many seem small compared with the overall need. But people care most when they can concentrate their efforts on a scale they can deal with and identify with.

That's why returning programs to local control is so important. People can get a hold of their lives and their environments, and do a better job of improving the quality of both. In none of these policies has the role of the federal government been totally eliminated or supplanted. But it has been placed in the more proper context of cooperator, rather that initiator.

In his State of the Union address a couple of years ago, President Reagan said: "Private values must be at the heart of public policies." There is a lot that sentiment has in common with the insight Aldo Leopold expressed in his essay on "The Land Ethic": "To sum up: a system of conservation based solely on economic self-interest is hopelessly lopsided. It tends to ignore, and thus eventually to eliminate, many elements in the land community that lack commercial value, but that are (as far as we know) essential to its healthy functioning. It assumes, falsely, I think, that the economic parts of the biotic clock will function without the uneconomic parts. It tends to relegate to government many functions eventually too large, too complex, or too widely dispersed to be performed by government. An ethical obligation on the part of the private owner is the only visible remedy for these situations."

A balanced system of conservation, then, is one that gets the economic incentives right and also restores to individuals a renewed sense of personal and community responsibility. That is a fundamental change in policy that our administration has brought about, and it is also one that I believe will best serve the goals for water quality and conservation, for fish and wildlife restoration, and for environmental improvement generally, that all Americans share.

The New Bureau of Reclamation: From Rhetoric to Reality

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Introduction

The concept of natural evolution has its parallels to both private and public organizations. Organizations, similar to plants and animals, are affected by environmental changes. If an organism successfully adapts to the change, it survives, although it may not emerge as exactly the same creature. If it does not adapt, extinction is the consequence.

The Bureau of Reclamation is an organization on which the weight of evolution is pressing. The Bureau was born in 1902, although its gestation period began in the late 1800s. With ample justification, a majority of its supporters believe that it was conceived as part of the grand design to settle the western United States by "making the desert bloom," and that it has achieved its purpose grandly. Cynics maintain that it is a creature designed to be preyed on by speculators, who divert its wealth-creating purposes for their own private gain, and that it has been a tool of environmental destruction. Throughout the agency's life, these diverse views have caused the Bureau of Reclamation to be center-stage on water and other natural resource issues.

There can be no question that the Bureau of Reclamation's traditional program of water development has been central to many economic, environmental and political controversies. Today, there are significant evolutionary processes at work in western water development and management that are driving changes in the Reclamation program. In 1987, in response to real and perceived changes in its environment, the Bureau of Reclamation's employees and management conducted a thorough self-examination of the institution and concluded that its mission is relevant and that the nation would best be served if the Bureau quickly adapted itself to its changing environment.

The purpose of this paper is to examine the evolutionary changes that are occurring in the West and the nation with respect to water resources, and to review what the Bureau is doing to respond positively to those changes.

The Changing Environment and Evolutionary Forces

For many decades, the Bureau of Reclamation operated in an economic and political environment that encouraged water project development. The Bureau enjoyed strong support from the Congress, and it was relatively easy to secure authorization and appropriations. Reclamation projects, large and small, provided visible, tangible benefits to local and regional constituencies, and thus gained considerable support from a broad cross-section of the Congress.

At least four factors have altered this stable environment previously enjoyed by the Bureau: (1) the paucity of economically developable dam sites; (2) the federal budget crisis; (3) the state of the farm economy; and (4) changing public values, particularly with respect to the environment.

It is evident that the number of potential dam sites that have a high benefit-to-cost ratio has dwindled significantly. A basic tenet of economic theory is that least costly projects will be developed first, and that is what has happened in the Reclamation program. The relatively inexpensive, high-yield dams along the Colorado, Columbia, Missouri, Sacramento and other major rivers in the West have been built. Dam sites that could be developed remain available, but they are more costly relative to the benefits they generate and are often subject to noneconomic or nonfinancial opposition. In fact, the Congress has not authorized a major new project since 1968. The only substantial initiative authorized by the Congress since 1968 was in 1976, with legislation requiring the retrofitting of existing dams for safety reasons.

Even though Reclamation projects require repayment of development costs by beneficiaries, the federal budget deficit has grown to a level where it is difficult to develop support for financing new projects, particularly with 100-percent federal financing as has been customary in the Reclamation program. In fact, the Department of the Interior, in its Fiscal Year 1988 budget requests to the Congress, declined to request funds for new projects and adopted a policy that would concentrate available spending authority on projects that were substantially underway or close to completion. This was in contrast to the historical practice of allocating some portion of available funds to all projects, which often resulted in few projects being completed on time or within original cost estimates. Given the intense budget negotiations and growing concern over the federal budget deficit during the past year, it is unlikely that significant federal funding for new projects, or even additional funding for projects already underway, will be forthcoming in the near future.

A third contributing factor to the changing environment of the Bureau is the general deterioration of the nation's farm economy. The supply and demand for many agricultural commodities currently are out of balance, and the farm community in many parts of the nation must rely on government-support programs in order to survive. A central purpose of the Reclamation program historically has been to provide western agriculture with reliable water supplies. It has been claimed that the Reclamation program is a major factor in the overproduction of farm commodities. Although Reclamation water serves lands that account for only 2 percent of the total national acreage producing crops under Department of Agriculture commodity-support programs, it it difficult to justify Reclamation expenditures for those new irrigation projects that would add significantly to the overproduction problem.

Finally, there is a growing realization within Reclamation that public values have changed over the years. We believe that we have passed from the "Age of Development" through the "Age of Environmentalism," and now we are in the "Age of Management" with respect to water resources. Neither developers nor environmentalists have a firm lock on the water resource agenda for the future, nor should they. Instead, we believe that public values lean toward a balanced, fiscally responsible approach to resource management. This means that public agencies, such as the Bureau of Reclamation, must take a closer look at the way their programs affect resources in their natural state, and strike a more reasoned balance among competing uses for limited water resources.

Against this backdrop, the Bureau of Reclamation looked inward and examined its history, its current operations, and its potential for the future. What began as an exercise to identify potential water and power efficiency gains that could be achieved at existing facilities, and to analyze new partnership opportunities with nonfederal entities, became a comprehensive assessment of the status of the Bureau.

The Assessment

"Assessment '87 . . . A New Direction for the Bureau of Reclamation" is the written product that emerged from the assessment process (U.S. Bureau of Reclamation 1987a). However, it is worth commenting on the process itself because it is rare that organizations, particularly federal bureaucracies, engage in the degree of self-examination as did the Bureau.

In March 1987, Secretary of the Interior Donald Hodel, at the request of the Assistant Secretary for Water and Science Designate, James W. Ziglar, initiated a review of opportunities to achieve efficiency gains in Bureau water and power operations, and to identify nonfederal partnership arrangements that potentially were available for future water resource development (Hodel 1987). In response to that request, a team of career Bureau employees was formed to conduct the review. The team was comprised of a cross-section of employees with particular skills and knowledge in the areas of power operations, water operations, planning, contracting and water project finance.

From the outset, it was a strongly held belief of Assistant Secretary Ziglar that the success of the project would depend on quality input from the Bureau's career employees throughout the organization. A request was made of the Bureau's regional directors to develop their own assessment reports and to be prepared to present and discuss them with the primary assessment team. In a remarkable display of initiative, innovation and insight, the regional employees put together a series of reports that challenged many traditional modes of Bureau thinking. They sought to eliminate the natural instinct for self-preservation and to analyze and appraise objectively the Bureau's current status and what it could do in the future to best serve the nation and the West.

In the subsequent discussions with the regions, the Bureau's Engineering and Research Center, and the headquarters staffs, and in the deliberations of the assessment team, something more than a mere report emerged. A dynamic process took hold of the participants and the outcome was a new managerial philosophy and a clear vision of the future mission of the Bureau of Reclamation.

The New Mission

There was one overriding conclusion in "Assessment '87"—the original mission of the Bureau to help settle the western United States through the provision of a water management infrastructure was approaching completion. The choice was clear that the Bureau would need to expand its mission to meet the future demands of the nation, or wait to be phased out of existence and replaced by an organization that could respond to the challenges of the future. In the assessment that took place, it was recognized that the Bureau's expertise and resources are vital to meeting the water resource needs of the West and the nation, and that a redirection of the Bureau's mission would be necessary to address those challenges successfully.

The analogy that we drew on was the March of Dimes. The March of Dimes was conceived as an organization to fight the dread childhood disease of polio. Eventually, through hard work and dedication to the task, polio was eradicated in most parts of the world. At that point, the March of Dimes had achieved its stated goal, and found itself an apparent victim of its own success. Instead of disbanding, the organization redesigned its mission to encompass the eradication of childhood diseases in general—a noble and worthy cause.

The Bureau of Reclamation has found itself in essentially the same position as the March of Dimes. And, similar to the March of Dimes, the Bureau has chosen to adopt a redefined role for itself—a role that has links to the past, but is fully oriented to the future. The essence of the "New Bureau" is the adoption of a total resource management philosophy to suceed its narrower construction-oriented philosophy. Construction will continue to be an important part of the Reclamation program, but only a part.

Lest such a reorientation sounds oversimplified, it is worth pointing out that this change will not be achieved without struggle. An organization cannot change its underlying way of doing business overnight. In addition to the need to secure congressional approval of many of the Bureau's new initiatives, it will take time to displace the old ways of viewing the mission and to institute a new way for success. Fortunately, most Bureau employees recognize and have embraced the need for change.

A number of conclusions were made by the assessment team in "Assessment '87" that are worth summarizing:

- The Bureau's original goal largely has been achieved. The arid West essentially has been reclaimed, as mandated by the Reclamation Act of 1902.
- New major water projects will become more difficult to justify, and the Bureau's construction program will decrease gradually as current projects are completed.
- Future development opportunities will be smaller, management-oriented and have a high percentage of nonfederal financing.
- Management of existing resources and facilities should be emphasized, particularly the rehabilitation and betterment of existing facilities. Additions to existing projects will be for system optimization, water quality and environmental protection.
- Flexibility is needed to enter into new water resource management partnerships with nonfederal entities.
- New initiatives and opportunities will include nonstructural and water conservation opportunities, system optimization, conjunctive use of surface and groundwater, and joint operation of federal and nonfederal projects.
- Water quality and environmental issues should be addressed as a part of the Bureau's ongoing programs and processes.
- Additional transfer of Bureau facilities to nonfederal entities for operation and maintenance should be pursued.
- Changes must be made in legislation, procedures and policies to facilitate more flexible and businesslike operations.

Specific objectives and initiatives also are set forth in "Assessment '87." Although not repeated here, those proposed objectives and initiatives are a combination of specific and general actions and programs. "Assessment '87" has been criticized by some as being too vague about the future mission of the Bureau or not containing a sufficient "menu" of specific projects or programs. The observation that "As-

Table 1. Program priorities in the Implementation Plan of "Assessment '87."

1988	1998
High Priority	
1. Operation and maintenance of facilities	1. Operation and maintenance of facilities
2. System optimization—joint use	2. Water quality—environmental restoration and enhancement
3. Dam safety	3. Groundwater management
4. Construction	4. Toxic cleanup and EPA Superfund
5. Water quality—environmental restoration and enhancement	5. System optimization—joint use
Medium Priority	
6. Groundwater management	6. Dam safety
7. Nonfederal system operation	7. Research
8. Transfer of facilities	8. Construction
9. Toxic cleanup and EPA Superfund	9. Private development on public lands (recreation)
Low Priority	
10. Research	10. Construction for the Department of the Interior
11. Private development on public lands (recreation)	11. Nonfederal system operation
12. Foreign activities	12. Foreign activities
13. Construction for the Department of the Interior	13. Transfer of facilities

sessment '87" contains a certain amount of vagueness is correct, but the criticism is not valid. If there is one thing that the Bureau realized in full measure in this assessment process, it is that the organization exists in a changing environment. Just as there cannot be a "let's build a dam" solution to every water problem, there cannot be a complete menu of programs and solutions to address every water resource challenge. In many areas, the best that can be done for the moment is to identify the nature of the challenges that exist, and to position the Bureau to be able to address those challenges.

In the "Implementation Plan" for the Bureau—a follow-up document to "Assessment '87" prepared by Reclamation's career managers—an evaluation was made of the program priorities as they exist in 1988 and as they are anticipated to exist in 1998 (Table 1), (U.S. Bureau of Reclamation 1987b).

Woven throughout "Assessment '87" and the "Implementation Plan" is the recognition of new resource challenges. Water quality, groundwater supply and quality, recreational development, hazardous waste management, and environmental restoration are a few of these challenges. Also of top priority is the objective of keeping existing facilities in good repair so as to assure an uninterrupted flow of benefits from the existing Reclamation infrastructure. Both budgetary and legislative initiatives are being undertaken to ensure that funds are available to carry out this latter objective.

The message of "Assessment '87" is that there exists a tool—a national resource—that is available to the nation to assist in satisfying its resource demands. The time has come for critics and supporters of the "old" Bureau of Reclamation to lay aside their differences, to regroup, and to help forge and support an agenda for the "New Bureau."

Organization

Following the completion of "Assessment '87," Assistant Secretary Ziglar reviewed its conclusions and recommendations with the senior career management of the Bureau and thereafter initiated the process whereby the Bureau could develop a response to its new mission initiatives. Again, it was concluded that the key to success in implementing currently desirable management changes, and in structuring the organizational flexibility to meet future challenges, could be found among the senior career management of the Bureau.

Structurally, the key organizational changes proposed for the "New Bureau" were:

- Relocation of the headquarters office of the Bureau from Washington, D.C. to Denver, Colorado. Relocation to Denver was proposed to improve efficiency through reduced duplication of effort, especially in reviews. Better accessibility to clientele, improved personnel recruitment and retention, and more effective program accomplishment through consolidating unique skills and capabilities also were seen as important results of relocation.[1]
- Maintenance of a small liaison staff in Washington for Departmental, Congressional and other contacts.
- Closure of the regional office in Amarillo, Texas. The Amarillo office's workload, especially the construction portion, had been decreasing at a faster rate than the rest of the Bureau, and its closure was being studied even before the assessment was undertaken.
- Consolidation of certain Bureau planning functions and capabilities into the Denver office. Given the reduction in the overall Bureau planning program that has been underway, maintenance of large planning staffs in the regions is inefficient. Consolidation of planning services will allow retention of important skills and knowledge, and provide a stable base to support future planning initiatives.
- The Bureau's Permanent Management Committee (PMC) comprised of the Commissioner of Reclamation, the Deputy Commissioner, the three Assistant Commissioners and the six (soon to be five) regional directors should be chartered

[1]Certain Members of Congress indicated a disagreement with the proposed relocation of the headquarters office and sought to prohibit all organizational changes. A compromise was reached in the Continuing Resolution adopted on December 22, 1987, providing for a professional staff of not less than 60 employees, with expertise in particular disciplines, to be maintained in Washington, together with the Commissioner of Reclamation and the Assistant Commissioner for Administration.

and expected to provide consistent management leadership as the Bureau moves into the future and as political changes occur.

Of equal importance was the new management philosophy expressed in the "Implementation Plan":

- The Bureau's service orientation should be strengthened to ensure a responsive, timely and high-quality product for its clients.
- Responsibility and authority should be delegated to the lowest feasible level in the organization.
- Flexibility to respond to new opportunities and problems should become a central way of doing business.
- Employee recognition should become ingrained in the organizational structure, including the positive acknowledgement of outstanding performers and management's dealing with poor performance.

The above principles are simply restatements of good management practices. It is unfortunate that federal organizations have the reputation of being bastions of stifling red tape rather than examples of organizational efficiency. A major part of that reputation exists because of the political climate and exogenous constraints within which federal agencies must operate. Yet, when an organization such as the Bureau of Reclamation can reorient itself internally to provide management leadership to carry out the mission requirements imposed by the President and the Congress, then the taxpayer and the general public are being well-served.

The Future

The "New Bureau" can best be summarized by the mission statement contained in the 'Implementation Plan": "The primary mission of the Bureau of Reclamation is the pursuit of comprehensive solutions to water resource management problems. To accomplish this, the Bureau directly, or through assistance to others such as state and local governments, plans, designs, constructs, operates, and maintains economic and environmentally acceptable project works to supply water for the benefit of irrigation; hydropower; municipal, rural, domestic, and industrial purposes; flood control; recreation; and fish and wildlife uses. The Bureau addresses surface and ground-water supply and quality needs through engineering, scientific and technical research, and by developing structural and nonstructural solutions. The Bureau of Reclamation serves as a significant national and international resource for the resolution of technical, financial, and management problems related to water quantity and quality."

The essence of that statement is that the Bureau is available and willing to assist state and local organizations to meet their resource management and development challenges. The mission and future activities of the Bureau of Reclamation will serve as a palpable example of working federalism where state and local governments, and private organizations, can look to the federal government as a partner rather than on overseer. In our view, there is no "water crisis" occurring in the nation of a magnitude that should invite the burdens of a comprehensive, regulatory national water policy and an expanded federal bureaucracy to implement it. Rather, the "water crises" of the nation are of a local and regional nature, and the appropriate role of the federal government is to support and supplement local and regional efforts in dealing with the whole range of water issues. And, if the Bureau can continue to enlist the support of its future political managers in these objectives, then the West and the nation stand to benefit.

The range of water issues is large—maintaining the operational integrity of existing facilities; salinity control; in-stream flows; temperature control; municipal use; groundwater management; hydropower production; Indian water right claims; and others. The Bureau of Reclamation, with its long history of success and expertise in water development and management, is the logical partner to work with and supplement the resources of State, local and private organizations to address these issues.

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Has the Wolf Bought a Sheepskin Coat or Have Water Resources Agencies Become Lambs?

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The strong thrust of water resources development reminds me of those super oil tankers that take 10 miles to stop after the brakes have been applied. The U. S. Army Corps of Engineers, the Bureau of Reclamation and the Soil Conservation Service, with hundreds of projects under construction, proceed with similar momentum. Many of these projects, such as the Central Utah Project and the Yazoo Basin Project in Mississippi, will take 15 years to complete. In addition, Congress already has authorized a 20-year backlog of projects.

The construction agencies' constituents cite numerous economic benefits from water resource-development structures. Thousands of completed water projects reduce flood damages, generate electricity, irrigate farmlands, store municipal water, facilitate navigation and provide reservoir recreation. Early projects like the Grand Coulee Dam are engineering marvels. The annual cost of less than $5 billion is a tiny share of the federal budget.

Because more than half of this annual $5 billion expenditure is spent on construction, the cumulative effects are considerable. Fish and wildlife managers should be concerned that the water development program in fact continues to plod—along with the nation's riverine and riparian areas. Your efforts to slow down or change the direction of this ponderous triumvirate can help to preserve the remaining habitat. Water resource management is a critical concern of economics *and* ecology. Few existing projects have proven to be profitable economic investments for the nation; many regional benefits have come at the expense of other areas of the nation.

Defenders of subsidies to beneficiaries of dubious water projects point to other more costly income- and wealth-transfer programs of the federal government, such as financial support to small businesses, housing and exporting firms. No federal program, not even the large subsidies to nuclear power plants, causes the degree of long-term adverse environmental impact that the water resource-construction program does.

The environmental effects of water resource development have proven more costly to the nation than the economic losses from bad investments. Many of the effects from damming, diverting, draining and dredging the nation's rivers, wetlands and estuaries are irreversible. Some of the habitat losses have been mitigated by more intensive management, catch and harvest limits, modifications in project operation, etc. Yet, fish and wildlife habitats have paid a large share of the costs of thousands of projects spread around the nation to nearly every Congressional district. Neither proper mitigation nor adequate compensation has been provided for most of the damage.

The accumulated development has altered much of the nation's water and related land resources. Federal, state, local and private entities have constructed more than 55,000 dams, dredged more than 25,000 miles of inland waterways, and 200 harbors and estuaries. Federal agencies annually divert more than 30 million acre-feet of stream water to irrigate crops, and probably an equal amount for municipal and industrial purposes. In addition to the direct federal investment, the Federal Energy Regulatory Commission (FERC) has licensed thousands of private and municipal hydroelectric plants at dams that block anadromous fish runs, change water temperature and grind up young fish. (An engineering report on the operation of the Harry S. Truman Dam on the Osage River in Missouri stated seriously that ''cusinarted'' fish would provide food for other fish.)

The Bureau of Reclamation's 349 dams, 15,000 miles of canals and 49 hydropower plants have blocked natural rivers, depleted stream flows, and contaminated surface and groundwater with salts and pesticides from irrigation runoff. In his recent bestseller, *Cadillac Desert*, Marc Reisner lamented: ''Glen Canyon is gone. The Colorado Delta is dead. The Missouri bottomlands have disappeared. Nine of of 10 wetlands in California have vanished, and with them millions of migratory birds. The great salmon runs in Columbia, the Sacramento, the San Joaquin, and dozens of tributaries are diminished.''

The Columbia River doesn't ''roll on'' as Woody Guthrie sang—it lurches through huge turbines and down 100-foot spillways, and without its immense historic runs of Pacific salmon. Riparian habitats along the once-wide Missouri, wild Colorado, scenic Appalachicola and many other rivers have been damaged permanently.

Water resource projects often stimulate other actions that cause environmental damages. In the Lower Mississippi Valley alone, landowners cleared more than 6 million acres of bottomland hardwood forests between 1937 and 1977, largely as a result of U.S. Army Corps of Engineers navigation and flood damage-reduction measures—they could afford to clear and farm land no longer subject to regular flooding.

Beginnings of Water Resources Reform

A myriad of events has finally forced the major water development bureaucracies to depart from their traditional way of fulfilling their missions.

- Growing public perception of the financial subsidies and environmental damages of water projects and persistent federal budget deficits have influenced recent Administrations to withdraw their support.
- Lower farm prices as a result of surplus production have led farmers to question the wisdom of subsidizing irrigated crops to drive prices down even further.
- The nation's surplus of electric generating facilities and the failure of oil prices to skyrocket as expected has made new hydroelectric facilities uneconomical.
- Local floodplain-zoning regulations, in part necessary for eligibility in the Federal Flood Insurance Program, have reduced the number of properties that might be protected by federal dams and levees.
- The National Environmental Policy Act has caused newly proposed projects to get a hard look.
- The overtopping of the Corps' Ross Barnett Dam in 1979 (which led to a destructive flood in Jackson, Mississippi) and the Bureau's alleged mismanagement of the Colorado River dams in 1983 (which caused flood damages and a near loss of Glen Canyon dam) dispelled long-held beliefs about the engineering omnipotence of the agencies.

- A strong coalition of environmentalists and fiscal conservatives was able to convince Congress not to pass any major water project authorization bills from 1974 to 1986, and to decrease the water development budget, in real terms.

A Turn in the Road

First Attempts at Reform Face Political Obstacles

The tough anti-spending stance of the Reagan administration, coupled with its political honeymoon, appeared to be an opportunity to make an abrupt break with the bankrupt water policies of the past. President Carter had been unable to round up sufficient political support to stop the worst projects and was forced to capitulate on the notoriously expensive Tennessee-Tombigbee Waterway. Carter attempted to obtain better economic and environmental planning of projects through improved interagency coordination and tightened planning regulations by the Water Resources Council.

The high hopes for change in 1981 quickly faded when Secretary James Watt seized the rudder from the reformists and jettisoned the few reforms of the Carter administration. He abolished the six nonstatutory river basin commissions, disbanded the Water Resources Council's staff, repealed the Principles, Standards and Procedures for Water Resources Planning, and increased the budget of the Bureau of Reclamation. John Leshy, a former Interior lawyer, described the role of Secretary Watt, "the keeper of the flame for water project funding against hostile forces," as "remarkable," in contrast to change and reform in other areas.

The internal struggle within the Reagan administration became public when advocates of water policy reform chose increased nonfederal sharing of the costs of new water projects as a method to put out the flame. Environmentalists supported cost-sharing reform because they expected the enthusiasm of local beneficiaries for dubious projects to flutter if they were forced to pay more of the costs.

In 1983, the Cabinet Council for Natural Resources and the Environment issued proposed nonfederal cost-shares for various project purposes, and the Department of the Interior asked for public comment on the proposals. William Gianelli, Assistant Secretary of the Army for Civil Works, testified in favor of increased nonfederal cost-sharing on June 15, 1983. Two days later, Secretary Watt wrote Senator James Abdnor, Chairman of the Water Resources Subcommittee, to "clear up" the confusion following Mr. Gianelli's testimony. Watt enunciated Interior's policy of case-by-case cost-sharing arrangements based on the ability of nonsponsors to pay.

President Reagan's January 1984 letter to Senator Paul Laxalt announced that each agency could seek its own cost-sharing arrangements with project sponsors. The President stated, "[W]e all agree on the goals. These goals are to revitalize the magnificent water development programs launched early in our Nation's history." The water lobby won this skirmish. Mr. Gianelli resigned as Assistant Secretary several months later.

Water Resources Coalition Forces Reforms

In 1983, several Administration officials, conservationists and fiscal conservatives coalesced. They eventually obtained passage of a landmark authorization bill for the Corps of Engineers—the Water Resources Development Act of 1986—which increased significantly the nonfederal share of the costs of water projects and water-planning studies. As a consequence, several local sponsors have asked for smaller projects or abandoned their requests. The Corps is having difficulty finding local sponsors for some projects.

Congress has been gradually altering its course regarding water resource development. It has declared dozens of river segments off limits to development through Wild and Scenic River designation.

The Food Security Act of 1985 contained "swampbuster" and "sodbuster" provisions that withdrew farm subsidies for crops grown on newly drained or broken land. In addition, the 1986 Tax Reform Act restricted tax deductions for expenses incurred in farming or preparing newly drained or broken land.

Conservation interests negotiated successfully for several water policy reforms that were included in the Garrison Diversion Reformulation Act. The Act requires the Bureau of Reclamation to charge 10 percent of full cost for water used to grow surplus crops; directs that the repayment of the costs of irrigation water above the farmers' ability to pay be amortized over 40 years rather than in the 22nd century; and that federal and state monies fund a Wetlands Trust to protect, enhance and rehabilitate wetland habitat in North Dakota.

The Electrical Consumers Protection Act of 1986 directs the Federal Energy Regulatory Commission to consult with fish and wildlife agencies when considering applications for new or renewal hydroelectric licenses.

The Soil Conservation Service has shifted its emphasis from drainage measures and dam building to a mix of structural and nonstructural measures designed to improve water quality and reduce soil erosion.

The Bureau of Reclamation announced a major change in its mission, from constructing subsidized water projects to managing resources effectively with increased sensitivity to the environment. James W. Ziglar, Assistant Secretary of the Interior for Water and Science, has been asked to describe the Bureau's New Direction at these meetings. These exciting new initiatives include increased emphasis on facilitating sales and exchanges of water and transfers of federal water projects to local interests. The Bureau's report recognizes that new "[M]ajor agriculture water and power projects are becoming increasingly difficult to justify from an economic, budgetary, and environmental perspective." In other words, the agency is running out of rivers to dam.

Assessing the New Direction

The quickening pace of water resource policy reform faces many obstacles. The large backlog of authorized projects and projects under construction is seen as a binding promise to project sponsors and to agency employees. Irrigation water and construction and operating costs for inland waterway navigation continue to be nearly 100 percent subsidized, so political pressures for new projects can be expected. Reforms to date have not addressed fully the unmet mitigation measures for fish and wildlife losses from completed projects.

Bureaucratic inertia, resistance and confusion may be the greatest hindrance to new directions in water resource planning and management. Employees often have personal identification with the plans they have worked on for several years. Agency staffs contain more engineers than biologists and economists, making it difficult to design environmental protection and restoration measures and water conservation and marketplace programs.

Assistant Secretary Ziglar introduced the *New Assessment* for the Bureau with an optimistic tone for the "new Bureau of Reclamation." He wrote, "[T]he prescience of the Assessment Team in identifying the Bureau of Reclamation's changing role and recommending a course for the future belies the notion that bureaucracies and bureaucrats are stagnant and inflexible."

In truth, economic forces are driving the Bureau's changing role. The surplus of farm crops has lowered prices and made new irrigation projects uneconomical. For example, at least 32 farmers are attempting to opt out of their 1977 commitments to purchase water from the nearly completed Dolores Project in Colorado. The "new Bureau" supports the proposed Animas-La Plata Project, close to Dolores, that would cost taxpayers over $5,808 per acre to increase the value of the affected lands by only $300 to $1,000 per acre. Farmers would pay only $47 per acre for water, less than 1 percent of the cost. On the other hand, the demand for recreation is rising. The new Bureau should recognize that the Animas Project would destroy commercial whitewater rafting and increase salinity in the Colorado River system.

The Bureau has already begun to take action to improve fish and wildlife habitat. Water in the Central Valley Project in California is being stored in wetlands in the Grasslands area as an experiment to provide winter habitat, rather than stored in reservoirs. The water will be released later in the year to irrigate crops. The Bureau, the Corps and the Bonneville Power Administration are cooperating with fish and wildlife agencies to partially restore fisheries in the Columbia River Basin. The Bureau has commissioned studies of the value of rafting and angling below Glen Canyon Dam to determine if changes in flow releases that would reduce hydropower output are warranted.

The *Implementation Plan* on future project opportunities for the Bureau of Reclamation should have developed an operating mechanism to effect the announced changes. This vacuous restructuring plan merely proposes to relocate the Headquarters Office to Denver and to shuffle staffs and offices. The Department of the Interior has announced the new direction but has not supplied a mode of travel.

A "new Bureau," truly dedicated to a new role, would find a way not to build the irrigation and drainage portion of the Bonneville Unit in the Central Utah Project. The facilities planned in 1965 are not wanted today. Municipal water users, power customers and taxpayers would be better off if the sunk costs allocated to irrigation were made nonreimbursable. The environmental costs of the Bonneville unit would be lessened.

A "new Bureau" would bank the remaining marketable water from the Central Valley Project, such as the savings from efficiencies obtained by the joint-management agreement between the Central Valley Project and the California Water Project. New long-term contracts for this water would inhibit the development of water markets in California. A water bank, analogous to the Strategic Petroleum Reserve, would lease water at market rates during dry years. The unsold water would provide freshwater flows to wildlife habitat in the Sacramento-San Joaquin and San Francisco Bay. The Bureau, by being the lessor of last resort, would provide liquidity to the emerging water markets.

A "new Bureau" would develop effective conservation programs linked to its proposed emphasis on developing water markets.

A "new Bureau" would look for partnerships with fish and wildlife agencies to provide greater recognition and protection to in-stream uses of water. Fish and wildlife agencies have already purchased water rights for in-stream flows and should be willing to do so for further habitat enhancement. Users of project water should bear the costs of water rights when purchased or leased for mitigation or project-induced losses.

Jay Hair, president of the National Wildlife Federation expressed skepticism about the Bureau's new direction. "The Bureau of Reclamation is to be congratulated for recognizing—at long last—that its original mission has been completed and that conservation is one of the 'new realities' facing federal agencies. But if the Bureau of Reclamation cannot promptly and more intelligently identify important contemporary missions for which it is uniquely suited, then it would be advisable to close the door on the agency and that chapter in American history. We have dams enough."

Toward a National Recreational Fisheries Policy

Frank Dunkle
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I first heard the phrase "National Recreational Fisheries Policy" just about a year ago. I assumed it was yet another of those dusty documents that provide ballast to bookcases back in Washington. In fact, I could even conjure a mental picture of it—a fading federal green paperback, way too thick, thoroughly unreadable and suitable only for breaking the visual monotony of CFR's (that is, Code of Federal Regulations) wedged on the shelf.

When a fishery staff person asked me what I thought of such a policy and its potential, I tried to be polite and sound at least vaguely knowledgeable, and I offered something like: "Well, it looks like its time really has not fully arrived." I like telling staff people things like that. It helps provide a dash of philosophy to their lives; it also reinforces my role as mentor and resident sage.

Now those of you familiar with the U.S. Fish and Wildlife Service know that, from time to time, rumors may occasionally well up in the ranks. Information can subtly change—perhaps to make it more palatable over the lunch table—and before you know it, what one said can swiftly become what others want to hear.

Thus the word went out: "Frank Dunkle says the time is ripe for a National Recreational Fisheries Policy. Policy placed on fast track by Dunkle!"

Now obviously, I am being facetious—I would not want folks to leave this room thinking and then saying, "Dunkle was coerced into the fisheries policy." No, the point I am trying to make should be quite clear—the National Recreational Fisheries Policy *sounds* like something that has been, or *should* have been, around for years. Imagine my surprise when I discovered one did not exist—that there was real void.

When I was approached last year by some of my senior fishery people and some of the leaders in the fishery conservation community, I listened quite carefully to what points they had to make and they, in turn, listened quite closely to what I had to say about the Fish and Wildlife Service's involvement.

The proponents noted that Canada, Ireland and New Zealand had already made substantial progress in formulating national policies for their sport fisheries. They pointed out that even Fish and Wildlife Service data from our five-year National Surveys of Fishing, Hunting, and Wildlife-associated Recreation confirmed the obvious—participation in recreational angling is steadily increasing, to the point where nearly 60 million Americans, or approximately one in four adult citizens, fish. The question emerged—would the United States be able to meet future recreational angling needs in a coordinated, well-planned, and effective way? Could a national recreational fisheries policy prove helpful in identifying and addressing future needs?

I agreed the points they made were valid and the questions they raised were good ones. I offered that the Service could not only provide input into the policy formulation process, it could also serve as the national coordinator as the policy developed. I emphasized then, as now, that the policy should be regarded as a *national* policy, not a federal policy. Moreover, it is *not* a creation solely of the Fish and Wildlife Service—a Service world view to be imposed in the public at large.

With these understandings acknowledged, the Service hosted the first meeting of the policy development effort on April 29, 1987. As a result of that meeting, and with input from nearly two dozen public and private organizations, we published a notice in the July 16, 1987, *Federal Register* that the Service would indeed serve as the national coordinator in the effort. By October 13, a draft outline for the policy was prepared and circulated. From November 16 to 18, a team of specialists from a number of public and private conservation groups convened at the National Fisheries Center in Leetown, West Virginia, and completed a finished first draft. After editorial revisions and internal review were completed, a draft policy was published in the January 8, 1988, *Federal Register*. Input received during the comment period has been evaluated and incorporated, and we hope that the document in its present form may yet be adopted at a formal ceremony during National Fishing Week this June in Washington.

One of the formidable difficulties to date in developing and advancing the policy has been the climate of advance speculation about what the policy would say and what the Service's role would be. Even before the draft policy was issued, there were press inquiries. Did the policy mean an increase in license costs? A decrease in creel limits? Would it call for a national fishing license? Would it strip states of management authorities? Was this not all really a power grab by the Service to take over the National Marine Fisheries Service as well as the fishery responsibilities of more than 30 other federal agencies? Obviously, our responses was a categorical "no" to all of the above. But fielding such questions can be a very valuable exercise, for it afforded us the opportunity to detail what the policy *will* do.

Let me share with you the policy's four guiding principles:

1. Recreational fisheries contribute significant social and economic benefits to the nation.
2. Recreational fisheries depend on abundant fishery resources.
3. Governments and the private sector must work in partnership to advance stewardship of recreational fisheries.
4. The existing authorities and responsibilities of governments will be recognized—or stated more simply, the policy stresses the rightful roles and prerogatives of the states.

I believe most would have to agree that these four principles are hardly startling, let alone controversial. In fact, the draft policy did come under criticism from some quarters for not being sufficiently provocative and hard-hitting.

While I can sympathize to an extent with the feelings and perceptions that prompt that critique, I would still have to counter that the goal of the whole policy effort was, in a very basic way, to take a first step in building a national consensus about the values our recreational fisheries represent.

As I noted recently in a letter to the membership of the Outdoor Writers Association of America, the National Recreational Fisheries Policy is not a panacea, nor was it meant to be. It will not cleanse our waters overnight. It will not guarantee a limit of fish. It is not intended to halt pollution, erosion, toxic spills or all the sundry threats to our waters and our recreational fisheries. But it is an important first step to the future, and it will serve as one of the vital resource management guides as we approach the 21st century.

The final point I wish to make about the policy—beyond urging each of you to read it for yourself and realize its broad base of applicability—is this: the policy recognizes the angler. It acknowledges who pays for fishery conservation. It underscores just how important an informed and concerned angling public is to the sound management of our recreational fisheries. As the preamble of the document says: "Why, each year, do more and more of our citizens heed the call of the waters? Anglers have many reasons to fish. Historically, and at present, many fish to catch quality food. Moreover, they fish for relaxation and excitement, for the thrill of capture and the joy of release, for the fellowship and for the solitude, for the enjoyment of nature's tranquility and for the challenge of encountering the raw elements, for escape from the daily routine, and for involvement in the complexity of our natural world. Most, perhaps, respond to an ancient human trait—anticipation—the expectation of catching fish."

And that, in sum, is what the policy is about—ensuring that we will have the fishery resources to keep that wholesome expectation alive and well in the years to come. I hope the National Recreational Fisheries Policy never becomes the type of dusty government document I alluded to at the outset. Instead, I hope it becomes a continuing challenge and goal, not just for the Fish and Wildlife Service, but for all groups and individuals, public and private, who care about our recreational fishery resources.

The National Recreational Fisheries Policy is indeed a policy whose time has fully arrived.

The Columbia Basin Fish and Wildlife Program: A Debt to the Past, An Investment in the Future

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Introduction

This is essentially a fish story. And like all good fish stories, it boasts of being the largest.

The story focuses on one of the nation's most important river systems—the Columbia and its tributaries. This complex waterway, traversing much of the Pacific Northwest, is home to unique and important fish, the salmon and steelhead. This is a story of how those creatures came to the brink of extinction and of what is one of the largest efforts in the world to rebuild an animal population. It is also the story of other fish and widelife facing the same problems in the Columbia River Basin of the Pacific Northwest. Finally, it is a story of that region and its citizens and their extraordinary cooperative effort to reclaim a biological inheritance.

A catalogue of the great natural resources of the Pacific Northwest—and there are many—must first include the Columbia River and its tributaries. This large and complex river system has given the region the most abundant and lowest hydroelectric power in the nation (Figure 1). That power has lighted and warmed homes, powered businesses and industries, and turned arid waste lands into productive croplands through irrigation.

But this extraordinary benefit was not without costs to the Columbia River Basin. Once a free-flowing river, the Columbia was turned into a series of lakes as dam after dam straddled the river's breadth. The impact on the basin's fish and wildlife was profound. Not only did the dams present physical barriers to migrating fish, but the regulation of the river altered water flows and temperatures. The reservoirs created by the dams inundated thousands of acres of spawning and rearing habitat. Development also stripped shoreline vegetation, increased erosion and sediment, and made wildlife more accessible to harassment. In some cases, certain strains of salmon and steelhead, for example—development all but eradicated these creatures.

The Decline of the Fish and Wildlife Resource

By 1980, the Pacific Northwest was perilously close to losing its Columbia River salmon. Some runs had been considered for classification as endangered species. The annual salmon and steelhead runs had dwindled to 2.5 million—less than a quarter (and by some estimates only 15 percent) of the run sizes 100 years earlier. Most of the losses were upriver from Bonneville Dam, where the least mitigation

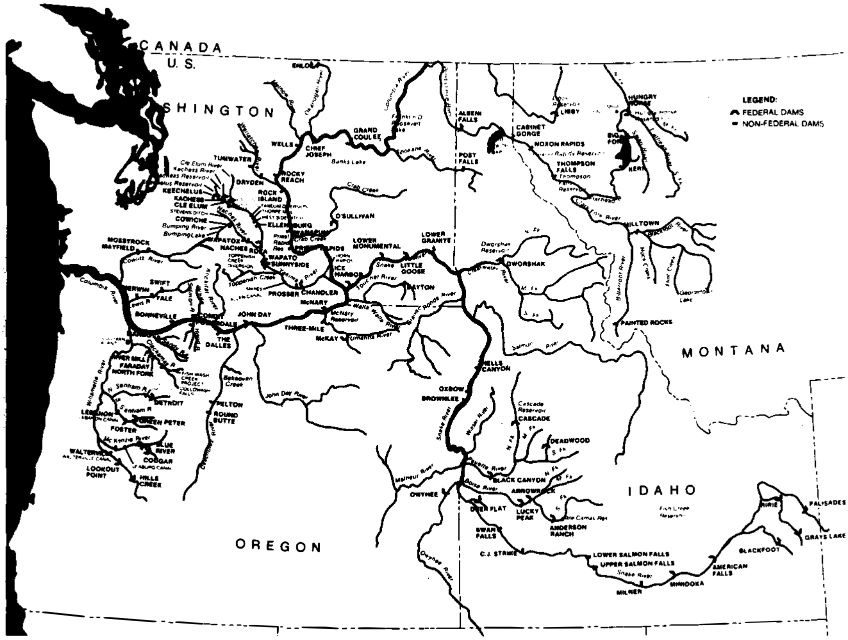

Figure 1. Columbia River Basin hydropower projects.

for damage had occurred. The accessible habitat for spawning was cut by one-third. Not all of these losses were due to hydropower; other forces also were at work. Irrigation, flood control, overfishing, and logging, grazing and farming practices added to erosion and devegetation of shoreline habitat as well as siltation of spawning beds. But the major decline of the fish coincided with the construction and operation of the hydropower dams.

The commercial and recreational fishing industry, the region's Indian Tribes and, indeed, the entire Northwest economy felt the impact of the fish losses. Many groups and individuals were becoming increasingly concerned about the problem. Sincere efforts had been made to protect existing fish and wildlife and, in some cases, to make up for the past losses. But, because the river and its tributaries ran through a number of jurisdictions, including states, federal and tribal lands, the work had been fragmented. A coordinated, systematic approach to reversing the decline of the basin's animal life was needed.

The Pacific Northwest Electric Power Planning and Conservation Act of 1980

The Northwest desperately needed a solution, and time was running out. Then, an unusual opportunity arrived. In the late 1970s, the region's electrical power interests turned to Congress for another problem related to the Columbia River. Hydropower alone could no longer meet the region's electricity needs—massive electricity deficits were predicted for the 1980s. Northwest utilities sought to expand the authority of the region's federal power marketing agency, the Bonneville Power Administration, to acquire new resources.

The time was ripe for the Northwest's fish and wildlife interests, and they found a sympathetic ear in Congress. A bill, which had begun as a Northwest power bill, soon picked up major fish and wildlife provisions. These provisions related directly to power because they called for protection, mitigation and enhancement of fish and wildlife affected by hydroelectric development and operations in the Columbia River Basin.

An unprecedented consensus began to take shape. The issue was clear—the dams had exacted a costly toll. The debate was only one of degree—how much responsibility for fish and wildlife losses should the hydropower system bear? What ultimately emerged was as innovative as it was historic. The basin's fish and wildlife interests were to be accorded equitable treatment with Northwest electrical power interests.

In December 1980, Congress passed the Pacific Northwest Electric Power Planning and Conservation Act, known more commonly as the Northwest Power Act. The Act authorized the states of Idaho, Montana, Oregon and Washington to enter into an interstate compact to create a policy-making and planning body for two important Northwest resources—electrical power and the Columbia River Basin's fish and wildlife. The entity authorized by the Act and created by the four states is the Pacific Northwest Electric Power and Conservation Planning Council—more commonly known as the Northwest Power Planning Council.

The governors of the four states each appointed two members to serve on the Council. The Council, headquartered in Portland, Oregon, began operation in April 1981. To underscore the importance of protecting fish and wildlife, the Act directed the Council to develop its Columbia River Basin Fish and Wildlife Program before it developed a power plan.

The Council's fish and wildlife program is implemented by the Bonneville Power Administration, the U.S. Army Corps of Engineers, the Bureau of Reclamation, and the Federal Energy Regulatory Commission and its licensees. Under the Northwest Power Act, these federal operating and regulating agencies are directed by Congress to exercise their responsibilities, in a manner consistent with the purposes of the Act and other applicable laws, to provide equitable treatment for fish and wildlife. The federal agencies are also directed to take this program "into account at each relevant stage of decision-making processes to the fullest extent practicable." In addition, Congress has directed Bonneville to use its funds and other authorities "to protect, mitigate, and enhance fish and wildlife to the extent affected by the development and operation of any hydroelectric project of the Columbia River and its tributaries in a manner consistent with . . . the program adopted by the Council under this subsection, and the purposes of this Act."

Congress expected action to overcome the harm to fish and wildlife caused by Columbia River hydroelectric dams. To that end, the Northwest Power Act anticipates that the Council and the federal implementing agencies will cooperate to achieve the goals set by Congress, as well as respect the role each has to pay.

The Fish and Wildlife Program

The program is the first systemwide approach to dealing with the impacts of the hydroelectric system on the Columbia River Basin's fish and wildlife. The enormity of the problem requires an unprecedented cooperative effort. The Council relied heavily on widespread public input in developing this program and continues to value such input as it monitors implementation and fine-tunes this program.

The Columbia River Basin Fish and Wildlife Program is, quite possible, the most ambitious effort in the world to save a biological resource. The program is, first of all, enormous on a geographic scale, encompassing the entire Columbia River Basin and more than 30 sub-basins—some 259,000 square miles. It is complex politically because the river and its creatures travel through a number of governmental and management jurisdictions. It is complex technologically and economically because of the requirements to balance fish and wildlife and power interests. And, not least of all, it is incredibly complex biologically, because it involves species of animal life with unusual migratory and life cycle characteristics about which much is still unknown.

The program's five-year action plan contains 234 measures. Bonneville's investment in the program ranges between $40 million and $100 million per year, depending on the number of projects funded and the market value of the power revenues foregone as a result of changes in the operation of the hydroelectric system. In addition, federal and state agencies spend approximately $200 million per year on other fish and wildlife activities in the Northwest.

Because the Council anticipates that the majority of program measures will be funded by Northwest electric ratepayers, it has a duty to ensure that (1) program expenditures are related to losses caused by the hydropower system, (2) the program produces results, and (3) Northwest electricity consumers are assured of an adequate, efficient, economical and reliable power supply. One way to help achieve these purposes is to set a realistic program goal and associated policies. A goal and policies can provide a means to evaluate regularly and consistently the progress of the program and to identify potential problems in the early stages. Clearly identifying the expected results of the program should substantially increase the likelihood of success.

Realizing this, the Council has set an interim goal of doubling salmon and steelhead runs, from 2.5 million to 5 million adult fish. In establishing the interim goal, the Council conducted comprehensive research to determine annual adult salmon and steelhead run sizes prior to major development in the Northwest. Subtracting current average run sizes from estimated predevelopment (mid-19th century) runs provides an estimate of the salmon and steelhead losses due to all causes. The Council then estimated what portion of those salmon and steelhead losses were due to the hydropower system. Only the hydropower-related losses are addressed in the program. The goal of doubling the salmon and steelhead runs is well-within the number of fish losses attributed to the hydropower system and has received widespread support throughout the region.

The time needed to double the runs will depend on a number of factors, including program policies for mainstream survival, harvest management and fish production, and on further assessment of production opportunities. Although doubling is a numerical goal, numbers will not drive the program to the exclusion of other important values, such as conservation of genetic resources. This numerical goal will guide planning and provide a context for evaluating program progress. As an ambitious, yet realistic goal, it should provide an incentive for innovation in program implementation, improvements in communication and institutional arrangements, and development of management agreements. The goal also provides a signal that the program is a long-term, serious effort to solve complex problems not amenable to quick-fix remedies.

Actions to Rebuild the Salmon and Steelhead Runs

The major goal of the Columbia River Basin Fish and Wildlife Program is to put more fish back into the Columbia River and its tributaries, and to do so with maximum effectiveness at a reasonable cost to ratepayers.

While the program addresses the needs of salmon and steelhead, resident fish, and wildlife affected by hydroelectric development in the basin, this section of the paper focuses on salmon and steelhead. More than any other species, these anadromous fish (fish born in freshwater that spend their adult lives in the ocean) are symbols of Northwest waters. No other Columbia Basin species has such a vital impact on both the region's and the nation's economy.

Anadromous fish, such as salmon and steelhead, have a life cycle unlike any other creature. The program is designed to address the needs of these fish at each important stage in their life cycle. These fish are born in freshwater streams throughout the Columbia Basin. Then, as smolts, they begin an incredible journey that will take them to the ocean where they spend their adult lives traveling thousands of miles over a period of roughly three to seven years. The fish that survive predators, including man, return to freshwater. Spurred on by a powerful homing instinct, they surge upstream to their birthplace to spawn. After spawning, the salmon die, but some steelhead species may live to repeat the cycle and reproduce again (Figure 2). The program addresses each part of this cycle.

Improving Survival Between Dams

Development of dams and hydroelectric projects on the Columbia and Snake rivers has greatly altered the natural flows in the Columbia River Basin. Spring runoff is stored in reservoirs to be used during periods of naturally low flows. Regulating the rivers in this fashion increases their ability to produce electricity throughout the year and also provides flood control and slackwater transportation as far inland as Lewiston, Idaho. However, it also reduces river flows, particularly during the spring when juvenile salmon and steelhead are migrating downstream to the ocean. The combination of reduced flows and the greater cross-sectional areas of the rivers due to reservoir storage slows the juvenile fish as they migrate from their area of origin to the ocean. This increase in travel time affects the ability of the juvenile salmon (smolts) to make the transition from freshwater to saltwater and increases their exposure to predatory fish and birds. Reduced flows also endanger juvenile salmon by raising water temperatures, altering water chemistry and increasing the susceptibility to disease.

The Council determined that increased spring flows are needed on the Columbia and Snake rivers to improve juvenile salmon migration. Power flows during the remainder of the year generally are sufficient to allow safe migration. To provide adequate flows during that portion of the spring when smolts are actually migrating downstream, the Council developed a "water budget" to be used between April 15 and June 15. The water budget is a block of water set aside for fish and released during the spring runs to create an artificial freshet that speeds juvenile fish to the ocean. Through the use of the water budget, the fish and wildlife agencies and Indian tribes can increase spring flows to aid the downstream migration of juveniles.

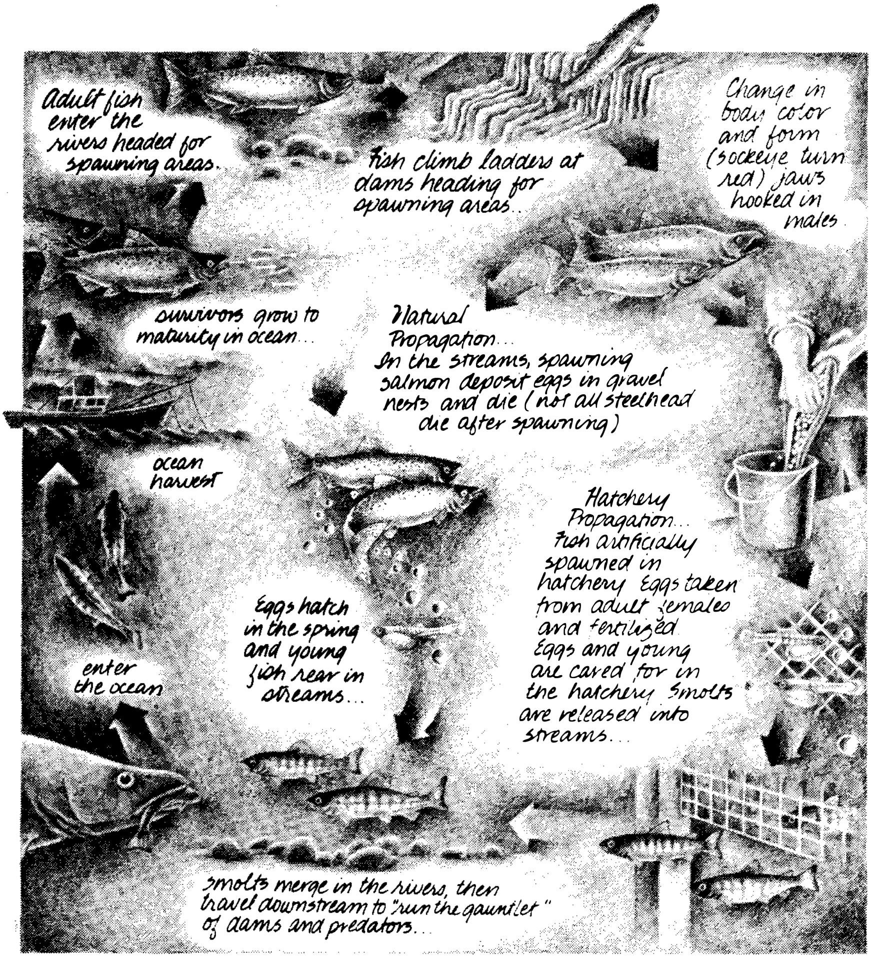

Figure 2. Salmon life cycle.

Improving Survival at Each Dam

When hydroelectric dams originally were constructed in the Northwest, many people believed that providing upstream passage over the dams for adult fish returning to spawn was sufficient to sustain salmon and steelhead runs. Since that time, research has shown that juvenile salmon and steelhead moving downstream also suffer a high mortality rate as they encounter the dams. As these migrants are drawn through a dam's power turbines, they are exposed to conditions that can cause injury and death in a variety of ways. Changes in pressure within each turbine are the primary contributor to juvenile mortality as the fish move from the top of the dam through the turbine intake and out a tunnel at the base of the dam. The impact of the moving turbine blades and the shearing action of water in the turbine can also cause injuries or death. In addition, juvenile salmon and steelhead become stunned and disoriented after passing through the turbines, thus increasing their vulnerability to predators, especially squawfish, which are abundant at the base of each dam.

The Council estimates that 15 percent of all fish passing through the turbines are killed. Because fish go through a number of dams, there is a significant cumulative loss. For example, on the mainstream of the Columbia, of 100 fish passing the nine dams along the migration route, more than 50 fish would be killed by the turbines.

The solution to the problem is to install bypass systems to provide safe juvenile passage around the turbines. The principal method is with submersible screens that deflect the fish from the turbines and into a bypass channel that deposits them at the tailrace of the dam. The Council estimates that these systems will cut turbine mortality in half.

Right now, the bypass facilities vary from dam to dam. Some are considered state-of-the-art; others are obsolete or non-existent.

While new bypass systems are being designed and installed, the program calls for the dam operators to spill water by releasing fish-laden water through a spillway bypassing the turbine. This interim solution means a loss of revenue for the hydroelectric system because the spilled water cannot be used to generate electricity.

Improving Survival in the Ocean

The commercial, recreational and tribal fisheries in the ocean and mainstem Columbia River are mixed-stock fisheries. This means they harvest a mixture of hatchery-produced and naturally produced stocks from numerous areas of origin. Because of their high juvenile survival rates, hatchery-produced fish generally can withstand a higher harvest rate than naturally produced fish can. Those who fish mixed-stock fisheries are generally unable to harvest specific stocks selectively. Thus, naturally produced stocks are often harvested at rates appropriate for hatchery-produced fish, resulting in overfishing of the naturally produced stocks.

The Council recognizes that an excessive mixed-stock ocean and mainstem Columbia River fishery could reduce the effectiveness of program measures designed to restore naturally produced stocks. While the Council looks to fisheries managers to ensure adequate levels of escapement (returning adults) to increase those stocks, the Council also recognizes that it must work with harvest managers to resolve problems.

In part, to address concerns about the mixed-stock fishery, Alaska, British Columbia and Washington have programs to reduce the number of fishing vessel licenses available. Although Oregon and California currently have a moratorium of new licenses, they have not initiated a license-reduction program. Ocean harvest regulations of Washington and Oregon have been more restrictive in recent years in an effort to reduce harvest rates of naturally produced stocks in the mixed-stock fisheries.

An important development since the program was first adopted was the signing in 1985 of the United States-Canada Pacific Salmon Treaty, a long-sought agreement of salmon allocation and conservation for the two countries' intercepting fisheries. The treaty has two major goals: (1) to encourage fish production while discouraging overfishing; and (2) to balance each country's harvestable returns against its investment in restoring the fishery. In addition, since ratification of that treaty, the state fish and wildlife agencies and Indian tribes in the Columbia River Basin have made substantial progress in addressing in-river harvest and production issues.

The Council has developed program measures that call for: consultation and coordination with ocean harvest-management entities; an electrophoresis testing-demonstration program to help determine which stocks contribute to which ocean fishery areas; research to improve stock identification; known-stock fishery demonstration programs; and research on how oceanographic factors in the Columbia River plume affect salmon. The fish and wildlife program also includes funding for specific projects, on the condition that they do not contribute to inadequately controlled fisheries.

Improving the Survival of Returning Adults

Hydroelectric projects present a physical barrier to adult salmon and steelhead migrating from the ocean to spawning areas upstream. To solve this problem, ''fishways'' (fish passage facilities) have been constructed at many of the dams in the Columbia River Basin. Water flows and spills also have been adopted to provide unimpeded passage and maximum attraction of the fish to fishways.

However, not all of these measures have been successful. For example, flow and spill conditions at the base of some of the mainstem Columbia and Snake river dams tend to discourage fish movement in the river or to mask the flows that attract fish to the fishway. In addition, inadequacies in certain fishway facilities and in the operation and maintenance of these facilities reduce the success of adult fish passage at both mainstem and tributary dams.

Losses of returning adult salmon and steelhead at each dam due to upstream migration problems can be heavy. Reducing these mortalities could increase significantly the number of adults available for spawning and harvest.

The Council has adopted a number of measures to improve adult migrant survival. For example, the Corps of Engineers is implementing operating criteria for fishways at its projects and correcting problems created by unreliable pumps. Tributary projects to improve adult fish passage have also been approved. In addition, the Council is working with fish and wildlife agencies and Indian tribes to explore other techniques to improve upstream migration.

Improving Fish Production

Hydroelectric development has eliminated much of the natural spawning and rearing habitat in the Columbia River system. Reservoirs created by dams have inundated nearly all of the mainstem Columbia spawning habitat. Although the Hanford Reach of the Columbia river and a portion of the Hells Canyon area of the Snake River remain free-flowing, fluctuations in water level caused by power-peaking operations hinder the use of those areas for spawning. Fortunately, the Columbia River Basin has a number of tributary streams with good spawning and rearing habitat. Many of those streams can be brought to their full propagation potential through habitat improvement. Other streams offer good habitat, but currently are underused by fish, primarily because passage problems block or inhibit fish from reaching those areas.

Hatcheries produce large numbers of fish. However, important questions remain concerning selection of stocks, control of disease, quality of smolts, genetics, integration of hatchery propagation with natural propagation, and the timing and locations for releasing hatchery-produced smolts.

The Council supports a three-part approach to producing more salmon and steelhead through a combination of (1) natural production, (2) hatchery production, and (3) supplementation of wild and natural fish production by releasing hatchery fish into natural habitats for rearing. To advance this threefold effort, the Council has adopted measures to: provide water flows and temperatures suitable for natural and wild propagation; improve habitat and tributary passage; increase knowledge of appropriate timing and sites for release of hatchery fish; improve existing artificial propagation facilities; and build some new hatcheries, mostly outplanting facilities.

Program measures call for new hatchery and outplanting facilities in the Umatilla and Yakima areas and in northeast Oregon, as well as acclimation ponds at John Day Dam. To ensure that new hatcheries are integrated with wild and natural production, and that other potential problems with hatchery production are addressed, the Council requires the development and approval of master plans before those facilities are built. The fish and wildlife program also promotes testing low-cost, small-scale production facilities for salmon and steelhead in the Columbia river Basin and specifically identifies the Nez Perce Reservation as the site for such facilities.

Maintaining the delicate balance between naturally produced and hatchery-produced fish will require a systematic approach to propagation. The Council is currently working with the region's fish and wildlife agencies to assess the production potential of all 31 sub-basins in the Columbia River system. Plans for each sub-basin will be integrated into a systemwide approach that coordinates production, harvest regulation and passage improvements.

Major Accomplishments of the First Five Years

In the five years since the first Columbia River Basin Fish and Wildlife Program was adopted, much has been accomplished by the many organizations involved in carrying out the program and other recovery efforts.

The accomplishment most frequently applauded is the increase and continually growing cooperation among fish and wildlife agencies, Indian tribes, utilities and hydroelectric dam operators. Observers who were not privy to the years of struggle among competing interest in the basin may not fully appreciate the careful negotiations that led to this new spirit of shared goals.

But five years is barely the duration of one salmon life cycle in the basin. Some of the first emerging fry of 1982 will push back up the Columbia this year—if they have survived their long travels. The river basin they find will be more hospitable than the one they left, and their young will experience even more nurturing in the "new and improved" Columbia River Basin.

It is likely, for example, that there will be more adult salmon and steelhead returning to the basin to spawn this year than in years that preceded the fish and wildlife program. The 1985 signing of the treaty between the United States and Canada to regulate salmon interceptions in the North Pacific means that more Columbia River Basin salmon were allowed to escape harvest in the ocean fishery last year. That leaves more of these powerful fish to follow their inherited routes back to the spawning gravels they left four or five years earlier. The Council supported and encouraged negotiations and funding for this treaty, but the region's fish and wildlife agencies and Indian tribes deserve the credit for building the consensus on which it is based.

In addition to new regulations governing the taking of Columbia River salmon stocks, passage for both adult and juvenile migrants has been improved, production in both natural and artificial environments has increased, projects to protect and enhance non-ocean-migrating fish and wildlife have begun, and innovative processes and policies have been developed to guide the reconstruction efforts. What follows is a list of some of the major accomplishments by the basin's fish and wildlife community over the past five years.

Protection for Juvenile Migrants

- Bypass systems to divert young fish from turbine intakes are in design or construction stages or are completed on 13 mainstem hydropower projects.
- Until these bypass systems are completed, spills at dams provide nonturbine passage for many young fish.
- A water budget has been implemented since 1983 to provide flows to speed migrating juvenile salmon and steelhead through the system each spring.
- In the Yakima River Basin and elsewhere in the Columbia Basin, dam bypass systems and the removal of other obstructives have cleared the way for both juvenile and adult salmon and steelhead. In the Yakima, if the schedule holds, all 20 passage projects will be completed by 1989. Returning adult salmon and steelhead numbers in the Yakima Basin have grown from 2,000 in the early 1980s to 12,000 in 1986.

Production of Additional Salmon and Steelhead

- More than 80 new projects to repair salmon and steelhead spawning habitat and increase natural production are underway or completed in the basin (not including the Yakima Basin work noted above).
- Six new salmon and steelhead production facilities have been initiated in the Yakima, Umatilla, John Day and Deschutes sub-basins, as well as in northeastern Oregon and on the Nez Perce Indian Reservation.

Resident Fish Production and Protection

- The first hatchery completed under the program—the Cabinet Gorge Kokanee Hatchery near Clark Fork, Idaho—is now producing kokanee (landlocked sockeye) to be released into Lake Pend Oreille. This hatchery will provide 20 million fry each year, leading to annual kokanee catches of up to 750,000 fish.
- A resident fish hatchery on the Colville Indian Reservation near Chief Joseph Dam in northeastern Washington is nearing construction. As much as 50,000 pounds of trout are expected from the hatchery.
- Operations of several dams in northwestern Montana are being altered to afford protection for spawning kokanee and other resident fish.
- An agreement was reached among the Montana Power Company, the Montana Department of Fish, Wildlife and Parks, the Bonneville Power Administration, and others to provide water from the Painted Rocks Reservoir to protect resident fish in the Bitteroot River.

- Planning is included in the program for future resident fish hatcheries in the priority areas above Chief Joseph and Grand Coulee dams on the Columbia River and the Hells Canyon Complex on the Snake River.

Protection from Future Hydroelectric Development

- The Council has proposed an amendment to the program that would designate 40,000 river miles for protection from future hydroelectric development.
- Encouraged by the Council and other organizations in the basin, the Federal Energy Regulatory Commission is now examining, on an experimental basis, the cumulative impacts on fisheries of more than one hydroelectric project in Idaho's Salmon River Basin, before licensing new projects.

Protection for Other Wildlife

- The first major wildlife-mitigation projects were approved in the program. These cooperative efforts will ultimately provide habitat restoration for some 1,800 deer, 130 elk, 30 black bear and grizzlies, and more than 60 bighorn sheep, in compensation for wildlife losses at Hungry Horse and Libby dams.
- Effects on wildlife of hydropower development and operation are being studied in other parts of the basin.

New Processes and Policies

- For the first time, research on salmon and steelhead in the basin will be coordinated basinwide.
- A new computer model of the life cycle of Columbia River salmon and steelhead can now increase understanding of the relationships of salmon and steelhead production, mainstem mortality and harvest regulations.
- The first comprehensive compilation of information on the extent and causes of salmon and steelhead declines in the basin was produced and distributed by the Council.
- A determination of the extent of salmon and steelhead losses resulting from the development and operation of the hydropower system is now included in the program along with a goal of doubling the runs.
- An adaptive management approach has been incorporated into the program to help measure and interpret both successes and failures in the program's inplementation.

Conclusion

The Pacific Northwest has made great strides in its efforts on behalf of the region's fish and wildlife. The Northwest Power Act provided the tools to develop a comprehensive program to address the debt to fish and wildlife from actions taken by the hydroelectric system over the last 50 years. Unprecedented cooperation by all of the entities that affect fish and wildlife is resulting in an investment to protect and rebuild one of the Northwest's most valuable natural resources.

Creating Wildlife Assets on Private Lands

Dayton O. Hyde
Operation Stronghold
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In the United States, wildlife faces either the worst of times or the best of times depending on how well our present wildlife management agencies can adjust to burgeoning pressures on the land. Despite a fine dedication on the part of wildlife professionals, the present system is encumbered by present philosophies and is not working well enough to meet accelerating demands.

Habitat available to wildlife shrinks at an alarming rate. Various user groups compete for larger slices of the resource pie, and when one sector, through political strength, is able to gain a larger slice, someone else's share inevitably becomes smaller. During the Depression years, my brothers and I used fair means and foul to court my mother's favor—each of us competing for a larger slice of her pie. She solved the problem, despite the times, by making the pie larger.

In the area of wildlife habitat, we are making the pie smaller, not larger, and must change our ways or soon will all be fighting for a share in a small tart.

Competition is fierce. For example, anglers see our rivers as sources of fish; to the industrialist, they are sources of power, and means of transporting raw materials in and finished products or waste byproducts out; whitewater rafters see rivers as a source of quality recreation; and to the farmer and rancher, they are the life blood of grain crops and livestock forage.

Seeking funding or political support for our own causes, we distort facts, deliberately misleading the public, seemingly unaware that this force may continue its involvement in issues and one day may become the tail that wags the dog, or the bad seed that becomes a weed in our gardens.

Because the responsibility for wildlife management lies primarily with state and federal agencies, the bulk of such management is done on public lands rather than on private lands. We place great value on wilderness areas for wildlife, ignoring the fact that such areas, though scenic, are seldom prime wildlife habitat. We place much stock in our spectacular refuge systems, unaware that such areas, however vital, concentrate wildlife populations and accentuate pressures from disease and predation. We see our national parks and forests as a panacea, when, in truth, man and wildlife compete for the same productive areas. More and more, *disturbance* is becoming a major factor in the deterioration of our wildlife resource.

Much of the money available for wildlife management is spent on public lands, yet more than 80 percent of our wildlife in the U.S., exclusive of Alaska, is dependent on private land for food, water, shelter, and that which is becoming increasingly scarce for wildlife and plants, privacy.

Those of us who reside in western states sometime forget that there are states such as Texas without much public land. We forget that 60 percent of our forests are private not public. We forget that most agricultural production, with its generous presence of insects, crop residues, available water and rich soils, is on private land. We fail to comprehend that most arid western public lands would not be viable for wildlife were it not for the generosity of adjoining private landowners, who control the bottoms and productive lands, thus the water, shelter, and winter foods for wildlife. These country dwellers are often our bulwarks against poaching and vandalism, after the daily exodus of government pick-ups and panel wagons to town.

We must realize that private lands serve a function for wildlife that most public lands simply cannot match. Picture a young graduate in wildlife management, eager to apply the fruits of his education. He goes to work for a state wildlife agency and does a spectacular job creating habitat. Wildlife populations are quick to respond, but soon the public discovers the project and its gains are wiped out by overuse. It is not that people are bad; there are simply too many of them, with a prevailing philosophy that, on public lands, one's footprints can go anywhere.

Clearly there would be advantages to building wildlife projects on private land, where public access could be restricted, but we are fast building a system that discourages wildlife use of private lands.

Besides being a professional writer, I am a cattle rancher in southern Oregon, operating on lands my family first saw in 1903. I happen to love wildlife as well as cattle and feel strongly that private lands, if they are to exist much longer, must contribute their full potential. With this in mind, I put 25 percent of my home ranch into wetlands, restored our tired, silted, old trout stream to full, productive glory. With teen-aged sons on some marginal land we owned nearby, we dammed up snow water runoff to create a lake with three and a half miles of shoreline. There is no way to legislate such caring.

I was unprepared for the success of the venture. Wildlife came flooding in, indicating that such habitat was in short supply on adjoining public lands. The wetlands moderated the temperature, eliminating the summer frosts that had once ruled the valley. Birdlife nesting in the marshes ate the grasshoppers and insects that had once plagued us. Hawks and other predators, such as coyotes, controlled the meadow mice and ground squirrels that had once ruined our plantings. We ended up with a 54-percent increase in beef tonnage, and a wildlife spectacle seldom present on public lands.

On the lake, more than 5,000 ducks, geese and swans found refuge. The number of resident bird species went from 8 to 83. Eagles and osprey came to nest. Wood ducks and bufflehead moved into the nest boxes I placed for them. Soon the trout I planted weighed up to 14 pounds. Loons soon adopted the lake and dove for minnows I bought from a catalogue. On that arid land, where once a chickadee in July would have had to travel several miles for a drink, the lake, built at my expense, made thousands of acres adjoining national forest viable for wildlife.

I have had much joy from these creations, but there have been problems too. Oregon leads the rest of the states in land-use socialism. A group of naive but well-meaning urbanites inflicted a land-use planning system on landowners that ended up punishing them for good land management, and wildlife has suffered. I am being zoned for wetlands that did not exist before I created them, for the presence of bald eagles that were not there until I developed habitat, for a fishery that had been forgotten until I spent time, money and labor to restore it, for the presence of concentrations of wildlife that drifted in from solitary everywhere to enjoy a habitat unmatched on public lands, for the presence of rare plants that might have vanished long ago had not I been concerned with their survival.

I was not the only landowner affected. In eastern Oregon, for instance, the state wildlife commission determined that most of the elk were wintering on private lands. In winter, elk must descend from high mountain forests to survive. The agency tried to create an "elk overlay zone," placing severe restrictions on those private landowners who wintered elk. Instead of an incentive program that would ease the financial burden of the ranchers, the state tried to take the lands by zoning without just compensation. Small wonder many a rancher who had once taken an interest in the elk, now wished they didn't exist.

At the root of the problem is the fact that the public agencies, in their battle to justify budgets, have created a myth that they are the *sina qua non* of wildlife existence. They seem to see private land conservation as a threat to their own status.

We are wasting the exciting potential that private lands, with proper management, could bring to wildlife habitat. The antipathy agencies have for private lands does not help. To reverse present trends that are hurting wildlife, we must deal not only with the neuroses on the part of wildlife managers, but also a generation of bad experiences for the landowners. Instead of grabbing land-use rights without just compensation, we must set up an incentive system, purchasing conservation easements instead of stealing them, working personally to involve the landowner in wildlife conservation.

In several states, sportsmen are battling to gain access to private lands. They should remember that, when a landowner loses his rights to control access, his instinct is to sterilize his land so that there is nothing left to attract the public. This can be done so subtly that it cannot be regulated by legislation.

In the 1970s, impressed by what my land had become for wildlife, I bought a rundown ranch in central Oregon, and applied a little money and a lot of care to offset years of neglect. First, I added privacy to the mix—posting the land and fencing all portions that had good potential for brush and willows. Then came riparian plantings to encourage reed's canary-grass along the river. Changing grazing patterns, I restored native bunchgrasses to the eroded hills, and developed water in arid canyons.

Suddenly, where there had been a few pheasant and quail, there were hundreds. On one summer day, I counted over 1,200 chukar partridges moving down off adjacent Bureau of Land Management lands to water and loaf in the new cover. Soon there was a resident herd of more than 40 elk, and hundreds of deer. Hawks and owls nested in the cottonwoods, and songbirds flourished. Once more, I had a heady taste of what private wildlife habitat development could mean.

In 1979, I set up a nonprofit corporation called OPERATION STRONGHOLD, to encourage wildlife habitat projects on private land. To give landowners incentive to join, I developed handsome signs that would help them protect what they created from unwanted public access. The signs stated: "MEMBERS, PRIVATE LAND WILDLIFE STRONGHOLD. THIS LANDOWNER CARES! HE HAS COMMITTED HIS PROPERTY TO A SIGNIFICANT WILDLIFE AND CONSERVATION PROGRAM BENEFITTING YOU. WILDLIFE NEEDS PRIVACY. PLEASE COOPERATE. IT IS UNLAWFUL TO ENTER THESE PREMISES WITHOUT WRITTEN, DATED PERMISSION OF THE LANDOWNER."

First, my neighbors joined, and then major landowners such as Lost River Ranch and the Disney Corporation's, Running Y. There were letters from ranchers in Montana, who, of all things, wanted information on developing habitat for butterflies, others who wanted to restore native prairies or rebuild trout streams. Memberships came in from Canada, England and Africa, from landowners who wanted to get involved personally in creating wildlife habitat.

Exposure of the idea on television programs, such as Dick Cavett and ABC's "20/20," and in various publications has brought in a host of new members, some with small acreages, some with huge tracts. Some have been able to offer wildlife only privacy, others have undertaken projects with a zeal to match my own. There are now over 5 million acres in the Stronghold program, which has yet to cost the government a penny.

We face an exciting time for wildlife *if* the agencies responsible for resource management will initiate a coordinated venture with the private sector to create and maintain wildlife habitat, and *if* the public will accept the task of funding reasonable, long-term incentives, so that the private landowner can consider raising habitat as an alternative to standard crops, or creating projects of significant value on private lands. But the landowner can never be allowed to fear that, as his land becomes more important to wildlife, he will lose it to "taking" by public agencies.

Wetland Inventories Derived from Landsat Data for Waterfowl Management Planning

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Introduction

With the signing of the North American Waterfowl Management Plan (NAWMP), waterfowl managers at federal, state or provincial, local, and private organizations are faced with many challenges. Some of the challenges include selecting optimum management strategies to meet the population and habitat objectives stated in the NAWMP, eliciting the cooperation of various agencies and organizations to implement the selected management techniques, and finding funding to implement and maintain these strategies to the year 2000.

Ducks Unlimited Canada (DUC), in cooperation with the Canadian Wildlife Service, the U.S. Fish and Wildlife Service, and various state or provincial wildlife agencies, is working to develop various Computer Planning Tools (CPT) to help in determining the management techniques that will meet the waterfowl population goals established in the NAWMP. Nearly all of the proposed CPT require current information on the wetlands and land cover for the primary waterfowl production areas. This information in the required digital format for input to the CPT is currently quite limited.

Ducks Unlimited, Inc. (DU) and DUC have, for many years, explored the use of satellite technology as a feasible means of gathering information on wetlands in digital format to enhance selection of their wetland project sites. In the late 1970s and early 1980s, DUC, working with the Laboratory for Applications of Remote Sensing at Purdue University, Interdisciplinary Systems Limited, and the Canada Centre for Remote Sensing, began using Landsat Multispectral Scanner (MSS) data to inventory wetlands in Canada (Neraasen et al. 1981, Barnard et al. 1981). DUC did not complete this inventory, due to limitations of this sensor and for other various reasons (Koeln et al. 1986).

In 1982, an improved earth-monitoring sensor, the Thematic Mapper (TM), was put into operation aboard the Landsat-4 satellite. In 1984, Landsat-5 was launched with another TM sensor. To determine the feasibility of using TM data for producing wetland inventories, DU funded a study conducted by the National Aeronautics and Space Agency (NASA) Earth Resources Laboratory. After favorable results were realized (Hill 1985), DU decided to utilize TM data to produce a wetland inventory and to monitor wetland changes in the future.

This paper (1) describes the areas for which we are initially producing a wetland inventory, (2) provides DU's wetland inventory requirements, (3) characterizes Landsat's TM, (4) highlights our specialized image processing procedures, (5) describes the products we produce from Landsat TM data, and (6) summarizes the benefits and limitations of using TM data for wetland inventories.

Study Area

Although DU, DUC, and Ducks Unlimited Mexico (DUMAC) are preserving, conserving and enhancing wetlands throughout North America, the majority of our work is done in the northern prairie, extending from South Dakota north to the boreal forests of Saskatchewan and Alberta. DU refers to our study area as the Primary Waterfowl Production Area (PWPA) because, in a typical year, more than 50 percent of all breeding ducks in North America nest in this region, which comprises less than 10 percent of the breeding range of waterfowl in North America (Crissey 1969 and Smith et al. 1964). Gollop (1964) estimated that this area—which, in part, is frequently referred to as the prairie pothole region—contains nearly 10 million glacially formed depressions of various size, depth and distribution. Throughout this paper, we will refer to these depressions as wetland basins or basins. From 1.5–6 million of these basins hold water each spring, depending on precipitation and frost patterns. Most of these basins are seasonal or temporary. Cooch (1969) estimated that, by midsummer, as few as 500,000 basins may contain water. Our study area is defined by 656 Canadian maps at a scale of 1:50,000 and nearly 1,500 U.S. maps at a scale of 1:24,000. Each Canadian map covers an area of 15 minutes of latitude by 30 minutes of longitude—an area roughly equal to 250,000 acres (101,000ha). Each U.S. map covers an area of 7.5 minutes of latitude and longitude, or an area of approximately 30,000 acres (12,000 ha). The total areal extent of the study area is roughly 350,000 square miles (900,000 km^2).

Wetland Inventory Requirements

Before initiating any type of natural resources inventory, the goals, objectives and requirements of the inventory must be fully enumerated. Many of the requirements of DU's inventory are listed below.

Wetland Classification

Any basins greater than 2 acres (0.8 ha) containing water should be detected; various wetland zones or types (e.g., deep marsh, shallow marsh, and open water) should be delineated. Ideally, the open water zone should be divided into alkali, turbid and freshwater classes.

Omission Errors

No basin greater than 25 acres (10.1 ha) should be omitted. For basins 6–25 (2.4–10.1 ha), fewer than 5 percent should be omitted. For basins 2–5 acres (0.8–2.0 ha), fewer than 15 percent should be omitted. A portion of small basins (less than 2 acres:0.8ha) should be detectable. No commission error should occur.

Areal Estimates

Errors in areal estimates for basins 2–5 acres (0.8–2.0 ha) should be less than 20 percent; errors for basins 6–25 acres (2.4–10.1 ha) should be less than 10 percent; and errors for basins greater than 25 acres (10.1 ha) should be less than 5 percent.

Registration Error

The location of each basin must be within 164 feet (50 m) of its actual location.

Perimeter and Shape Index

The perimeter for each basin and an index to the shape of each basin are required.

Maps

Maps at scales of 1:50,000 and 1:24,000 must be produced.

Wetland Data Bases

Data bases containing characteristics of each basin greater than 2 acres (0.8 ha) must be developed.

Quarter Section Analyses

For each quarter section (160-acre area:64.8 ha) of the public land survey, total number of basins, number of basins less than 2 acres (0.8 ha) which were detected and acres by wetland type need to be summarized and entered into a data base.

Cross-index

For each wetland basin greater than 2 acres (0.8 ha), cross-index records describing the quarter section or sections on which the basin occurs must be produced to facilitate the identification of basins in specific townships, sections or quarter sections.

Images

Color images in slide and print format, at scales from 1:24,000 to 1:240,000, are required for assisting ground reconnaissance, land cover photo interpretations, and demonstrations.

Change Detection

The capability of determining yearly and seasonal changes in size and abundance of the pond portion of the basins will be required.

Land Cover/Land Use

General land cover and land-use information summarized by quarter sections will be required.

Financial Constraints

Only a small portion of DU's conservation expenditures will be committed to wetland and upland inventories.

Completion Date

The initial wetland inventory for the study area must be completed and loaded into the data base by 1990.

Landsat Thematic Mapper

The Landsat-4 and Landsat-5 satellites orbit at a mean altitude of 438 miles (705 km), and cover the world after 233 orbits requiring 16 days. The near-polar orbit routinely collects data during the daylight part of the orbit as it travels from north to south. Along each orbital path, the satellite can continually scan a swath 115 miles wide. These scanned data are systematically divided into an area termed a "Landsat scene," which measures approximately 115 miles wide by 107 miles long (185 km by 172 km). Each scene covers approximately 8 million acres (3.2 million ha). The TM records six values of reflected light energy (visible to infrared) and one value of emitted thermal energy for each 100 by 100-foot (30 by 30 m) area (typically termed a "pixel") within the scene. Others have described the Landsat system and TM in great detail (USGS and NOAA 1984, Freden and Gordon 1983).

NASA developed the MSS and TM sensors and the National Oceanic and Atmospheric Administration (NOAA) operated the satellite until recently, when the Earth Observation Satellite Company (EOSAT) was contracted by the U.S. government to manage the Landsat system.

Image-Processing Procedures

DU has extensively modified NASA's image-processing software package ELAS (Earth Resources Laboratory Application Software) (Graham et al. 1985) to accommodate our full scene and wetland inventory image-processing requirements. Details on our standard image-processing procedures have been described (Koeln et al. 1986, 1987, Rude 1987). Two analyses, fairly unique to DU's wetland-inventory procedures, require sophisticated software and will be described.

Identifying the Wetland Basin

DU uses a connective components algorithm to identify every unique basin on each map within a Landsat scene. One connective component algorithm has been presented by Nichols (1981). As many as 32,767 wetland basins can be identified per map. The maximum number of wetlands encountered on a map to date was more than 17,000.

A basin is defined as all of the wetland pixels that adjoin one another. A basin can range from one wetland pixel to thousands of adjoining wetland pixels. Each basin is given a unique identifier within the computer data base, and for each basin, statistics are produced on the total area, area of each wetland type, the northwest Universal Transverse Mercator (UTM) coordinates, basin perimeter and basin shape index.

Quarter Section Analyses

The second unique analysis technique involves summarizing the wetland statistics by quarter sections. Each quarter section is approximately 160 acres (64.8 ha).

Currently, digital coordinates for all 1,100,648 quarter sections have only been acquired for the Canadian portion of the study area. For each quarter section, the acreage of each wetland type is being computed, as is the number of wetland basins. In addition, a record for each basin greater than 2 acres (0.8 ha) is created for each quarter section in which the basin occurs. By using these cross-index records, basin specific information can be retrieved by quarter sections, sections or townships.

Both the connective component and the quarter section analysis techniques are useful for obtaining critical wetland information for use in the CPT for the NAWMP. This is true whether the wetland information is obtained from analyses of satellite data or from digitizing wetlands identified on aerial photographs. Digital data from the U.S. Fish and Wildlife Service's National Wetland Inventory can be analyzed readily by these techniques.

Wetland Inventory Products

Various maps or map-like color images are generated from the Landsat scenes. Using a digital film recorder, TM Bands 3, 4 and 5 are imaged to blue, red and green, respectively, to generate quarter scene images (2 million acres:800,000 ha) that simulate color infrared photography. These images are printed at a scale of approximately 1:240,000 and provide a reconnaissance tool for large regions. Even basins less than 2 acres (0.8 ha) are readily detectable on these images. In a similar manner, TM data for each map is being recorded on 35mm slide film.

Other useful reconnaissance tools produced are gray-tone maps of TM Band 5 data that are plotted at scales of 1:50,000 for Canadian maps or 1:24,000 for U.S. maps. From these Band 5 maps, basins can be delineated as well as field borders and general land use. Wetland maps at the same scales are produced on translucent paper and show wetland types as different gray-tone patterns. This map product can overlay onto the Band 5 maps or any published map for enhanced interpretation of the current wetland conditions. A label map that has each basin's (greater than 2 acres:0.8 ha) unique identifier number, is also produced on translucent paper and designed to overlay onto the wetland map. The wetland statistics produced for any of these basins can be reported given the unique basin number.

The primary reason DU chose to use TM data for producing a wetland inventory was for the creation of digital wetland data bases. Various data bases are being produced. Three of the wetland data bases are the Wetland Basins File, the Quarter Section Land Use File, and the Basin Identification/Land Key Cross Index File. Currently, we are producing the Wetland Basins File from processing spring imagery alone. Ideally, data for this data base will eventually be derived from coprocessing both spring and summer Landsat TM scenes. The spring data represent near maximum water levels for the basin, while summer data are used to determine a water permanency index for each basin. The Wetland Basins File contains data for only those basins greater than 2 acres (0.8 ha). The type of information within this file includes the map name, basin identification number, UTM zone and coordinates, and the statistics produced for each basin, as described earlier.

Currently, only wetland information is being loaded into the Quarter Section Land Use File. For each quarter section, the following information is being recorded: the meridian, tier, range, section and quarter section number; total acres of wetland occurring in the quarter section; acres of various wetland types (e.g., open water, deep marsh, shallow marsh); total number of wetland basins in the quarter section; and number of wetland basins less than 2 acres (0.8 ha) found on the quarter section. In the future, acres of various land-use types occurring on the quarter section will be added to this file.

The Basin Identification/Land Key Cross Index File contains records used to identify the quarter sections on which specific basins occur. Each record in this file identifies the quarter section and basin identification number. For each basin, the number of records in this file is equal to the number of quarter sections on which the basin occurs.

By use of these data bases, various questions important for future waterfowl management planning can readily be addressed. A few examples of the wide range of inquiries to the data bases are:

1. In Saskatchewan, which five map sheets contain the greatest amount of deep marsh and shallow marsh?
2. Of the 1,500 quarter sections on a Canadian map sheet, which are the 50 quarter sections with the greatest number of basins less than 2 acres (0.8 ha)?
3. Which sections in Saskatchewan have one or more wetland basins greater than 50 acres (20.2ha)?

The initial data base will be completed by 1990 for the entire study area.

Conclusion

We have found that using Landsat TM data had greatly improved the accuracies of our wetland inventory, as compared with the use of Landsat MSS data. The major problems encountered in using MSS data (Koeln et al. 1986) have largely been resolved by using TM data. The accuracies of our wetland classifications have been good, but slightly less than the ambitious requirements previously listed. Jacobson et al. (1987) compared the wetland basins detected by the DU wetland classification of TM data with the basins identified on wetland maps prepared by the U.S. Fish and Wildlife Service's National Wetland Inventory. Seventy percent of the basins between 2 and 5 acres (0.8 and 2.0 ha) were detected by TM data; 91 percent of the basins between 5 and 10 acres (2.0 and 4.0 ha) were detected; 96 percent of the basins between 10 and 25 acres (4.0 and 10.1 ha) were detected; and all basins greater than 25 acres (10.1 ha) were detected. Manual editing of the DU wetland classification would have allowed a greater number of smaller basins to be detected.

DU has found the following benefits in using Landsat TM data for wetland inventories:

- provides views of large regions;
- facilitates the creation of wetland data bases or geographic information systems required for waterfowl management planning;
- economical at a cost of less than 0.1 cent per acre (0.25 cent per ha) for the data alone, and total processing costs at 0.4 cent per acre (0.99 cent per ha);
- repeat satellite coverage facilitates monitoring seasonal or yearly changes; and
- mid-infrared bands of TM data offer improvement in wetland detection over data from the MSS or similar spectral range sensors.

DU has found the following limitations in the use of Landsat TM data for wetland inventories:

- lack of accuracy and detail in defining various wetland types when compared with aerial photography;
- emergent vegetation growing in dry basins is difficult to separate from some upland vegetation types;
- wetland basins less than 2 acres (0.8 ha) are difficult to detect;
- cloud, cloud shadow and, in areas of high relief, terrain shadows will cause similar spectral signatures to occur for different land cover types;
- weather conditions may preclude data acquisition on desired dates;
- the TM sensor on Landsat-5 could fail and TM data would not be collected until Landsat-6 is launched;
- it is unlikely that a replacement satellite for Landsat-5 will be launched before the TM sensor on the Landsat-5 satellite fails; and
- U.S. government funds for the development and launch of future satellite remote sensing systems may not be available.

DU feels that TM data can be used to inventory wetlands successfully, especially when digital data bases are required. In our efforts, TM data analyses are proving to be the most economical method, in terms of time and money, of obtaining wetland information over a large area. Unfortunately, the uncertain future of the Landsat program will probably discourage potential users from investing in technical personnel and equipment to process this type of data. It is our hope that the Landsat program will continue to benefit the many different professions that it has in its 16-year history.

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Fisheries Habitat Restoration Within Water Resources Development: An Innovative Approach

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Introduction

This paper describes a three-year Pilot Study being conducted jointly by the National Marine Fisheries Service (NMFS) and the U.S. Army Corps of Engineers (Corps).[1] The study came about as the result of a 1985 agreement between the Administrator, National Oceanic and Atmospheric Administration (NOAA), and the Assistant SEcretary of the Army For Civil Works. Now in its third year, the Pilot Study was designed to test the cooperative abilities of our two agencies to restore and create fisheries habitats, while operating within existing resources, authorities and capabilities. Findings will be used to evaluate the practicability of a nationwide, interagency program of fisheries habitat restoration and creation.

In this special session, we have been asked to address new dimensions in water resources planning, development and management. Of particular importance to marine fisheries is the net loss each year of marine and estuarine habitats due to wetlands destruction, acid rain, nonpoint and point discharges, eutrophication, waste dumps, and other causes. Despite our efforts in planning, protection and preservation, human population growth and development in coastal areas continue to impart this net loss. Programs of protection and preservation, while vital and in need of expansion, are only part of the answer. We can either acquiesce to the inevitable net habitat losses or pursue alternatives that will routinely restore them.[2]

One alternative would be the establishment of programs to carry out habitat restoration and creation systematically along our coasts and rivers. Careful consideration of this approach is appropriate, since in an increasing number of cases, the technology, authorities and funding requirements have been judged adequate, and specific restoration projects are in place or underway. In other instances, serious consideration of identified restoration opportunities are constrained by: prohibitive costs; inadequate state, local or federal authorities; inability to guarantee success; difficulty of quantifying benefits; and/or political objections.

Five general questions relate to the feasibility of larger scale, systematic habitat-restoration programs.

[1]Based on the report, ''First Year Assessment: National Marine Fisheries Service-Corps of Engineers Pilot Study to Determine the Feasibility of Establishing a Nationwide Fisheries Habitat Restoration and Creation Program,'' September 1987.

[2]Restoration, as described in this paper, is decidedly different from that designed for mitigation in coastal development projects (i.e., through permit and license application processes). The former results from opportunities identified in the ongoing operation and maintenance of water resource projects and, when implemented, results in a *net increase* of habitat. The latter is designed to mitigate the adverse impacts of proposed individual water development projects and, almost invariably, is accompanied with a *net loss* of habitat.

1. Do restoration opportunities exist in sufficient abundance and quality to make a difference?
2. Is the state of the art for restoring an creating habitats sufficiently advanced to permit significant restoration of productivity?
3. Are there adequate government authorities and programs to plan and implement large numbers of restoration projects?
4. How well are we able to measure the success of restoration projects and assess their benefits?
5. What would be the costs associated with such programs?

Under the Pilot Study, NMFS and the Corps are addressing these questions cooperatively. This three-year effort was designed to assess: the process of identification and selection of three to six specific restoration and creation sites; planning, design, construction and maintenance of selected measures at these sites; and the restoration progress accomplished within the study period. It will also asses the cost effectiveness of the restoration and creation measures and the success of institutional arrangements required with affected federal, regional, state and local agencies.

Origin

The Pilot Study came about as the result of 1984 discussions between the NMFS Southeast Regional Director, Mr. Jack T. Brawner, and the Corps South Atlantic Division Commander, Brigadier General Forrest Gay III. They envisioned the possibility of a nationally funded, interagency habitat-restoration program that would involve NMFS, the Corps, and other agencies and organizations. Once established by law, the program would systematically identify habitat restoration opportunities in coastal areas and fund implementation of plans to restore fishery production.

The concept was brought to the attention of Washington, D.C. officials of both agencies. The legislative approach was replaced subsequently with the smaller scale pilot approach designed to test the feasibility of a national program. The resulting Agreement was signed in October 1985 by Robert Dawson, the Acting Assistant Secretary of the Army for Civil Works and Anthony J. Calio, the NOAA Administrator.

Design

During January 1986, the Southeast and Southwest regions were selected as the geographic areas for conduct of the Pilot Study. Implementation was assigned to the NMFS regions and research centers and the Corps divisions and districts in these two regions. Involved staff were asked to select, in cooperation with states and other involved third-party agencies and interests, one to three restoration or creation sites in each region. Subsequent planning, engineering, design and construction at the selected sites were to be a combined NMFS/Corps venture.

Progress

Start-up and selection of the one to three sties involved a significant work effort. Overall, the process involved 12 NMFS offices, 15 Corps divisions and districts, and the Corps Waterways Experiment Station. Field progress reports from both agencies cited a high degree of NMFS/Corps interagency cooperation.

From the outset, it was recognized that success would depend on the support of other agencies and parties (e.g., state fish and wildlife, permitting, and/or licensing agencies, and the U.S. Fish and Wildlife Service). The need to obtain and maintain this support has been emphasized at every stage. In practice, other agencies were found to be generally supportive of the Pilot Study. Altogether, 42 federal, state, and other agencies and parties participated at one point or another in the selection process. Their inputs came in form of official and unofficial approval, review, technical support, consultation and/or liaison.

Assigned NMFS/Corps staff in each region faced a difficult task in working toward the national target of six projects. They reviewed Corps projects over the California coast and, in the Southeast, multistate areas for viable restoration opportunities. In reviewing 45 potential sites (i.e., 32 in the Southeast and 13 in the Southwest), the staff considered: (a) unique site and resource conditions; (b) design and construction requirements; and (c) the likelihood of success. Potential projects included those for marsh restoration and creation, oyster bar creation, sea turtle habitat creation, shallow water enhancement, artificial reef creation, water control regulation for shrimp passage, improved water circulation for oysters, and water flow modification techniques to improve salmon migration.

Major factors instrumental in pruning down the list were cost, third-party objections, compatibility with Corps project scheduling and adequacy of authorities. Project costs for the purchase and construction of restoration features (e.g., channels, revetments, artificial reefs and wetlands) eliminated 13 projects, while operational costs (e.g., manpower, travel, planning, research and monitoring) reduced the list by 10. Twenty were eliminated because Corps project work was not scheduled within the three-year Pilot Study period. Third-party objections eliminated three, while three more were eliminated because of questions about the applicability of Corps authorities.

Four projects were submitted by the field. Approval was given by the Assistant Secretary of the Army For Civil Works on September 23, 1986, to proceed with actual implementation on three and with additional review on the fourth. Diverse in terms of both proposed habitat modifications and impacted fisheries resources, each of the four are described briefly in the following sections.

Disposal Site Vegetation—North Carolina

Portions of two Atlantic Intercoastal Waterway dredged material disposal islands at New River and Bogue Inlets and one at Harkers Island have been redesigned and planted with saltmarsh cordgrass, eelgrass and shoal grass. These two areas are exposed to persistent erosion from boat wakes, while the third experiences erosion from wind-driven waves. Work involved grading portions of the existing dredged material disposal sites, and planting slopes and intertidal ares with emergent and submergent vegetation. The objectives are to enhance sediment stabilization and create nursery habitat for shrimp, blue crabs, flounder, sea trout and menhaden. Construction work was completed in 1987 and monitoring is now underway.

Participants include the NMFS Southeast Center and Region, the Corps South Atlantic Division and Wilmington District, the Waterways Experiment Station, and North Carolina State University.

Disposal Site Vegetation—Texas

During 1987, saltmarsh creation work was carried out at the Chocolate Bay and Pelican Island disposal sites along the Gulf Intercoastal Waterway. Prior to planting with cordgrass, interconnected channels were dug in the deposits to improve water circulation and fish and shellfish access. The work is designed to demonstrate whether productive salt marshes can be established on recently dredged material. To be successful, the projects should clearly show increased production of juvenile brown shrimp, spotted sea trout and southern flounder. Monitoring efforts are underway.

Participants include the NMFS Southeast Region and Center, the Corps Southwestern Division and Galveston District, the Waterways Experiment Station, and the State of Texas.

Reef Habitat Construction—California

During September 1987, a series of boulder clusters as placed on relatively low value, shifting littoral sand and habitat adjacent to the toe of the Mission Bay Jetty. The project is located near the mouth of the San Diego River. The boulder clusters, consisting of 11–18-ton stones, are located about 50–100 feet from the jetty toe.

This work was conducted as part of repair work resulting from 1986 winter storm damage to the outer 100 feet of the northern jetty. In addition to the repair work and the fisheries benefits, the Corps is testing the effectiveness of placing a series of boulder clusters parallel to the toe of the jetty to reduce scouring and accompanying jetty damage. The rock structures would replace existing sand bottom habitat with a structure, which ought to attract kelp bass, sheephead, white surfperch, opaleye, brown rockfish, cabezon, and such invertebrates as crab and lobster. Monitoring has been hindered by poor water visibility, but is to continue on a quarterly basis for at least one year.

Participants include the NMFS Southwest Region and Center, the Corps South Pacific Division and Los Angeles District, the Waterways Experiment Station, the U.S. Fish and Wildlife Service, the California Department of Fish and Game, and the California Coastal Commission.

Conversion of Farmland to Wetlands—California

An effort is underway to convert 1,276 acres (516.4 ha) of leveed, fallow agricultural land adjacent to the Sacramento River to wetlands. Under current plans, the Corps plans to purchase a fee interest to the privately owned agricultural land and breach the levees, thus converting this significant block to wetlands and open water habitat. The title will be transferred to the California Department of Fish and Game.

Conversion will be accompanied with construction of tidal channels and plating of selected wetland vegetation. Once established, the area should enhance delta productivity by contributing organic detritus and food organisms. Benefits are expected for striped bass, steelhead trout, chinook salmon, American shad, freshwater fish species and waterfowl.

Participants include the NMFS Southwest Region, the Corps South Pacific Division and Sacramento District, the U.S. Fish and Wildlife Service, an the California Department of Fish and Game.

Summary and Conclusions

With less than one year to go, the Pilot Study has yielded four habitat-restoration projects that are in place or well-underway. In arriving at these projects, the process has exhibited: (1) a concerted NMFS/Corps commitment testing our interagency cooperative capacity to restore and create fisheries habitats; and (2) positive support and active participation by the part of state resource agencies and other third parties.

The results of the three-year effort will be jointly assessed with respect to the feasibility of a broader, continuing program. A final report, including recommendations, will be forwarded to the Assistant Secretary of the Army for Civil Works and the NOAA Under Secretary.

Beneficial Uses of Dredged Material: A Strategic Dimension of Water Resource Management

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Introduction

The U. S. Army Corps of Engineers (CE) has been increasingly involved for a number of years in wildlife and fish habitat development and enhancement and water resource management of both CE-owned and leased properties. This dimension of the its authority includes ownership of more than 19 million acres (7,695,000 ha), and many thousands of acres for dredged material disposal or other mission-related activities. Maintenance of the nation's navigation channels within rivers and harbors is a major CE responsibility, and dredged material placement is the agency's Number One problem with regard to the environment and any possible impacts of CE activities (Hatch 1987).

Dredging and the Water Resources Development Act

Current and future dredging is directly tied to the Water Resources Development Act of 1986 (WRDA), which includes the still-new concept of cost-sharing by local project sponsors. The WRDA has authorized a large number of port and harbor development projects that will involve the removal of approximately 1 billion additional cubic yards (764,600,000 m^3) of dredged material over the next decade (Hatch 1987). This figure does not include other types of water resource projects authorized by the WRDA, nor does it include routine maintenance dredging responsibilities, which amount to an average 365 million cubic yards (279.1 million m^3) annually. The CE is also responsible for the millions of cubic yards of dredging that are required for the U. S. Navy's Homeporting Program.

With such quantities of dredging necessary to provide for vital national interests of commerce and defense, the CE is making a concerted effort to incorporate beneficial uses of dredged material into every water resource project, both ongoing and proposed (U. S. Army Corps of Engineers 1986). Many of these will benefit wildlife and fisheries.

For example, one of the ways that dredged material is used beneficially for natural resources is for wetland nourishment and development at numerous locations (Landin 1986, 1987a). One project, the New Orleans Deepening and Widening Project, will use dredged material along the lower Mississippi River to build approximately 35,000 acres (14,175 ha) of salt marsh and to stabilize eroding shorelines (Gunn 1987). There are literally hundreds of examples of dredged material being used for natural resource enhancement in both coastal and inland waterways.

The CE Beneficial Uses Initiative

The CE is working closely with local and state project sponsors and with cooperating agencies and offices to ensure that beneficial uses are considered for dredged material placement sites. Through the development of a widely circulated Engineer Manual, *Dredged Material Beneficial Uses* (U. S. Army Corps of Engineers 1986), and a series of internationally attended technical workshops, the CE has taken its initiative to the public sector to encourage and advise project sponsors and agencies of ways that beneficial uses can enhance the environment, save taxpayers money and put a valuable resource back into production rather than treating it as a waste product (Landin and Smith 1987, Landin 1987b, 1988). The Engineer Manual was based on 15 years research on dredged material placement sites. The workshop series has featured different aspects of dredged material beneficial uses, such as inland rivers and lakes, coastal and marine habitats, the North Atlantic coast, and the northern Gulf Coast.

The CE/National Marine Fisheries Service Memorandum of Agreement, which will demonstrate that dredged material can be used to enhance marine habitats and increase fisheries production, is underway now at several sites on the Atlantic, Gulf and Pacific coasts. Preliminary talks have begun between the CE and the USDA Soil Conservation Service to determine ways these two agencies can cooperate on placement sites using plant materials and conservation techniques. Cooperative agreements have been developed on critical sites between the U. S. Fish and Wildlife SErvice and the CE, and with state agencies.

Long-term Management Strategies

The CE Director of Civil Works has issued a policy letter encouraging CE offices to develop regional, long-term, management strategies for dredging and dredged material placement that incorporate responsible and innovative uses of the material (Klesch 1987). In existing case studies, these uses already include such water resource-related features as waterbird nesting islands, seagrass habitats, wetlands development, nesting and grazing meadows, sea turtle nesting beaches, beach nourishment, aquaculture, mussel flats, oyster beds, wildlife management areas, and natural resource recreation (fishing, hunting, hiking, boating, bird watching, etc.) (Murden 1987).

Long-term management strategies (LTMS) for a given region (for example, Chesapeake Bay) would include development of a master plan and the establishment of a permanent interagency working group, and would incorporate periodic review and revision to allow for any environmental, physical or socioeconomic changes that may have taken place over time. These LTMS include water resource projects authorized under the WRDA and cost-sharing by project sponsors, and must each be approved at the Washington level. To date, Baltimore, Portland, Norfolk, Mobile, Seattle, Rock Island, St. Paul and Wilmington CE Districts have ongoing or upcoming LTMS plans for dredging regions. Wilmington District has had a working LTMS plan for the Cape Fear River for more than 10 years.

Case Studies

Four examples of the use of dredged material for natural resource development and enhancement will illustrate the kinds of habitat development that are possible, and that such beneficial uses are becoming routine within the CE. Two are multipurpose sites that include long-term site management, and two are relatively new aquatic habitat development sites in inland waterways. The techniques used at the four sites can apply to other, similar dredged material placement sites in the United States and Canada. Long-term monitoring has played a key role in documenting site success. These case studies are only a small sample of dredged material beneficial use sites developed by the CE.

Aquatic Habitat in the Tombigbee River, Mississippi

Background. Construction of the Tennessee-Tombigbee Waterway converted much of the free-flowing Tombigbee River into a series of run-of-the-river reservoirs with deep, slow-moving water and fine-grained substrate. Reservoir construction provided habitat for slack-water species at the expense of organisms that normally inhabit riffles and gravel substrate (McClure 1985). Prior to waterway development, the Tombigbee River supported a dense and diverse riverine fauna, including darters, minnows, snails, oligochaetes and aquatic insects. Selected reaches with gravel and sand substrate provided habitat for freshwater mussels, many of which were commercially harvested.

In March 1985, the Mobile CE District constructed two gravel bars in an abandoned channel of the Tombigbee River near Columbus, Mississippi. This project had two objectives: (1) to provide habitat for organisms that had been abundant in the Tombigbee River prior to construction of the Tennessee-Tombigbee Waterway; and (2) to develop guidelines for aquatic habitat rehabilitation or improvement in navigable waterways using dredged material.

Site selection and construction. The project site was an isolated reach of the Tombigbee River blocked in 1981 by construction of Columbus Lock and Dam. An upstream minimum-flow release structure with a maximum capacity of 200 cfs (5.6 cms) removes surface water from Columbus Lake and sends it down a riprapped flume into the upper end of the 20-foot (6 m) deep, clay-bottomed channel.

To meet the objectives of this project, it was necessary to increase water velocity, decrease water depth and provide suitable substrate for riffle-inhabiting species. This was accomplished by constricting the channel with dredged material (sand and silt) brought in by barge. A clamshell dredge was used to fill a 394-foot reach (120 m) of the channel to an elevation of 130 feet msl, which is about 6.5 feet (2 m) below normal water level. This fill was then capped with 25,000 cubic yards (19,115 m^3) of 0.08- to 3.1-inch (2–80 mm) coarse sand and gravel.

The gravel created two exposed bars, with a riffle or channel down the center of each. Both riffles are 150.9 feet long by 78.7 feet wide (46 by 24 m) and have a maximum depth of 3.9 feet (1.2 m). The fill constricts the channel cross section, and causes a velocity of approximately 1.5 feet per second (45 cm/sec), which is sufficient to remove excess sediment but not erode the gravel. At high discharge, the entire habitat, including the normally exposed gravel bars, is covered with backwater from the Tennessee-Tombigbee Waterway. When flood levels recede, the water is again restricted to the channels, and velocity returns to 1.5 feet per second (45 cm/sec).

Macroinvertebrates. Macroinvertebrate colonization at the new habitat was rapid. Four months after construction (June 1985), 19 and 21 taxa, respectively, were found in the first and second riffles. Samples collected in June 1986 contained 25 and 24 taxa, which was not substantially different from 1985. Macroinvertebrate species richness, total density and biomass were greater in the fall than the spring, a phenomenon of life history strategies.

Significant density differences existed between June and October of each year, although there were no differences between years for each season. These data indicate that the riffles had been colonized by the majority of the invertebrates within the first few months of construction. Total invertebrate biomass values were similar in June of each year. However, total biomass in October 1986 was significantly greater than in October 1985.

Immediately after construction, immature flies of the family Chironomidae dominated. Throughout the study the density of chironomids was approximately the same; however, their percentage composition declined in comparison to aquatic worms and bivalves, which consisted mainly of *Corbicula fluminea*. By October 1986, bivalves had increased, and because of their large size, were the dominant component of the biomass.

Fish. Forty-two species of fishes were collected during four sampling periods—39 were found at the gravel bar and 25 were found in the river channel immediately below the habitat. The crystal darter (*Ammocrypta asprella*), listed as endangered by the State of Mississippi, and the blue sucker (*Cycleptus elongatus*), considered to be uncommon in the Tombigbee River, were two important species. Dominant species in the pool and the riffles included gizzard shad (*Dorosoma cepedianum*), threadfin shad (*D. petenense*), bluegill, (*Lepomis macrochirus*), largemouth bass, (*Micropterus salmoides*), bullhead minnow (*Pimephales vigilax*), white crappie (*Pomoxis annularis*), and orange spotted sunfish (*Lepomis humilis*).

Total fish density at the gravel bar was 2,841.6 fish per acre (1,150 fish/ha) in December 1985, and 7,148.6 fish per acre (2,893 fish/ha) in May 1986. These densities are lower than expected (8,045.6–41,315.1 fish per acre, 3,256–16,720 fish/ha) in large natural streams with riffles (Kelly et al. 1981, Schlosser 1985) but are similar to smaller streams with pool-riffle sequences.

Aquatic Habitat in the Lower Ohio River, Kentucky

Background. In December 1980, a grain company near Mound City, Illinois, applied to the Louisville CE District for a permit to dredge an access to their barge-loading facility. As part of the permit evaluation, a mussel survey was conducted. A species of concern known to inhabit this river reach is the endangered orange-footed pimpleback (*Plethobasus cooperianus* Lea) (Williams 1969, Miller et al. 1986).

During a period of extremely low water in autumn 1983, the grain company had to dredge an access channel to its loading facility, although no permit had been granted. This killed an unknown number of common (although no endangered) mussels. As a result, the grain company was in violation of Sections 10 and 301 of the Clean Water Act. A series of measures to offset the damage to the mussel bed was considered, including construction of a boat ramp, providing funds to conduct mussel research in the Ohio River, eliminating or reducing sedimentation on the existing mussel bed, and constructing an experimental gravel bar for mussels.

In November 1984, the grain company agreed to construct an experimental gravel bar to compensate for damages. Since mussels are a valuable resource in large rivers and their habitat should be protected or created whenever possible, this project provided an opportunity to investigate techniques for constructing and monitoring artificially placed habitats. The gravel bar had to be located at a suitable site outside the navigation channel where no live mussels were found. Gravel was placed in the river in August 1986.

Site selection and size. The site was located on the Kentucky side of the Ohio River across from Mount City, Illinois (RM 972), on an exposed shoal built of maintenance dredged material. At low flow, water behind the shoal ranges from 9.8 to 13.1 feet (3 to 4 m) deep, which is suitable for mussels and other benthic organisms. Based on collections made in 1984, the exotic Asiatic clam *Corbicula fluminea* Muller dominated. Intensive searches, using a brail and divers, yielded only three native mussles—one ebonyshell (*Fusconaia ebena* Lea) and two pink heelsplitters (*Potamilus alatus* Say). Although optimal mussel habitat usually consists of gravel and sand, this shoal was primarily coarse sand.

Bottom water velocity at the selected site ranged from 7.9–12.9 inches per second (20–33 cm/sec) during low flow, which is sufficient to keep the substrate free of fine sediment. Presence of Asiatic clams and a few larger mussels indicated that high current velocities do not disrupt the substrate. The site was outside the navigation channel and was protected from river traffic. It was decided that the gravel bar should measure at least 500 feet long by 100 feet wide (152.4 by 30.5 m). A structure this size would be large enough to be found easily by divers, and provided sufficient habitat for mussels and other macroinvertebrates. Enough material was obtained to make the bar at least 9.8 inches (25 cm) thick. Most aquatic insects live in the top 1.9 inches (5 cm) of substrate, and freshwater mussels are usually in the upper 5.9 inches (15 cm).

Construction details A 10.8-inch (27.5 cm) diameter hydraulic dredge pipe and suction created by a 355-horsepower engine was used to pump 2,500 cubic yards (1,911.5 m^3) of gravel from the main channel. Material was sieved through a 0.37-inch (9.4 mm) mesh screen, and only the coarse sediment was retained. Since sand was the predominant sediment at the proposed site, only coarse material was used for the habitat.

Bouys were set at 150-feet (45.7 m) intervals along the landward side of the site. A tug was used to keep the crane barge and the materials barge in position throughout the operation and to position the barge as it spread gravel. Each 150-foot (45.7 m) bar section required one bargeload of gravel (600 cubic yards: 459 m^3). Work proceeded downriver so that propeller wash from the tug would not disturb the newly placed gravel. It took 4–hours to position and unload a single barge, and four bargeloads of gravel were used.

After all gravel had been spread, divers measured the dimensions of the bar, secured a reference cable down the center of the habitat, and collected substrate samples with a hand-held corer. The bar was 1.2–29.5 inches (3–75 cm) thick and about 100 feet wide by 500 feet long (30.5 by 152.4 m). the top 5.9 inches (15 cm) of substrate contained approximately the same size distribution of sand and gravel. An even, vertical distribution of particles was achieved by having the crane operator open the clam-shell bucket slowly and spread the material in layers.

Physical and biological conditions at this habitat site will be monitored over the next four years. Samples will be collected to analyze sediment particle size distribution and composition of the invertebrate community, and to determine if mussels are recolonizing the habitat naturally.

Habitat Development and Restoration at Pointe Mouillee, Michigan

Background Prior to the 1950s, Pointe Mouillee State Game Area was one of the finest freshwater marshes and recreational fishing and waterfowl hunting areas in the Great Lakes, and is becoming so again. Record lake levels and severe erosion had reduced the 4,600-acre (1,863 ha) site to a primarily highly wave-impacted, open water area, and completely removed a barrier island that had originally protected the site.

Through a mutual need and cooperative effort, the Detroit CE District and the Michigan Department of Natural Resources (MDNR) agreed to build a 900-acre (365 ha), confined disposal facility in the configuration and location of the old barrier island, with crossdikes at each end leading to the shoreline. The CE financed construction costs, while the MDNR agreed to provide all natural resource management. The project has a number of objectives. However, the primary ones were to: (1) to protect and stabilize the wetlands and shoreline inside the state wildlife area; (2) reestablish the marsh through encouragement of sedimentation and plant colonization; (3) establish a multi-use recreational site on both the confined disposal facility and the wildlife area (visitors center, waterfowl and small game hunting, fishing, boating, bird watching, hiking, jogging, etc.); and (4) provide a place to dispose of maintenance dredged material from the shipping channels in the Huron and Flynt Rivers and western Lake Erie (Landin 1982).

To accomplish these objectives as efficiently and as cost-effectively as possible, a draft long-term management plan for the site was drawn up while construction was underway (Landin 1984). Such features as gated culverts to allow for water to flow-through the marsh, access crossdikes, dredged material island formation within the marsh for nesting waterfowl, and intensive wildlife management were incorporated. The potential impacts of the construction activities and dredged material placement were examined (MDNR 1979).

Monitoring and management. Monitoring of this site has not been extensive; however, wildlife and vegetation data have been collected since 1979, and trends in plant, animal and human use of the site have been established. Interviews with fishermen and other site users have been conducted. Construction of the confined disposal facility and the crossdikes was completed in 1983, and water quality and contaminant monitoring has been conducted.

The MDNR carries out a year-round schedule of recreational and management activities at Pointe Mouillee. For example, wildlife area employees plant extensive food crops for migratory waterfowl and resident wildlife at Pointe Mouillee. They have established trails, fishing piers, picnic facilities, a visitors center, a marina, and hiking and jogging areas on the dredged material site. Vehicular access is limited for safety and to provide higher quality visitor experiences. The MDNR intends at some points to fluctuate water levels for vegetation manipulation within the marsh, and to provide more fishing and day-use facilities, such as additional picnicking and hiking areas.

Current and anticipated benefits of the site. Monitoring and interviews at the 4,600-acre (1,863 ha) site have shown that: (1) as soon as it is placed, the dredged material is colonizing with herbaceous vegetation with both wetland and upland plant species, primarily with cattail (*Typha latifolia*) and common reed (*Phragmites australis*); (2) the site is receiving ever-increasing, year-round wildlife and fisheries use by resident, migratory and nesting species; (3) the site is finding wide acceptance by local and regional citizens for recreational purposes; (4) the disposal facility is carrying out its purpose of holding maintenance dredged material as intended, is an ongoing activity, and has many years' life left for additional material placement; (5) emergent marsh vegetation is slowly increasing inside the eroded wetland portion of the wildlife area, but is not as dense as anticipated due to continued record-high lake levels; and (6) contaminants were not found to be a problem due to leaching from the top layers of upland soils in the facility and to the relative stability of contaminants in wetland soil conditions. Year-round fishing, including ice fishing, is very popular at Pointe Mouillee, and bird-watching clubs from three states and Ontario regularly congregate at the mud flats, marshes and dike areas of the disposal facility due to the very high species diversity, especially during migration. Waterfowl events such as duck-calling and decoy-carving contests are held annually, and fishing events are held in the summers.

Actual monitoring has resulted in the observation over time of some 145 birds species using Pointe Mouillee, and year-round mammal residents include beavers (*Castor canadensis*), muskrats (*Ondatra zibethica*), woodchucks (*Marmota monax*), occasional white-tailed deer (*Odocoileus virginianus*), eastern cottontails (*Sylvilagus floridanus*) and others. Black-crowned night herons (*Nycticorax nycticorax*) and herring (*Larus argentatus*) and ring-billed (*L. delewarensis*) gulls now nest in colonies at Pointe Mouillee.

Beneficial uses of the confined disposal facility and wildlife area at Pointe Mouillee are varied, and the quality of the habitat and the recreational experience is expected to increase over time.

Island Development at Gaillard Island, Mobile Bay, Alabama

Background. To fulfill the need for a placement site for dredged material in lower Mobile Bay, Gaillard Island, a 1,300-acre (527 ha), three-sided, confined disposal facility was built in 1980–81, with hydraulically placed, gently sloping dikes. The island was built in an area of relatively low benthic productivity and replaced bay bottom habitat with a combination of island, wetland and upland habitats. Wave and wind erosion affect all sides of the island, and the shorelines have been protected by a combination of salt marsh plantings and stone armoring. A large, ungated weir was installed to allow intertidal flow into a 700-acre (284 ha) containment pond.

The island has been monitored by the CE for wildlife and plant colonization and success since 1981. A LTMS is being prepared for the island, and a permanent interagency working group has been established. The U. S. Navy is now using the island to hold new-work and maintenance dredged material from its Homeporting site in Mobile Bay, in addition to CE maintenance dredged material. The island originally had a projected life of 50–80 years, depending on the level and intensity of management; however, with unanticipated uses, such as Homeporting, the island will be filled in less time, and the containment pond will become a part of the island upland.

Island wildlife. Even before construction of the island was completed, seabirds were congregating and nesting on the dikes. Each year since 1984, 16,000–25,000 seabirds have nested there (Landin 1987c). This is not an unusual event for dredged material islands, and such rapid colonization has occurred at numerous other dredged material sites (Soots and Landin 1978). However, it is a first for Mobile Bay. Primary colonial nesting seabirds now using the island are seven species of terns (*Sterna* spp.), black skimmers (*Rynchops niger*), laughing gulls (*Larus atricilla*) and brown pelicans (*Pelecanus occidentalis*). Black-necked stilts (*Himantopus mexicanus*), clapper rails (*Rallus longirostris*) and 13 other species also nest there in increasing numbers each year as vegetation on the island increases.

One of the most remarkable occurrences on Gaillard Island has been the colonization and nesting by brown pelicans, which began to nest on the island in 1983. This was the first recorded nesting of brown pelicans in Alabama in the 20the century, and in 1987, more than 1,500 brown pelicans were using the island, with 331 successful nests.

Vegetation. In 1981, the CE began a series of tests combining wetland plantings with temporary breakwaters and erosion-control features to determine if moderate wave-energy areas such as the dikes of Gaillard Island could be stabilized with vegetation, rather than with engineering structures such as riprap (Allen et al. 1984). Smooth cordgrass (*Spartina alterniflora*) sprigs were planted behind floating tire breakwaters, in erosion-control matting, plant rolls and several other biocontrol experiments.

Cordgrass established best in treatments using well-anchored erosion-control mat and plant rolls embedded horizontal to the tidal action along the dredged material beach. On the northwest dike, approximately 35 acres (14.2 ha) of cordgrass have established and are spreading. Behind these intertidal plantings, swales have formed from sand trapped by the cordgrass. The brackish swales have colonized with salt-meadow cordgrass (*Spartina patens*), American three-square (*Scirpus americanus*), saltmarsh bulrush (*Scirpus robustus*), cattail (*Typha latifolia*) and other high marsh species. Muskrats and marsh-nesting birds are frequenting these swales as well as the interior borrow pits formed by the Mobile CE District during upgrading operations on low points in the dikes.

Efforts to establish wetland vegetation on the south dike have been less successful due to higher wave action and ship traffic. However, in protected coves on all three dikes, cordgrass is either remaining after planting or has colonized the cove. Analyses on wave action effects show that points along the beach and a straight beach configuration suffer the worst erosion, while an irregular configuration with protected coves allows the greatest establishment and growth of intertidal plants.

Anticipated changes and beneficial uses at Gaillard Island. The development and use of a LTMS for Gaillard Island will accomplish several objectives over the life of the dredged material site: (1) maximize life of the placement site; (2) allow for more efficient use by the CE and other agencies that have placement needs; and (3) allow for an acceptable arrangement whereby this ongoing placement site can continue to be used by large numbers of seabird for nesting, even as upgrading and dredging activities are taking place.

The CE believes that environmental and engineering activities are compatible at Gaillard Island, and projects that there will be increasing use of the island by more diverse wildlife and fish species. The CE provides protection via posting for seabird colonies on the island, and works through the news media to let the general public know about the seabirds' isolation requirements. Monitoring will continue on the island for a number of years, and these data will be used as a base for development of similar sites and to allow for better management and protection of the island.

Both Pointe Mouillee and Gaillard Island projects have been presented the U. S. Army's annual Environment Honor Award, in 1983 and 1985, respectively.

Summary

The CE is committed to the incorporation of beneficial uses of dredged material in every water resource project where they are practicable, and will continue to encourage such beneficial uses as habitat development, wetlands restoration, natural resource recreational opportunities, marine and freshwater fisheries enhancement, and beach nourishment. Hundreds of examples exist of beneficial uses, and four were presented in this paper as representative case studies.

With cost-sharing a reality of the WRDA, the CE is also encouraging cooperation by project sponsors in the consideration of beneficial uses in their projects. In the formation of permanent working groups for LTMS dredging regions and in its Memoranda of Agreements with agencies, the CE is stressing coordination and communication among the parties involved. The CE sees its water resource activities as a responsibility to the U. S. public and to the nation's resources.

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A Reconciliation of Water Markets and Public Trust Values in Western Water Policy

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Introduction

Western policy makers seek a framework in which traditional water demands can be accommodated and public trust values protected. Rapid population growth in the West is increasing municipal demands for water. At the same time, western courts have incorporated the public trust doctrine into western water law, requiring state policy makers to protect public trust values (including navigation, commerce, fisheries and wildlife) whenever reasonable. In addition, western legislatures have empowered state agencies to set minimum stream-flow standards to protect fisheries and recreational uses of water resources.

Rising water demands and emerging public trust values represent incompatible uses of existing supplies. Dwindling supplies of unappropriated surface water, disappearing federal funds and depleting groundwater aquifers preclude expanding the amount of water to satisfy all water demands. Yet this conflict between traditional uses and public trust values can be limited by water conservation and water reallocation. Water conservation can stretch existing supplies to serve more consumptive uses. Water reallocation can support economic growth by transferring water from low-valued to high-valued uses. By avoiding possible adverse effects of new water-development projects on the environment, conservation and reallocation can promote economic growth and protect the environment (Graff 1986).

Economists, lawyers and western legislatures have concluded that water markets can organize socially responsible water conservation and reallocation (Anderson 1986, Weatherford and Shupe 1986, *Water Strategist* 1987b). Voluntary negotiations among buyers and sellers can establish prices that provide current users with financial incentives to conserve water and voluntarily reallocate a portion of their supplies to new uses. As a result, crop patterns, irrigation techniques and consumption practices would reflect the increased value of water.

Water trades may conflict with the protection of public trust values, although the conflict need not be inevitable. Under western water law, only consumptive water use (the amount of diverted water not returned to the rive system) can be sold to buyers. (Johnson et al. 1981). In principle, therefore, trades unaccompanied by changes in the point-of-diversion leave instream flows undisturbed. Moving the diversion point upstream diminishes instream flow, but moving the diversion point downstream enhances instream flow (Anderson and Johnson 1986). To date, western states have not formulated clear policies on how administrative agencies should balance the economic development versus environmental effects of water trades when they review proposed water transfers.

This paper shows how the economic principles of property law can reconcile water markets with the protection of public trust values. To set the economic context, it reviews the forces prompting western legislatures to endorse water markets. To set the legal context, it describes key court decisions and statutes that instruct state water agencies to protect public trust values and instream flows. It then shows how the economic concepts of a reasonable nuisance and efficient damage remedies support a water rights administration scheme in which the state may reasonably enjoin the transfer of water to protect public trust values, provided private parties receive compensation for any water denied transfer.

Economic Principles of Property Law

Three principles guide the economic analysis of property law (Coase 1960, Posner 1986). They provide a framework to address the fundamental question raised about the relationship between water markets and public trust values—under what conditions and with what obligations can a buyer move a diversion point upstream and thereby reduce stream flow between the old and new diversion points?

The first principle notes the reciprocity of harms. It is impossible to conclude that only one party is responsible for the incompatible uses of resources. If the exercise of two unqualified rights creates a conflict, both parties are responsible. For example, the public trust values associated with instream flow and the economic interests of the diverters *jointly* create the conflict raised by a proposed change in diversion point. The conflict over the use of a stream would not exist without the presence of both interests. How should the rights of one or both parties be restricted to afford a reasonable balance between the interests served by both parties? The presence of the conflict *per se* provides no guidance on how to answer the question.

The reciprocity of harms principle need not be biased toward the protection of private interests against government regulation. Professor Sax (1975) has used this principle, expressed in terms of ''interdependencies'' in the use of private rights, to advocate that the government should be allowed to engage in a broader range of regulatory activities than allowed by other legal analyses of the taking clause of the U.S. Constitution. As discussed below, however, modern case law on the public trust doctrine does not require the subordination of private interests for the protection of public trust values.

The second principle states that rights should be defined in accordance with the structure of transactions costs—the costs of negotiation and enforcement of agreements among parties in light of the rights defined by the law. This principle acknowledges that legal proceedings have notorious difficulties in establishing the value of resources in alternative uses. As a result, the initial allocation of resources, as defined by legal rights, need not be the economically efficient allocation of resources (Calabresi and Melamed 1975). Therefore, legal rights should be assigned so that affected parties can negotiate a reallocation of resources with the least transaction cost. This principle assures that the final allocation of resources reflects a reasonable balance between affected parties, even if the legal rule was economically inefficient, without undue expenditures of resources to correct any economic inefficiencies inherent in property rules.

This second principle is not alien to western water law. Under the no-harm rule for water transfers, a diverter cannot transfer the portion of his water right that generates return flows used by other (including junior) appropriators (Getches 1984). If the no-harm rule were not adopted, then downstream water users reliant on return flows must constantly investigate whether their interests may be adversely affected by potential transfers under negotiation by other parties. Under the no-harm rule, buyers who seek to purchase more than the consumptive use associated with the original water diversion will approach downstream users to negotiate an agreement in which the downstream interests waive their right to the affected return flows. The no-harm rule reduces transactions costs because it economizes on the resources spent on identifying potential parties whose interests may be affected by a water transfer.

The third principle addresses the situation in which high transactions costs deter any subsequent bargaining among parties. It states that, if damages can be easily computed, allow one party to impair the interest of another party provided they pay damages. If damages are not easily computed, impose an injunction. Damage remedies are favored over injunctions because the court need not decide the efficient allocation of resources. The party with damage liability decides whether the use of its resource creates sufficient economic value to warrant the payment of damages. Only when significant problems stand in the way of damage remedies must the court decide the allocation of resources. In that situation, it must consider whether an injunction should be issued because some uses inflict harm on other parties greater than the economic value created for the resource owner.

In sum, different property rules can address a situation in which two interests conflict with each other. To design an efficient property rule, the analysis must consider the nature of the economic interests of the parties and the structure of transactions costs. Before applying these principles to the potential conflict between water markets and public trust values, discussion must consider the growing interest in water markets and the emergence of environmental values in western water law.

Growing Interest in Water Markets

Western states face potentially significant water supply problems (*Water Strategist* 1987c). The U.S. Bureau of Census forecasts that the West's population in the year 2000 will be 41.2 percent greater than in 1980. Population in Arizona, Nevada and Wyoming will more than double. The Pacific Northwest will grow at the West-wide average. The situation of the Upper Basin states is mixed—the population of Colorado, Idaho and Utah will grow faster than the West-wide average, while Montana and new Mexico will grow slower. Growth in the two most populous states, California and Texas, will be significant, at 29.3 and 45.8 percent, respectively. Oklahoma will have 30.4 percent more residents by the turn of the century. Only the Dakotas, Kansas and Nebraska are expected to experience modest population growth.

Statewide population growth understates the increased demand for urban water because there has also been a dramatic trend toward urbanization in all western states (*Water Strategist* 1987c). In 1960, only two-thirds of the West's population resided in urban areas. By 1980, 80.3 percent were urban residents. The shift in population was particularly strong in Arizona, Colorado, new Mexico, Nevada and Utah. Even though the U.S. Bureau of Census does not predict urbanization rates, it seems likely that the movement of population from rural to urban areas will continue unabated.

Rapid population growth and continued urbanization will change the distribution of western water. In 1980, agriculture accounted for 78.77 percent of water use in the western states, urban systems 7.39 percent, industry—through its own supplies—12.70 percent, and rural residents for their domestic purposes only 1.14 percent (*Water Strategist* 1987c). Only Nevada, Oklahoma and Texas deviate from the rule that agriculture dominates water use in the West; in all three states, self-supplied industrial water use plays an abnormally large role due to the importance of oil and gas and mining. With few remaining opportunities for water development, neither urban systems nor industry can draw on significant new supplies. Additional water must come from reduced water use by agriculture.

Without conservation and reallocation, the urban water supply problem will become serious. If per-capita urban water use were to remain constant over the next 20 years, urban water demands would grow as fast as urban population. Even if the urbanization rate did not increase (the most conservative assumption), urban water demands in the West would increase by 40 percent. If all state population growth settles in urban areas, urban demands would increase by 50 percent (*Water Strategist* 1987c). Without reallocation of supplies, significant shortages will develop in urban areas. Without water, population growth and economic development in cities will be far short of expectations.

The reallocations of enough water to meet urban demands will not cause widespread retrenchment of irrigated agriculture. Even without reductions in per-capita urban water use, the necessary reallocations will be modest for most western states (*Water Strategist* 1987c). West-wide, a 4–5 percent reduction in annual irrigation use would be required to meet the growth in urban water demand. Agriculture in five states (Arizona, Nevada, Oklahoma, Texas and Utah), however, would have to make larger percentage reductions. In absolute terms, about 6–8 million acre-feet must move annually from the country to the city. Texas and California would account for half, moving 2.5 million and 1.5 million acre-feet, respectively. Arizona and Utah would each move slightly less than one million acre feet. Colorado and Washington would transfer even less, about 0.5 million acre feet. Water reallocations in the other states would involve even smaller quantities.

While the quantities may be modest, water markets can ease the reallocation of water. With less water, agricultural areas must invest in water conservation, shift crop patterns and perhaps reduce irrigated acreage—adjustments that will cost them money and effort. But the cost of not transferring water to the city may be higher, both in terms of stifled economic growth and more frequent shortages. By relying on voluntarily negotiated transactions to organize water-management decisions, water markets would offer the following answers to the policy questions raised about conservation and reallocation of existing supplies:

1. *Q*: How would crop patterns be changed to save water? *A*: Farmers would shift crops to the extent that the value of the water saved exceeds any loss of farming income.
2. *Q*: How can investments in improved irrigation technology be financed? *A*: From the potential revenues received from the sale of conserved water.
3. *Q*: Would farmers invest in drip irrigation and other water-saving devices? *A*: To the extent that the revenues received from the sale of conserved water exceeded the cost of investment.
4. *Q*: How would conserved water be allocated? *A*: To the buyer who offered the highest price.

5. *Q*: Who benefits from conserved water? *A*: As established in negotiation, both buyer and seller benefit. Otherwise, neither would enter into an agreement.
6. *Q*: How would individuals who lose water be compensated, and by whom? *A*: Through the monies paid by the individuals and organizations who received the additional water.

The use of water markets is receiving growing support. The U.S. Supreme Court has declared water to be an "article of commerce" that knows no state boundaries.[1] The California Legislature has passed a series of bills that protect individual incentives to conserve and transfer water through negotiated agreements (Smith 1988). Legislative actions in other western states, including environmentally conscious Oregon, reflect a considered move toward greater freedom in trading water (*Water Strategist* 1987b). And the Western Governor's Policy Office has released a report that endorsed trade in water and called for state/federal cooperation in removing any impediments to water transfers that remain as legacies of past water policy (Driver 1986).

Emerging Environmental Values in Western Water Law

Western policy makers, of course, have trust obligations that require them to consider more than what promotes water trades. Traditionally, states have met that responsibility be devising water right regimes that enabled individuals to apply water to economically valuable uses (Hutchins 1971). By the early 1980s, however, statutes in more than half the western states had deemed water used for fish and wildlife and recreational purposes to be beneficial uses (Getches 1984). Recently, case law and statute law have broadened the meaning of that trust responsibility to include the effect of diversions and water use on public trust values, including minimum stream flows.

Public Trust Doctrine

In its famous, 1983, "Mono Lake" decision, the California Supreme Court identified a vital role for the *public trust doctrine* in western water policy.[2] The doctrine requires states to consider how their water policies affect public trust values and to protect them whenever reasonable. State water codes no longer have sole control over how water is used. The facts in the Mono Lake case and the court's reasoning place the ruling in its proper perspective.

In 1940, the City of Los Angeles received permission from the California Water Commission (predecessor to the State Water Resources Control Board) to divert virtually the entire flow of Mono Lake's feeder streams. The Commission reached its decision by relying on the "established policy of this state that the use of water for domestic purposes is the highest use of water," and therefore believed that it had no choice but to approve the diversion despite its potentially harmful environmental effects.[3] The California Supreme Court held that the Commission's judgment was in error because the public trust doctrine required the Commission to consider those adverse effects.

[1]*Sporhase* v. *Nebraska* 458 U.S. 941 (1982).

[2]*National Audubon Society* v. *Superior Court* 33 Cal. 3d 419 (1983).

[3]*Ibid.*, pp. 427–428.

The Court ruled that either state courts or the State Water Resources Control Board must reconsider the Commission's erroneous permit decision. It reasoned that "the state is not confined by past decisions and accordingly has the power to reconsider allocation decisions" in light of changing circumstances and societal values. The Court also held that grants of water rights or permits will be construed as subject to the public trust, unless the state Legislature explicitly deems otherwise. But the state can only relinquish its public trust responsibility if such action achieves the purpose of that responsibility. The Court will defer to legislative and administrative judgments about how economic development and public trust interests should be balanced, provided the Legislature or agency considered and was knowledgeable about the effect of its decision on public trust values.

In effect, the Court spurned past judicial interpretations of the public trust doctrine and the appropriative doctrine (Casey 1984). It required that review of water diversions balance the effect on the interests of the appropriator against the protection of public trust values. The Court concluded: "To embrace one system of thought and reject the other would lead to an unbalanced structure, one which would either decry as a breach of trust appropriations essential to the economic development of this state, or deny any duty to protect or even consider the values promoted by the public trust."

The public trust doctine is a broad mandate to consider public trust values rather than a rigid prescription to protect them. In fact, western courts in subsequent cases have upheld permits that have allocated water for economic-development purposes, even though public trust values were impaired (Water Strategist 1987a).

This decision conforms with the first two economic principles of property law. Following the principle of the reciprocity of harms, the Court rejected protecting the interests of water rights over public trust values, or public trust values over water rights. Given the nature of public trust values, the reliance on administrative review to balance the conflicting interests follows the principle of defining rights in accordance with the structure of transactions costs.

Since public trust values represent community interests, not individual interests, they can not be legitimately represented outside the realm of administrative procedures. With whom would a owner of a water right contract if he wished to purchase a waiver of public trust values? How could voluntary contributions fund the acquisition of water rights to protect public trust values when there are no means to exclude the nonpayers (see Graff 1986)? The intractable nature of these questions compels the balancing test outlined by the Court.

In effect, administrative review must decide what constitutes a reasonable or unreasonable nuisance. The use of a nuisance framework is supported by the Court's reasoning in the Mono Lake case. In deciding that the public trust doctrine can be applied to nonnavigable rivers, the California Supreme Court relied on two cases showing that California case law has not protected water rights when their use has created a public nuisance.[4]

[4]*Ibid.*, p. 436.

Instream Flow Legislation

Western legislatures have protected instream flows before the incorporation of the public trust doctrine into western water law. The most popular method involves reservation of unappropriated waters from future appropriation. Colorado allows state acquisition of water rights dedicated for maintenance of instream flows. Neither method has effectively protected minimum stream flows. The reservation method confines state actions to those streams not fully appropriated and, in any event, will result in junior rights that are ineffective in supplementing stream flows during dry period (Huffman 1984). While state acquisition programs can result in the purchase of senior rights to protect instream flows during dry periods, the administrative agency in Colorado has been reluctant to seek public monies for this purpose.

In crafting instream flow status, western legislatures have been cautious to avoid conflict with prior appropriative water rights. The approaches are illustrated by a brief review of statutes in California, Colorado, Montana and Oregon.

California. In passing the Wilderness and Scenic Rivers Act, the California Legislature declared that certain rivers possess extraordinary scenic, recreational, fishery and wilderness values. It found that the preservation of the designated rivers in their free-flowing condition was a reasonable and beneficial use of water.[5] The dedication of scenic rivers prevented future appropriations, but respected inplace private rights. In adding §5093.63 to the Public Resource Code, the Legislature stated that the Act does not "permit or require reservation, use, or taking of private property for scenic, fishery, wildlife, or recreational purposes, for inclusion in the system or for other public use, *without just compensation*" (emphasis added). The Legislature required the use of the power of eminent domain rather than police powers to protect wilderness and secenic rivers.

In 1985, the Legislature also extended the power of state agencies to impose streamflow requirements. The State Water Resources Control Board may now establish streamflow requirements to protect fish and wildlife as part of the conditions the Board attaches to water permits and licenses.[6] In making its decision, the Board must consider proposed streamflow requirements prepared by the Director of the California Department of Fish and Game, who may also propose revisions or modifications of the Board's streamflow requirements. The purpose of the proposed standards is to assure that the Board considers the effects of its water-permitting decisions on streamflows, because fish and wildlife resources "are important for the entire state and are inextricably linked to the continued economic viability of industries, such as the fishing industry."[7]

Colorado. In the Water Right Determination and Administration Act, the Colorado Legislature recognized the need to preserve the natural environment when it vested the Water Conservation Board with the power to appropriate or acquire water rights to maintain instream flows.[8] However, the Legislature adopted the following language

[5] Calif. Pub. Res. Code §5093.50.

[6] Calif. Ann. Water Code §1257.5.

[7] West's Ann. Calif. Pub. Res. Code §10000(c).

[8] 15 C.R.S. 37–92–102(3).

in assuring that protection of instream flows will not interfere with private rights: "Nothing shall be construed as authorizing any state agency to acquire water by eminent domain, or to deprive the people of the state of Colorado of the beneficial use of those waters available by law and interstate compact."[9]

Any appropriation made to protect instream flows is subject to the following limitations. It shall not interfere with the use of water imported from another water division.[10] Nor may it interfere with the present uses or exchanges of water being made by other water users pursuant to appropriations or practices in existence on the date the appropriation for instream flows is made.[11] Before the Water Conservation Board makes a filing, it must also determine that the natural environment will be preserved to a reasonable degree by the water sought by the Board, and that such an environment can exist without material injury to water rights.[12]

Montana. Under Montana's reservation law, 5.4 million acre-feet of flow from the Yellowstone River have been reserved for the maintenance of fish habitat. (Huffman 1984). Under its code, any state or political agency may reserve water to maintain instream flows or quality throughout the year or during such periods designate by the Board of Natural Resources and Conservation.[13] A reservation shall have a priority date given by the date the Board approves the reservation, but shall not adversely affect any rights in existence at that time.[14] The Board may later reallocate water if it finds that all or part of the reservation is not required for its purpose, provided the applicant for the water demonstrates that its need outweighs the need of the original reservation.[15] As in other states, Montana law states that nothing in its provisions vests the Board with authority to alter a traditional water right not reserved for the protection of instream flows or water quality.[16]

Oregon. The Oregon Legislature has also established the maintenance of minimum stream flows as a high priority for the Water Resources Commission and the Water Resources Department.[17] The Department of Environmental Quality or the State Department of Fish and Wildlife may submit a proposal for minimum stream flow standards to the Water Resources Commission.[18] Like in other western states, the priority date equals the time the application is filed,[19] and nothing in the system can affect the priority date of any prior water permit or certificate issued.[20] When acting on applications for minimum streamflow, the Commission must protect existing

[9]*Ibid.*

[10]*Ibid.*, (a).

[11]*Ibid.*, (b).

[12]*Ibid.*, (c).

[13]Mont. Annotated Code §85–2–316(1).

[14]Mont. Annotated Code §85–2–316(9).

[15]Mont. Annotated Code §85–2–316(11).

[16]Mont. Annotated Code §85–2–316(12).

[17]O.R.S. §536.235.

[18]*Ibid.*, (1).

[19]*Ibid.*, (3).

[20]*Ibid.*, (8).

rights[21] while fostering the setting of minimum perennial stream flows if existing rights and priorities under existing laws will permit.[22]

Resolving the Collision Between Water Trades and Public Trust Values

Water trades confront policy makers with many decisions. For example, a buyer of 1,000 acre-feet of consumptive water use may seek to move the diversion point upstream, thereby diminishing stream flow between the old and new diversion points. Under the public trust doctrine, administrative review must consider these adverse effects when deciding whether to approve, modify or reject the buyer's application. Similarly, instream flow legislation requires consideration, but not necessarily absolute protection, of instream flow. The third principle of property law (rely on damage remedies when feasible, rather than injunctions) provides a perspective to be followed during administrative review.

The administrative review should consider alternative resolutions of the conflict. Should the buyer be allowed to change the diversion point of the entire 1,000 acre-feet of consumptive use it purchased, or none at all? Would a compromise be in the public interest? For example, the buyer could be allowed to change the diversion point for 700 acre-feet but dedicate the other 300 acre-feet to enhance the stream flow below the original diversion point.

If damage remedies are feasible, the policy choice involves the selection between two possible rules. If damages to public trust values can be easily computed, the buyer could move the diversion point for as much of the 1,000 acre-feet it purchased, provided it pays damages. If the value of water dedicated to enhancement of stream flow can be easily computed, the agency could dedicate as much of the 1,000 acre-feet to enhance stream flow below the original diversion point, provided it compensated the buyer for its lost water. The economic analysis of property law predicts that either situation would divide the 1,000 acre-feet between use of the buyer and protection of stream flows that strikes a reasonable balance between the two interests. The choice depends on which damages are easier to compute—the value of water rights in traditional consumptive uses or the value of water to enhance instream flows and other public trust values.

Without water markets, the problem of inaccurate information can not be avoided. Contingent Valuation (CV) studies, for example, can measure the value of the public trust affected by an application. But the accuracy of such studies can become a forum for debate and alternative interpretation. (For an assessment of CV methodology, see Cummings et al. 1986.) Even the economic valuation of water rights is more complex than estimating the capital and operating costs of developing alternative supplies. A sound financial valuation must also value the contribution of the disputed water source to the reliability of the user's overall water supply (*Water Strategist* 1987d).

Transactions in water rights generate estimates of the value of water in traditional consumptive uses, which can be used in the balancing analysis required by the public

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[21]O.R.S. §536.310(1).

[22]O.R.S. §536.310(7).

trust doctrine. Since a damage remedy is feasible, it should be used. The state may enjoin the change in diversion point for the partial or complete entitlement purchased by a buyer, but it must pay compensation. Compensation could be based on the price terms negotiated between the buyer and seller. In principle, the state agency would only prevent the change in diversion point for water where the economic value in traditional consumptive uses is less than the economic value of protecting public trust values.

Administrative review based on the proposed property rule provides incentives for interested parties to introduce accurate assessments of their interests during the administrative hearing. Despite being compensated on the basis of their bids, purchasers of water rights have no incentive to bid more than they value water. They pay the price and receive the water if their application is approved, and only retrieve their money back if their application is denied.[23] Where feasible, benefit assessments can finance the payment of compensation to the purchaser of water rights. Unlike taxes, benefit assessments require a legal finding that the proposed project creates real, tangible benefits in which project costs will be distributed among beneficiaries in proportion to those benefits. By taking financial responsibility for their forecasts, proponents of the public trust have an economic incentive to introduce accurate estimates of the benefits of protecting public trust values, rather than the greatest plausible estimate.

Conclusion

The conflicting demands for water require that policy makers rethink the nature of their trustee obligation over the state's natural resources. Water markets would help policymakers in two ways. Markets allocate water efficiently among traditional consumptive uses so that states can maximize the economic benefits from their water resources. They also provide information about the economic value of water, which can be used to devise reasonable property rules so that administrative review can implement the balancing test required by the public trust doctrine. As demands for traditional water uses and for protection of public trust values intensify, so will pressures for water law to develop economically efficient property rules.

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[23]A simple model illustrates the point. Let ν be the buyer's valuation of water if the change in diversion point is approved, Θ be the probability of an injunction, and C the compensation received if the injunction is granted. The buyer's optimal bid B for the water right is:

$$B = (1-\Theta)\nu + \Theta C$$

But $C = B$ under the compensation rule. Substituting into the expression for the optimal bid yields: $B = \nu$.

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Water Efficiency: Opportunity for Action in Western States

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Water in the West is a very controversial issue—primarily because the West has so many water problems.

One basic problem is the fact that there just isn't enough water. This is particularly true in Nevada and Arizona. Another problem is that much of what water there is, is in the wrong places and occurs at the wrong time.

California, in particular, has been working at solving its water problems for more than a hundred years. A great many water problems have been solved, some new and related problems have been created, and some problems still remain.

For those water problems that remain, yesterday's conventional solutions in many instances now are not workable. State, federal and local budgets in today's economy have difficulty coping with the expense of structural solutions. Conservation has helped and will help, but there is a limit to what can be done with this tool.

Enter water-use efficiency—an increasingly important water-management tool. It really does provide an opportunity for action in western states.

Let's take a quick look at several examples of what better water use efficiency can do for the people, for the state and for the environment.

Example 1. If water exchanges or transfers or marketing in Southern California result in making more efficient use of the available water, it will mean less water exported from the Sacramento-San Joaquin Delta. This can mean less impact on the Delta fishery.

Example 2. A coordinated operations agreement between the U.S. Bureau of Reclamation and the California Department of Water Resources, signed in 1986, provides for more efficient water use. The Bureau has some excess water that is not yet under contract. The Department has some excess aqueduct capacity, and is negotiating to exchange some of its wheeling capability for some of the Bureau's water.

Example 3. Last July, the Department of Water Resources signed an agreement with the Yuba County Water Agency for a temporary water transfer. The agency, which holds appropriative water rights to Yuba River water, had "surplus water" in storage at its New Bullards Bar Reservoir. After the State Water Resources Control Board approved the trade, the Department purchased 83,000 acre-feet for about $400,000 from the Agency, allowing the Department to reduce releases from Lake Oroville and thus carry over storage for 1988 water deliveries.

Example 4. In the Sacramento-San Joaquin Delta area, fertile islands are protected by levees. Many of these islands have land that is significantly below sea level. Studies are currently under way to investigate and evaluate the concept of intentionally flooding some of these islands, to serve the dual purpose of performing the function of a reservoir and providing habitat for ducks and other waterfowl.

Example 5. Improved irrigation efficiency—perhaps with marketing of the water conserved—could result in significant contributions to improving agricultural drainage problems. In California's San Joaquin Valley, for instance, the toxic element selenium has been leached from the soils and created a very serious problem at the Kesterson National Wildlife Refuge. Better irrigation efficiency, with less applied water, would result in less toxic drain water.

Those examples are typical of the type of water-management opportunities that exist and which, if implemented, can end up making positive contributions to the environment in California and other western states.

In addition to positive environmental benefits from such opportunities, western states *will* make more use of water marketing, transfers and exchanges because they can't afford not to–in terms of dollars and everything else.

A basic business concept is that the item being traded is put to a more valued use. The concept holds true in the water business. For example, by increasing irrigation efficiency, water not used for overwatering golf courses could be traded for use in maintaining wildlife habitats or fisheries. From the farmer's viewpoint, unused water could be shared with other farmers in the area or traded to an urban entity. The point is that one use of water will be traded for a more valued one—theoretically, society will dictate which use has more value.

Water trading, however, is not a panacea. I believe there is a danger that we may expect too much from it too fast. Water-use efficiency and the entire family of related techniques—marketing, trading, transfers, sharing and exchanging—is moving ahead rather quickly in several states. California isn't one of them. There are some very basic reasons why California won't be in the forefront with water marketing or transfers or exchanges. I'd like to share some of those reasons with you.

California is different from the rest of the world—particularly for such purposes as water marketing.

First, California is physically quite big—more than 750 miles in length from Oregon to the Mexican border and about 200 miles wide. These are potentially great distances to move water, particularly when mountains are in the way.

Second, California water law is unusual. California is one of a few western states that recognizes both riparian and appropriative rights. Riparian rights are tied to land ownership; the right to water depends on title to the land. Riparian land owners may use natural flows for beneficial use on their land if the water is available. On the other hand, appropriative rights to water use are independent of land ownership and, thus, easier to transfer than riparian rights.

California does not have many laws governing groundwater use, and efforts to change that fact have met with a lot of resistance. Rights to groundwater are also connected to land ownership. Landowners may pump water for use on their land if it overlies the groundwater basin. If the basin has "extra" water, the excess may be transported to other land for use.

As you can see, there are a few "if's" along with quite a few terms that are legally defined within the context of a certain type of water right. The amounts and terms—that is, the conditions placed on a right to use water—are determined by our State Water Resources Control Board, a quasijudicial body. The key issue in California is that entities do not own water or water rights; they simply have a right to use water that the State holds in trust for all Californians. When issuing a water right, the Control Board must balance municipal, industrial and agricultural uses with instream, fishery, wildlife and recreational uses.

To encourage water efficiency through water trading, the California Legislature passed a law in 1982 allowing the sale or lease of water that is "surplus" to a user's needs. However, with the variety of conditions placed on the variety of water rights, water users are not always sure just what they've got to offer in trade or if they have the right to offer it.

This simplified picture of California water law leaves out other statutes that affect whether or not a water trade will work. Some of the major ones are: California Fish and Game codes requiring certain instream flows to maintain fisheries; the California and National Wild and Scenic Rivers Acts protecting selected reaches of rivers from development; and both the California Environmental Quality Act and the National Environmental Policy Act. There is also case law that has developed under the public trust doctrine, which Dr. Rodney Smith discussed earlier.

Layered on top of the problems I have mentioned is the problem of people's attitudes. California and its people and agencies have different attitudes about water than does the rest of the world.

California became a great state because it developed its water and moved it from place of occurrence to place of need. But current attitudes about water tend to be quite parochial—don't export "my" water. Many Californians, therefore, support the concept of water marketing and transfers, except when it involves water in their area.

In 1984, the Imperial Irrigation District and the Metropolitan Water District of Southern California began talks on how Metropolitan might help Imperial pay for some water-conservation improvements to Imperial's delivery system in exchange for the water conserved. Imperial is the largest Colorado River water consumer. It uses about 2.8 million acre-feet a year to supply irrigation water to almost 500,000 acres of farmland in the southeastern corner of California. Metropolitan uses about 1.2 million acre-feet of Colorado River water a year to supply several counties in California's southern coastal plain. It would be willing to pay the costs of lining Imperial's canals and computerizing water delivery schedules. In return, Metropolitan wanted to use the Colorado River water that Imperial conserved—initially, about 100,000 acre-feet a year. Estimates show that there is a potential of up to 400,000 acre-feet a year, once all conservation projects have been finished.

For the past four years, the trade negotiations have been on-again-off-again, mainly due to disagreements over price. Imperial's last offer was 100,000 acre-feet at $175 an acre-foot for the first year. Its proposed 38-year agreement included an escalation clause tied to the Consumer Price Index—meaning that, in subsequent years, the price would adjust for inflation. Metropolitan's Board of Directors recently rejected this latest offer.

Lessons Learned

The proposed water trade between Imperial Irrigation District and Metropolitan Water District of Southern California is a classic lesson on the difference between theory and practice. In theory, since both parties to a water trade will benefit from it, the trade should happen fairly fast, at least relative to the time it takes to develop a water supply.

However, as most of you have probably experienced, theory often leaves out certain details so that a concept can be explained. Applying theory is a whole other ballgame. Such is the case with the Imperial-Metropolitan trade. In theory, if the price for a product is so high that the buyer is unwilling to pay it, you lower the price or find another buyer. In practice, the answer is much more complicated, especially in this case. Besides price, there are other issues, such as whether Imperial has the right to sell the water to Metropolitan. It could be that the conserved water is automatically available to others who have rights to use Colorado River water. Another issue is the timing of the trade—a lot of unforeseen things can happen in 38 years. For example, Congress could pass a bill that says Metropolitan can line the All-American Canal at no cost to the federal government. In return, the water conserved, thanks to the lining, would go to Metropolitan. Such a bill was introduced in the U.S. House of Representatives last month, and Imperial has filed a resolution opposing it. The effects of the trade on the supplies of other water users and on fish and wildlife must also be resolved.

Unlike the Imperial-Metropolitan trade, our exchange with the Yuba County Water Agency happened fairly quickly. The fast action was crucial to the intent of the trade—to enable us to carry over 83,000 acre-feet of water in storage at Lake Oroville. We thought that the exchange was a good, clean, direct trade that benefited everyone. What we learned is that no matter how benign and squeaky clean a potential proposal may seem, somebody isn't going to like it.

Water transfers usually involve some sort of change in the water right (for example, change in place of use or point of diversion). The State Water Resources Control Board must approve the change and as part of its approval process, must consider the environmental effects of the change. Our trade with the Yuba County Water Agency was a good one, and the Control Board agreed that the operation was exempt from the California Environmental Quality Act under a Class One Categorical Exemption. We had consulted with California Department of Fish and Game experts, who agreed that fish in the Yuba and Feather rivers would not be harmed if the water trade took place. So, we went ahead with it.

Since then, the Control Board has received official complaints about the trade and is working with us to address those complaints. Most of the criticism stems from disagreement over effects on fishery resources in the Yuba and Feather rivers and the claim that "proper, detailed" environmental analysis was not made.

Since this was one of the first trades that took place under fairly untried laws, and since it happened fairly quickly, we anticipated criticism. Thanks to the criticism, though, we see at least one area where we could use some improvement—primarily in formulating plans with enough lead time to inform the public adequately of the proposal so that interested third parties can provide input.

Besides price, timing, environmental effects, third-party effects and procedural issues, there are other issues that must be resolved. One of them is how to allow for constraints due to conveyance capacity of existing facilities. Another one is how to regulate the trading of water obtained by way of the U. S. Reclamation Act—the question of whether selling subsidized water is "unjust enrichment" must be answered. By the same token, should Indians be allowed to sell water normally used on reservations? Yet another issue is whose rules should prevail in water trades, the federal government's, each state's or a combination of both? As we practice using water trading as a tool, answers to many of these issues will, no doubt, be found.

Making Water Trades Work

To make water trading easier in California, one of the most obvious things we need is practice. After a few more trades have taken place, our "weak spots" will emerge, and we will be able to strengthen our abilities in those areas. So far, we know that we must approach each potential trade with a positive attitude and resolve issues step-by-step, with full public review.

A few needed changes were made in our State laws to encourage water trading. Since 1982, laws concerning water exchanging generally seek to make water trading easier, while protecting existing water rights, preventing groundwater basin overdraft and preserving environmental quality. One statute assigns the California Department of Water Resources several duties that mainly have us acting as a clearinghouse and center of assistance. Additionally, we are committed to developing a "water-transfer guide" and a catalog of water-transfer proposals.

When I started this presentation, I said that California isn't using the water-trading tools as often as other western states are. One area where California is up with if not ahead of other western states is that of striving for a balance between water for people and water for fish and wildlife. Groups like the Environmental Defense Fund, the National Audubon Society, the Mono Lake Committee and others are working with such agencies as the Metropolitan Water District and City of Los Angeles Department of Water and Power to find ways to meet the needs of both human and natural resources. It could be that, as we become more practiced at putting together workable water trades, some of the conserved water can be put toward restoring or enhancing wildlife habitats and fisheries. So there still is a lot of interest in this water-management strategy.

I will sum things up by saying that the strong interest in water trading is a definite signal that society is now acutely aware of our resource limitations. As Mayor Clint Eastwood once said in one of his "Dirty Harry" films, "A man's got to know his limitations." I think we've come to know ours. We see the Bureau of Reclamation changing its emphasis to management strategies, and we see national policies on natural resource use being refined and redefined and redefined. By knowing our limits, we are forced to think in more creative terms, make well-thought-out trade-offs, and make the most of our strengths. In this light, we can look at water trading as one way of keeping our natural resource base strong while making water use more efficient—a strategy that benefits us all in the long run.

Special Session 6. *New State and Local Initiatives for Management of Wildlife and Other Natural Resources*

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Missouri Cooperative Effort on Food Security Act Implementation

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Changes in American agriculture have had a profound effect on wildlife resources, and the decline in abundance of many species is well-documented (Harmon and Nelson 1973, Vance 1976, Fredrickson 1979). States have responded to habitat losses by promoting a variety of habitat development and wildlife restoration programs that have met with limited success (Madsen 1981).

Provisions of the 1985 Food Security Act (FSA) provide considerable potential for both wildlife habitat development and soil erosion control. This increased potential provides an opportunity for increased interagency coordination and initiative toward a common end. The degree of benefit is directly proportional to the depth of related agency interaction.

The Conservation Reserve Program (CRP) provision of the FSA is designed to curtail production of excess commodities while reducing soil erosion. Nationwide, the goal is to idle approximately 49 million acres of highly erodible cropland.

Grasses, legumes, trees and shrubs will be planted to stabilize these CRP acres. Some approved cover establishment options are more beneficial to wildlife than others—selection and implementation of the appropriate cover options at the local level is the key. Approved conservation practices of the CRP include the following: CP-1—permanent introduced grasses and legumes; CP-2—permanent native grasses; CP-3—tree plantings; CP-4—permanent wildlife habitat; CP-5—field windbreaks; CP-6—diversions; CP-7—erosion-control structures; CP-8—grass waterways; CP-9—shallow water areas for wildlife; CP-12—food plots; and CP-13—filterstrips.

The variety and/or blend of vegetative types established on CRP acres will determine the habitat potential for wildlife on those acres during the 10-year contract period. The cover option choice will also help determine the most appropriate land use after the acres come out of CRP.

In Missouri, nearly 5 million acres are eligible for CRP. Another 6.3 million acres will require conservation plans by 1990 in order to meet the Conservation Compliance provision of the FSA. And, 200,000 acres of Farmers Home Administration (FmHA) inventory lands will also need conservation planning to address specific resource conservation problems and needs; conservation easements may be placed on these lands to provide long-term soil and wildlife resource benefits.

The FSA provides a solid framework for related agency interaction. And, with Missouri ranking second in farm foreclosures and third in cropland soil loss, the need for strong interagency cooperation is underscored.

Agriculture Liaison

Fortunately for Missouri, productive interagency working relationships were developed long before the introduction of the FSA. This system was strengthened in 1981, when the Missouri Department of Conservation (MDC) established an Agriculture Liaison position to facilitate communication and cooperation between MDC, related agriculture agencies and the agricultural community. This liaison was and is directed toward impacting program and policy changes to improve total resource management. The long-term objective to correct resource problems by identifying and effecting common of goals of related agriculture agencies.

Interagency orientation and cross-training sessions have been held to improve understanding and cooperation between agencies. Additionally, through the Agriculture Liaison position, MDC has funded University of Missouri agronomic research that could lead to improved benefits to wildlife. This research has included such projects as native warm-season grass (NWSG) establishment, NWSG fertility requirements, grass-legume compatibility and nutrition, and livestock forage utilization. MDC also funded development of a bibliography on published native warm-season grass studies.

The Agriculture Liaison also helped develop a system for grants to Soil and Water Conservation Districts (SWCDs). These grants have been used to purchase specialized equipment to accomplish agricultural practices that also improve wildlife habitat. To date, specific grants have been made for two no-till drills and 52 root pruners.

And, in 1985, the MDC Agriculture Liaison participated as a member of the National Resource Agency Committee to help ensure the inclusion of fish, forest and wildlife considerations into the FSA. To accomplish this task, the Liaison worked through the committee and with legislators, related agency heads and other public officials.

Incentive Cost-share

MDC recognizes the effective statewide organization of the Soil and Water Conservation Districts of the Department of Natural Resources (DNR), and the Agricultural Stabilization and Conservation Service (ASCS). These agencies have offices in most counties and deliver program services to landowners in a timely and efficient manner.

Recognizing the wildlife potentials of CRP acreage as well as effective program-delivery systems of the SWCDs and ASCS, MDC embarked on a cooperative venture with these agencies. A landowner incentive program was subsequently developed to encourage lanuowners to establish desirable wildlife cover on their CRP acres. In this case, the incentive was identified as an additional MDC-funded 25-percent establishment cost-share for selected cover options. The following CRP practices qualify for this additional cost-share.

CP-2—permanent native grasses. These grasses produce better wildlife habitat than many of the introduced varieties. High quality forage produced by native warm-season grasses will have value to landowners after the contract period. (Bermuda grass and Old World bluestem are not eligible for additional cost-share.)

CP-3—tree plantings. Timber continues to be an increasingly valuable resource. Landowners can produce a crop of trees for future income and wildlife habitat on land that is too erodible for row cropping.

CP-4—permanent wildlife habitat. Establishment of native warm-season grasses and selected cool-season grass/legume mixtures can provide long-term wildlife benefits. The cool-season grass and legume option must include strips or blocks of native warm-season grasses and/or trees and shrubs. Eligible mixtures on CP-4 acres are: (1) redtop, timothy, and Korean lespedeza; (2) orchardgrass, lespedeza and ladino clover; (3) orchardgrass and red clover; and (4) native warm-season grasses, alone or in mixtures.

To help ensure consistent utilization of USDA cost-share on CRP acreages, the county ASCS must cost-share 50 percent of the actual average establishment costs in order for a particular acreage to qualify for the additional 25 percent MDC incentive.

Farmers interested in applying for additional cost-share on approved CRP land complete a request form at their local SWCD office. ASCS then transmits a copy of the necessary federal program cost-share forms to the SWCD and through the DNR to generate the additional MDC payment.

FmHA Inventory Lands

The FSA requires that all FmHA inventory lands have a conservation plan before they can be sold. The close working relationship between the Soil Conservation Service (SCS) and MDC provides an opportunity for joint development of these conservation plans to address total resource needs. The goal is to control soil erosion and improve wildlife habitat on FmHA inventory land. The developed procedure allows for placement of resource-conserving restrictions on any significant land features, (Clark 1987).

To help ensure proper identification and protection of identified resource features (fish, forest and wildlife included) on FmHA inventory land, SCS entered into a Memorandum of Agreement with FmHA and MDC. To provide support for the concept, MDC has agreed to pay any additional costs to implement certain fish, forest and wildlife beneficial practices included in conservation plans; easements will protect the monetary investments over the long-term.

Cooperative guidelines provide direction to aid planning and to identify any special considerations, including riparian zones, wetlands, prairies, old-growth forests and impoundments. Consideration is also given to lands that provide habitat for threatened and endangered wildlife species, or that fall within geographical areas identified as critical to the management of prairie chickens, pheasants or river otters, among other species. Wildlife habitat enhancement will be accomplished by choosing and blending soil erosion-control practices that provide appropriate benefits.

Once planned, and with conservation practices installed, these farms will serve as models to promote total resource conservation among local landowner communities.

Demonstration Farms

In 1981, MDC established two demonstration farms to document the compatibility of farming and wildlife. The idea was to integrate farm economics, soil conservation and wildlife planning. SCS assisted by designing soil- and water-conserving measures, and Missouri University Extension helped to set up the livestock and forage systems. MDC, in turn, operates and monitors these farms with respect to economics and wildlife habitat.

Practices demonstrated on these farms include rotational grazing, contour farming and strip-cropping, minimum and no-till farming, grassed backslope terraces, woodlot management, and pond management. These farms are available for all agencies to use for landowner tours and in-service training.

To date, these farms have been used as training sites for many new SCS employees. Landowner tours have also been held to demonstrate that soil can be conserved and wildlife produced while, at the same time, maintaining the economic integrity of the farming unit.

Neighbor to Neighbor Tours

Another demonstration system called "Neighbor to Neighbor Tours," was developed to encourage conservation compliance on highly erodible land. These tours have been organized in 12 northwestern Missouri counties, as a cooperative effort between resource agencies and private landowners. The DNR, SWCDs, SCS, MDC and select private landowners are part of this effort.

Demonstration sites are located so they may be viewed from adjacent roadways. Host farmers volunteer their time to explain specific land treatments to other farmers who visit. Fact sheets explaining the purpose of individual demonstrations were produced and made available through local Soil and Water Conservation District offices.

These Neighbor to Neighbor Tours have been developed to show that severe soil erosion can be curtailed on cropland and wildlife habitat enhanced under intensive cropping activities. Grassland and woodland management demonstrations also have been developed to show that soil stability and improved wildlife habitat are compatible with economic gain. The most unique facet of these tours is the concept of "farmers helping farmers" to identify and tailor available conservation practices and systems to fit the local need. The results are very positive benefits for the landowner and the resource.

Native Warm-season Grasses

Native warm-season grasses provide quality livestock forage during the hot, dry portion of the summer. These grasses also provide higher quality wildlife habitat than do cool-season grasses, particularly fescue. MDC's native warm-season grass program is directed toward the wide-scale improvement of grassland in Missouri. The concept centers on the integration of native warm-season grass and cool-season grass forage units to create a mosaic of grassland types and vegetative heights during the growing season. Landowners benefit from the availability of palatable and productive livestock forage all through the growing season. And, wildlife benefits from the added habitat diversity.

Through this program, MDC provides technical assistance to establish and manage native warm-season grasses. MDC also operates six special grass drills, statewide, to establish these grasses on private land. This service is provided on a first-come-first-served basis. Priority is given to landowners in counties or regions of the state that do not have ready access to grass drills that can seed these native grasses.

Native warm-season grass newsletters are also prepared and distributed three to four times a year to landowners and related agency personnel. These newsletters provide the most up-to-date information on establishment and management of native grasses, circulation averages 2,500.

Group Planning

Group planning is another avenue being used in Missouri to assist landowners who have enrolled highly erodible cropland in the CRP. SCS schedules and invites landowners to attend these sessions. ASCS explains the provisions of the CRP program; SCS outlines the permanent cover options that are available; and MDC relates potential wildlife interactions with specific cover types. Slide presentations are used to illustrate the individual options and how each might fit into farming operations both during and after the 10-year contract period.

Each participating farmer receives a folder that includes an aerial photo of his farm. The landowner then completes a work sheet that identifies the practices, seedings and/or tree and shrub plantings that are most efficient and effective to establish as a part of his operation. SCS, ASCS and MDC personnel provide individual assistance as needed during each group planning meeting. This system is designed to speed up the planning process and yet allow necessary technical input from all agency personnel concerned.

This same group planning system will be used to provide planning assistance to farmers on highly erodible cropland that comes under the Conservation Compliance provision of the FSA. These plans must be developed by 1990 for each farm with highly erodible land. It is estimated that some counties in Missouri will have up to 90 percent of their cropland acreage designated as highly erodible. Economy of time, landowner participation and sound technical advice are the goals, and group planning is providing the method to accomplish these goals. Some SCS offices estimate that

60–90 group planning meetings will be needed between now and 1990 to reach all landowners who need assistance.

Personnel Sharing

MDC Wildlife Services biologists have been assigned to each of the seven SCS areas in Missouri. A biologist operates out of each of the SCS Area offices and fills the role of staff biologist. The primary objective of these biologists is to identify and work to integrate fish, forest and wildlife management techniques into SCS conservation planning with landowners. These biologists provide SCS field staff with wildlife training that includes sessions on wildlife habitat development, native warm-season grass management, windbreak and shelterbelt planning, fisheries management, and forest management, to name a few.

Wildlife Services biologists have historically served a liaison function between MDC, SCS and other related agriculture agencies. A close working relationship in the past with SCS provided a ready conduit for an intensified effort. This cooperative effort served to increase further the level of communication and understanding between all agencies, particularly at the field level. Once the commitment was made to provide MDC biologist staffing at each SCS Area office, SCS sponsored resource conservation planning conferences to train MDC personnel in SCS planning procedures and methods. MDC reciprocated by providing program and procedure-oriented training to SCS staff. This sharing of knowledge and assistance has been of considerable benefit to both agencies.

Wildlife Habitat Appraisal Guide

To help accomplish joint goals identified by SCS and MDC, an effort was made to develop a system to serve several functions. These are: (1) to evaluate habitat on private land in a consistent and repeatable fashion (knowledge of habitat condition could then be used to make management recommendations); (2) to predict the effect of management recommendations on habitat quality; (3) to display in a graphic form to landowners the impact of land management on wildlife habitat quality; and (4) to document conditions after management implementation.

To meet these needs, the Wildlife Habitat Appraisal Guide (WHAG) was developed. This system assigns numerical values to land use or condition characteristics so that any given unit of land can be systematically evaluated in terms of wildlife habitat quality (Urich et al. 1984). WHAG was initially developed for 12 wildlife species (Miller et al. 1985) though additional species are slated for future accommodation.

Summary Recommendations

1. State fish and wildlife agencies should contact their SCS State Biologist to discuss existing programs and determine ways to become involved in joint interaction. An important first step is to identify common goals. Beyond that, increased communication and development of close working relations at the state and local levels should be priorities. Familiarization with farm programs is also impor-

tant—this will facilitate the identification of alternative ways to incorporate fish, forest and wildlife resource planning into agricultural agency programs.

2. State fish and wildlife agencies should develop guidelines to assist planning of FmHA inventory lands to ensure selection of conservation practices that provide maximum multiple-resource benefits. A formal memorandum of agreement between agencies is essential.
3. State and fish wildlife agencies should encourage landowners to develop formalized conservation farm plans. These farm plans will chart a sound management course toward the integration of economic and resource conserving goals.
4. A system of wildlife habitat evaluation should be developed between state fish and wildlife agencies and the SCS. This system will facilitate consistent integration of wildlife needs into conservation-planning efforts. And, an evaluation system also provides a means to measure program effectiveness over the long term.

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Place To Hunt Committee: A Cooperative Illinois Program

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The Committee and Its Recommendations

The Place To Hunt Committee is a cooperative effort between the Illinois Departments of Conservation and Agriculture. The committee began in December 1985, as an informal body seeking to improve landowner/sportsman relations and thereby open more private property to public access. In March 1987, the Governor of Illinois endorsed a formal, cooperative agreement between these two departments to continue the Place To Hunt Committee as an established advisory body. Eighteen committee members represent the two forementioned departments and the Illinois Department of Commerce and Community Affairs, farm organizations, individual farmers and sportsmen.

Several factors motivated the Department of Agriculture to become involved in public access issues. The acreage reduction and conservation programs of the 1985 Food Security Act has increased habitat and upland game in Illinois. The continually expanding white-tailed deer herd and dramatic success of wild turkey restoration have brought greater opportunities for sportsmen. The same expansion has resulted in more complaints by the farm community of crop damage and hunter trespass. The Department of Agriculture is also interested in economic opportunities afforded farmers who wish to utilize their land for recreation.

The state's 36 million acres are 95 percent privately owned. Approximately 29 million acres are utilized for farming practices; 22 million acres are used to produce intensively cultivated and managed crops such as corn, soybeans and wheat. The 1985 Food Security Act chartered a new direction for land use in Illinois. More that 344,000 acres were enrolled in the Conservation Reserve Program through 1987. The 1988 total should approach 0.5 million acres. More than 3.3 million acres are also enrolled in the annual acreage set-aside program.

There are approximately 12 million people in Illinois, including approximately 325,000 farmers and their families farming about 80,000 farms. The farm population has decreased substantially to the point where half as many farmers are managing half as many farms, which are twice the size as those in production 30 years ago. During this 30-year span, the population of Illinois has grown from 7.2 million to 11.9 million. These trends indicate a changing environment for recreation on private property.

The Place To Hunt survey (discussed later) revealed that most sportsmen allowed access to property already are known to the farmer. The vastly decreased number of farmers in Illinois and a substantially higher urban population set the stage for difficulty in finding land on which urban residents—most of whom do not have acquaintance with rural landowners—are allowed to pursue their sport. Sportsmen who are strangers to farmers are much higher profile than neighbors or other known parties who used to frequent the larger acreages of naturally occurring wildlife habitat.

Sales of general hunting licenses in Illinois have decreased from 476,471 in 1960 to 321,000 in 1987. The impact on Illinois lands has remained high in the eyes of the farm sector because, while fewer sportsmen pursue upland game, the natural habitat and general upland game populations have decreased substantially. High-profile recreation, such as the six-day firearm deer-hunting season, cannot be overlooked by any rural resident. Approximately 100,000 hunters are licensed to pursue white-tailed deer with firearms in Illinois and spend more than 400,000 man-days afield. Current estimates indicate that hunting for all species accounts for 6.7 million days afield annually in open seasons in Illinois.

A key element in hunting and other recreations in Illinois is the use of private land. Public lands alone cannot sufficiently provide the variety of recreational opportunities required by the public or even begin to provide adequate wildlife habitat for the diversity of species existing throughout the state. The sale of hunting licenses franchises and legalizes hundreds of thousands of people and millions of man-days of field recreation annually. This recreation is primarily conducted on private property.

Committee Recommendations

The Place To Hunt Committee has reviewed landowner/sportsman relations programs from a number of other states. These programs have assisted in the formulation of recommendations for Illinois. The committee has also considered the results of the conservation/recreation survey, partially reproduced here, in making recommendations. This survey of farmers revealed that three primary barriers exist to access to private property: fear of liability; unauthorized access or trespass; and property damage/unethical behavior. The state can employ several methods to reduce the impact of these problems and improve the climate for outdoor recreation in Illinois.

Liability

For some time, the Illinois Department of Conservation has been attempting to strengthen the Recreational Use of Land and Water Areas Act. This law affords protection to landowners allowing recreational use without charge. In 1986 and 1987, the Illinois Department of Agriculture and the committee took an active role in promoting the passage of this legislation. The new law, Public Act 85–959, signed December 8, 1987, provides greater protection from liability for landowners allowing recreational use of their property. The law also provides greater flexibility for incentives received by property owners allowing access.

The law will assist in abating liability fears in the State of Illinois. In order to make the improved statute known to landowners, an educational and promotional program needs to be undertaken. This effort can be enhanced with the assistance of the University of Illinois Cooperative Extension Service and other university resources. A layman's explanation of the current recreational/trespass statutes can be prepared under the banner of a new law for Illinois. The explanation should clearly inform landowners as to the laws' features and what protection they will and will not receive. Accompanying this layman's explanation should be a copy of the Recreational Use of Land and Water Areas Act. This information can be printed at the Illinois Department of Agriculture's print shop. Distribution should be through Extension Offices, Farm Bureaus, USDA Agricultural Stabilization and Conservation

Service offices, and any other appropriate government interfaces with Illinois landowners.

Accompanying this information could be a copy of the model Waiver of Liability, as drafted by the Illinois Department of Agriculture, Illinois Department of Conservation and the Attorney General's Office of the State of Illinois. Inclusion of a smaller landowner permission card, with a much abbreviated version of an ethical pledge to respect property and exhibit safety and a brief "hold harmless" statement should be considered. The State of Illinois can give credit to legitimate sportsmen by allowing them to participate in programs that identify those individuals as responsible outdoor resource users. This concept adds a new dimension to the potential for improved relations between sportsmen and landowners.

Trespass

Illinois has undertaken noble but mostly passive measures to reduce trespass. State law requires that permission be acquired prior to anyone entering another's land for recreational purposes. This concept, however, is conveyed to the sportsmen of Illinois in a less than aggressive manner, as it is not part of any major advertising or promotion campaign. Hunter education regarding this law is one area that can be improved.

Based on review of the landowner survey statistics, discussions in the committee meetings, ag sector complaints, and a review of the 1986 trespass violations (as written by the Illinois Department of Conservation police officers), a strengthening of programs in Illinois to abate trespass is necessary. Unauthorized trespass was a concern of 77 percent of the statewide sample of farmers surveyed. "Ask Before Entering" efforts are already underway in the Illinois Department of Conservation. The number of instances of trespass, where citations were issued by the Illinois Department of Conservation, is insignificant compared with the magnitude of the problem in Illinois.

Trespass abatement requires education on the part of the landowner, law enforcement officials and, most importantly, the Illinois sportsmen. Signs, media advertising, additional enforcement, law changes and information dissemination could all be employed to reduce this perpetual and unwanted problem.

Hunter safety programs for youngsters and adults are methods to improve ethical behavior and reduce trespass. The expansion of hunter safety, snowmobile safety and boating safety programs to educate adults in ethical behavior and its importance for the continuance of their outdoor sports should be strongly considered.

The committee recommends that the Illinois Department of Conservation and Illinois Department of Agriculture cooperate in strengthening penalties for recreational trespass. A new section of Chapter 61 of the Illinois Revised Statutes can be added to define recreational trespass. The abatement of trespass should be reinforced as a priority issue with conservation police officers and county law enforcement officials. The specific penalty for trespass under the wildlife code is the posting of $50 in cash bail. This bail effectively represents a fine as it is normally forfeited when the violator does not appear in court. The published implementation of a higher bail or fine can be used as a psychological deterrent and part of a new initiative even if actual prosecutions are not increased greatly.

The committee further recommends that the Illinois Department of Conservation utilize its administrative powers to revoke license privileges for repeat trespass violators. For instance, a second-offense trespasser would not only be fined but lose hunting privileges for one year; third-offense violators lose privileges for five years.

The committee believes there is an undefined, negative, landowner reaction to perpetual abuse of access privileges. Over time, this results in increased no trespassing signs, unavailable land for any recreational use and greatly diminished images of outdoor recreationists.

Education/Promotion Efforts

The Illinois Department of Conservation should undertake an aggressive education and promotion program to improve outdoor sportsmanship and ethics in this state. This program could be linked to the safety programs already in existence. Methods to strengthen the behavioral portions of these programs can be studied and hopefully implemented. The St. Louis School District and the State of Maryland are already including ethical behavior training in their high school and grade school systems. Information on ethical behavior training should be collected by the Illinois Department of Conservation and utilized to strengthen this portion of its existing training program and incorporated in any future public relations program.

Staff Support

To coordinate the implementation of these recommendations, a full-time employee and the addition of funds to support necessary programs are recommended. The Illinois Department of Conservation, Illinois Department of Agriculture, and Illinois Department of Commerce and Community Affairs should share the cost of this full-time employee. A Memorandum of Understanding could be developed between the three departments, outlining their roles and the role of the employee. It is recommended that participation on the part of the Illinois Department of Agriculture and Illinois Department of Commerce and Community Affairs diminish in subsequent years, with the Illinois Department of Conservation eventually fully supporting the program. The new employee's title could be "Coordinator of Landowner/Sportsman Relations." The employee would work closely with the Division of Law Enforcement's Hunter Safety Education Program, the Division of Information and Education, and the Division of Wildlife Resources' Private Lands Wildlife Habitat Management Program, all within the Department of Conservation. The employee would also be required to coordinate activities with other agencies, such as the Tourism Division of the Illinois Department of Commerce and Community Affairs and USDA's Land Management Programs.

It should be stated here that it is not the committee's intent to recommend programs or methods that will expand greatly the cost of recreation in Illinois or embody huge administrative costs or other large budget commitments to implement. It is our belief that substantial progress can be made through minor legal changes, redirecting of some advertising resources and refocusing of some administrative priorities to increase attention on the important issues herein addressed. Infrastructures are already in place to reach all sportsmen and landowners in our state without building new delivery systems.

Additional Concepts

An additional step could be taken to protect landowners relative to liability and damage to property—the first and third most important barriers in allowing public access. That step is one of establishment of a state insurance pool or indemnification program to protect the property owner. Committee research has not revealed a sufficient number of lawsuits to cause the state legal, administrative or financial damage. However, a law to set up an insurance pool to protect farmers and their insurance companies from litigation brought by licensed and legal sportsmen engaged in recreational activities would be a strong step in improving the perception of liability in Illinois.

The indemnification of livestock is used in the State of Montana; however, claims against the indemnification fund have been minor. Such a fund in Illinois could not only provide purchased insurance or an insurance pool maintained by the State of Illinois to protect landowners form lawsuits stemming from recreational use, but could also provide property damage protection. Time and again, farmers have used the tired but sometimes true argument that livestock were shot on their property. Damage to livestock, fences or other personal property by licensed sportsmen could easily be paid for by the State of Illinois without any significant financial burden. The ability to implement a program where *proven* damage to such livestock and property is reimbursed by the state could greatly allay fears of landowners. In 1987, the State of Montana indemnified landowners against livestock damage in approximately one-third of the state. It spent less than $800 to do this. In 1988, Montana plans to expand the program statewide and does not expect to spend more than $5,000 (Rich Clough [Montana Department of Fish, Wildlife and Parks] personal communications: 1987). This is excellent public relations at a very reasonable rate.

While the Illinois Department of Agriculture does not intend to promote fee hunting actively, we believe some fee hunting will inevitably exist. This will give direct economic importance to proper wildlife management techniques on private property. It will reduce pressure on public lands now managed for wildlife and reduce pressure on private lands where free hunting exists. Regardless of the state of fee hunting, it will require continued vigilance on the part of the Illinois Department of Conservation and Illinois Department of Agriculture to ensure that the state is encouraging and directing trends in recreational land use rather than reacting to land-use changes. In order to ensure that this kind of foresight exists in our programs, we should maintain an advisory structure comprised of the agriculture, recreation and tourism segment of our state to identify emerging trends and prepare to direct these trends for the greatest benefit.

To accomplish this, the committee recommends that a permanent advisory body continue, which will include representatives from the Illinois Farm Bureau, Farmers' Union and any other organizations representing a substantial segment of the farm population. Nonaffiliated farmer representation is also important. Since we are using the resources found on property owned by private, rural landowners, their opinions are essential and should be incorporated into recreation and tourism plans in this state. Rural landowners should become advisors to our programs and partners in recreation and tourism in the State of Illinois.

Conclusion of the Committee's Report

The President's Commission on the American Outdoors issued its report and recommendations to the President in December 1986. That report clearly identifies the tremendous importance of outdoor recreation to our country. The Commission recommended " . . . a 'prairie fire' of local action to sweep the nation, encouraging investment in outdoor recreation opportunities and rededication to the protection of our great natural heritage . . . . We believe that we must enter a new age of partnership, among private businesses, nonprofit organizations, local associations, and all levels or government. The private sector holds immeasurable potential for the delivery of outdoor recreation.'' The Commission's report also noted that linking private and public recreation is essential.

The programs and concepts the Place To Hunt Committee recommends, speak directly to the issue of engaging the private sector, through cooperation, encouragement, incentives, and common sense. If monetary or other benefits accrue to landowners, they should come naturally through the evolution of hunting and recreational use in the United States. Human nature and private property rights dictate that public use of private property is a somewhat unnatural condition. Our challenge and charge should be to set a climate in Illinois in which sportsmen and landowners work together for mutual benefit.

We believe the implementation of programs outlined herein will carry Illinois far toward the goal of better landowner/sportsman relations and better recreation and tourism for the state. We believe these programs can be implemented without great cost to government. This is certainly an important part of this recommendation, given current and possibly long-term future conditions. In our work with these programs, it has become abundantly clear that many reports are generated by different branches of government. Many good recommendations could be better implemented with oversight and cooperation among all federal, state and local entities working in these related fields. For that cooperation to exist, strong top-down leadership must be in place and willing to exert the necessary pressure to ensure cooperation and optimization of resource use. It is our sincere hope that this environment will be established and maintained as programs are developed and initiated, and as budgets are formulated for recreation and tourism in Illinois.

Illinois' private land base is used for one of its highest purposes in the production of agricultural commodities. Recreation can, in many cases, be a compatible use of the land base and certainly is a requisite of a healthy society. Illinois has been a leader in many disciplines in our nation. It should now step up to the role of a leader in recreation and tourism, and in developing acceptable and mutually productive methods for public recreation on private property.

The Conservation/Recreation Survey

The Place To Hunt Committee unanimously agreed on a need for basic data regarding the condition of private property access in the State of Illinois. A subcommittee was formed representing both state departments, wildlife biologists and farmers. The subcommittee worked with the Illinois Agricultural Statistics Service to create a special survey soliciting information from farmers on conservation and recreation issues. This survey was conducted by the Service using its normal methodologies and a random sample from the Illinois Farm Operator Lists. The total cost of the survey was $4,600, shared equally by the Illinois Departments of Agriculture, Conservation, and Commerce and Community Affairs. The committee has used this information in formulating recommendations to improve landowner/sportsman relations. It is also considered an appropriate benchmark to assess the success of future programs. The data were collected before passage of the revised Recreational Use of Land and Water Areas Act, and prior to any significant release of information about committee actions and recommendations. If actions proposed by the committee are implemented, this survey can be repeated any number of years to help evaluate their effectiveness. It is important to emphasize the benchmark qualities of the survey data because of the nature of the programs and actions we are supporting.

A four-page questionnaire was mailed on September 4, 1987, to a random sample of 1,197 farm operators. Those not returning the questionnaires by mail were contacted by telephone. A total of 622 reports was tabulated. Twenty percent of the original sample were no longer farming; 11 percent refused to participate in the survey; and 17 percent were inaccessible. Basic information questions about each farm were asked in order to summarize results by type of farm, type of land-operating arrangement and size of farm, in addition to geographic breakdowns. Operators were asked to report the number and kind of game species present on their farms, if these animals had caused any significant crop damage, and if they would like more, fewer or no change in the species populations. They were then asked a series of 19 questions concerning their attitudes, opinions and experience about hunting and other recreational activities on their farms. Table 1 shows, by Crop Reporting District, the percentage of reporting farms with crop-only operations, crop and livestock operations, average farm size and type of land arrangement. Also shown is the percentage reporting land in the 10-year Conservation Reserve Program (CRP) and the 1-year Feed Grain Set-aside Program (ACP). Other survey results are shown by District or by type of farm only when there was a significant difference from the state average or percentage.

Highlights of Survey Results

The average size of farm in the survey was 450 acres. Slightly more than half of the farms reported livestock as part of their farm operation. Thirty-four percent of those reporting owned all the land in their farming operation; 14 percent rented all the land; and 52 percent had a combination of owned and rented land (Table 1).

Table 1. Selected characteristics of Illinois farms.

Crop reporting district	Average acreage	Farm operation[a]		Ownership[a]			Land in[a]	
		Crops only	Crops and livestock	Own all	Rent all	Rent and own	CRP[b]	ACP[c]
Northwest	408	36.2	63.8	47.8	11.6	40.6	1.5	66.5
Northeast	402	51.4	48.6	29.2	26.4	44.4	1.4	62.5
West	518	39.7	60.3	29.4	11.8	58.8	7.4	80.9
Central	528	52.0	48.0	24.0	21.3	54.7	1.3	80.0
East	423	65.4	34.6	25.6	18.0	56.4	5.1	87.2
West Southwest	490	38.1	61.9	41.3	9.5	49.2	9.5	74.6
East Southeast	371	47.1	52.9	38.6	12.8	48.6	4.3	68.6
Southwest	390	32.8	67.2	34.4	4.9	60.7	4.9	59.0
Southeast	520	43.9	56.1	42.4	3.0	54.6	9.1	65.2
Average	450	45.8	54.2	34.4	13.7	51.9	4.8	72.0

[a]In percentage.
[b]CRP = Conservation Reserve Program.
[c]ACP = Feed Grain Set-aside Program.

If there were sufficient wildlife, do you view hunting as very desirable, somewhat desirable, undesirable or no opinion? (Table 2). Twenty-three percent of those surveyed viewed hunting as very desirable, 42 percent as somewhat desirable and 25 percent viewed it as undesirable. Forty percent of those surveyed in the Northeast Crop Reporting District viewed hunting as undesirable, as did 32 percent in both the Northwest and the East Crop Reporting districts. Farm operators with livestock viewed hunting more favorably than did those with crop-only operations. Seventy-one percent of farm operators with livestock viewed hunting as desirable, compared with 59 percent of the crop-only operations. Twenty-nine percent of farms with 500 or more acres viewed hunting as undesirable, compared with 23 percent of those farms with less than 500 acres.

Seventy-nine percent reported that someone hunted on their land in the past three years. The Northeast District had the lowest percentage reported in this category, with 65 percent; the Southeast was highest, with 97 percent reporting someone hunting. Eighty-four percent of farm operators with livestock allowed hunting on their land, compared with 74 percent for crop-only operations. The game animals most often hunted were deer and rabbit. Acquaintances of the farm operators were those who hunted the operators' land most often, followed by the farm operator himself and his immediate family. Twenty-three percent allowed recreational access other than hunting.

Have you charged a fee for hunting on this farm during the past year? Almost no farm operators surveyed currently charge a fee for hunting or are leasing any land for any recreational purpose. Nine percent reported that they were considering charging a fee, although 28 percent in the Northwest Crop Reporting District were considering such a fee. Eighteen percent of tenant-only operators were considering charging a fee.

How many times have you been asked permission to hunt on your land over the past three years? How often have you observed hunters on your farm who did not ask permission? Farmers were asked for permission to hunt an average of 10 times during the past three years. They observed hunters on their farm who did not ask permission an average of six times during that period. Slightly more than half of

Table 2. Illinois farm owner/operator perception of the desirability of recreational hunting.

Crop reporting district	Owner/operator perception of hunting (in percentage)	
	Desirable or somewhat desirable	Undesirable
Northwest	58	32
Northeast	53	40
West	69	24
Central	68	24
East	58	32
West southwest	73	17
East southeast	69	16
Southwest	72	18
Southeast	74	18
Average	66	25

those surveyed said they did not post their land, though larger farms tended to post their land more than did smaller farms.

Eighty-three percent of the respondents indicated concern about allowing others to hunt on their land (Table 3). Of those with concerns, liability, unauthorized trespass and risk of property damage were most often flagged as sources of reservation.

Respondents felt that public agencies should be involved in reducing liability risks and increasing wildlife and wildlife habitat (Table 4). Roughly two-thirds indicated that public agencies should *not* be involved in reducing wildlife damage to crops or dealing with hunters concerning access to private land.

When asked about crop damage of economic importance by wildlife, 21 percent reported that deer were a problem (Table 5). Seventeen percent indicated they wanted fewer deer on their farms. Damage by deer was noted by more than 25 percent of those reporting in the West, West Southwest and the East Southeast Crop Reporting Districts. Damage by other game species was reported by 3 percent or less of the respondents.

Sixty-two percent of those surveyed thought a published list of farms permitting hunting would be a good idea, but only 5 percent said they wanted their name on the list. An additional 13 percent said they would "maybe" put their name on the list.

Table 3. Illinois farm owner/operator reservations about allowing others to hunt their land.

Reservation	Percentage indicating concern
Unauthorized trespass	77
Liability	91
Interruption of farming activities	37
Vandalism	60
Littering	54
Privacy violation	46
Inconvenience	38
Risk of property damage	71

Table 4. Illinois farm owner/operator opinion on public agency involvement efforts to improve conditions for hunting.

Agency involvements	Owner/operator opinion (in percentage)	
	No	Yes
More abundant wildlife	43	57
Less inconvenience in dealing with farmers	62	38
Freedom from liability	27	73
Less wildlife damage to crops	70	30
Help improve wildlife habitat	39	61
Increased availability of conservation police	54	46
Better control of access to your land by hunters	66	34
Less property damage by hunters	49	51

Table 5. Crop damage by deer on Illinois farms and farm owner/operator view of deer populations.

Crop reporting district	Percentage reporting deer damage	Percentage wanting fewer deer
Northwest	17	14
Northeast	18	21
West	29	21
Central	16	8
East	17	14
West southwest	27	21
East southeast	26	19
Southwest	25	18
Southeast	20	17
Average	21	17

Thirty-five percent said they would and 26 percent said they might be more inclined to allow hunting on their land if hunters presented a pledge card or some evidence of safety and ethics training. Tenant farm operators (71 percent) were more likely to be influenced by a pledge card than were owners only (54 percent) or owners and tenants (63 percent).

Slightly more than half of those surveyed felt improved conditions for hunting would improve the rural economy, and 20 percent felt that their own economic well-being would be enhanced as a result.

Two-thirds of the farm operators said they maintain habitat for wildlife, but almost half (47 percent) did so without a formal plan (Table 6).

For More Information

Excerpts from and explanations of the Place To Hunt Committee's first annual report have been included to provide an overview of Illinois' cooperative efforts. A portion of the conservation/recreation survey summary has also been provided to highlight the information gathered. The Illinois Department of Agriculture believes efforts to date have been successful in identifying existing problems and recom-

Table 6. Practices or management plans of Illinois farm owners/operators to improve conditions for wildlife.

Practice or plan source	Farm owner/operator percentage
None	33
USDA Soil Conservation Service Conservation Plan	17
Illinois Department of Conservation Private Lands Biologist	2
Quail Unlimited	2
Pheasants Forever	1
Ducks Unlimited	4
No formal plan, but do maintain habitat	47
Other	2

mending reasonable solutions. This is especially true in light of the current farm situation, the large amount of resources dedicated to tourism in the State of Illinois and the general condition of the resource. Copies of additional information may be acquired by contacting Neal Gunkel, Illinois Department of Agriculture, State Fairgrounds, P.O. Box 19281, Springfield, IL 62794–9281.

Author's Note. Any or all of these additional pieces may be requested by writing the above address:

- Complete Conservation/Recreation Survey questionnaire and results
- Model Waiver of Liability
- Text of modified "Recreational Use of Land and Water Areas Act," PA 85–959, Illinois Revised Statute
- Interagency Agreement, Illinois Department of Agriculture/Illinois Department of Conservation
- National Association of State Departments of Agriculture, 1988 Resolution Proposal, Agriculture/Conservation Cooperative Efforts

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Natural Area Assessment in the Chicago Region

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Introduction

For years we have been asked to make evaluations and assessments of natural quality or environmental integrity of various local open land areas. It has always been frustrating to designate an area as, for example, "high quality" and then attempt to explain, in definitive terms, why such a designation is neither arbitrary nor whimsical. This frustration is exacerbated in several ways. There is a natural tendency for assessments such as "significant," "exceptional," "high quality," etc., to be vague or sound trite, losing both impact and meaning. Second, the differences between "significant" and "exceptional" are concepts that are at best difficult to describe in words. Importantly, definitions that clarify meanings for such words over the course of time and with changes in assessment personnel have been difficult to standardize. One person's "significant" may well be another's "exceptional," depending on differing philosophical alignment or technical experience in the field of natural area assessment, both of which influence evaluations that already are often viewed as subjective. Repeatable application of such an assessment system is problematic, so the ability to evaluate consistently the success or failure of a management protocol, decade after decade, does not yet exist.

For these reasons, we have developed a method by which natural area assessment can be expressed in numerical terms. This method permits anyone with a reasonable knowledge of field botany to arrive at an evaluation that reflects a consistent philosophy of assessment. This method assesses a fundamental character of the site, irrespective of community type(s). It avoids the use of such parameters as frequency, dominance, physiognomy, or productivity, because positive or negative connotations with respect to natural quality are only ambiguously related to these factors. This method has encouraged local uniformity in natural area evaluation, enabling planners, land custodians, ecologists and other practitioners to make standardized comparisons among various open land areas.

Natural Area

This assessment system is based on the following definition of natural area. Natural area is land on which the existing vegetational assemblage approximates the condition that prevailed just prior to the settlement of the Chicago region in the early 1800s. Implicit in this botanical approach to a definition for natural area is the ecological health of the system as a whole. This conceptualization of natural areas avoids emphasizing ancillary factors, such as cover values or wildlife habitat potential. Rather, it seeks to define natural area in terms of fundamental components, such that its integrity would be irrecoverably compromised in the event of trauma or neglect. The National Environmental Policy Act of 1969 asks us to assess the degree to which the impact on an area is irreversible or irretrievable. This is a wise charge, and the working definition of natural area employed here attends to it.

A natural area is an incredibly complex amalgamation of interrelated biotic and abiotic elements, the intricate workings of which largely remain unknown. We recognize the impossibility of assessing comprehensively all imaginable factors, so we are assuming that the quality of the vascular flora, a relatively easy parameter to assess, serves as a gauge in assessing the overall synecological health of the system.

Premise

The premise on which the evaluation method is based derives from the fundamental character of the Chicago region flora itself. It has long been recognized that our native flora displays varying degrees of tolerance to disturbance, as well as varying degrees of fidelity to specific habitats. Species conservatism—the degree of faithfulness a plant dispays to a specific habitat or set of environmental conditions—is the basis for this premise. The natural quality of an area then is reflected by its richness in conservative species.

Conservative floristic elements are those species that, through millennia, have become supremely adapted to an environment determined by a specific set of biotic and abiotic factors. These factors include local edaphics and extremes of drought, humidity, inundation, fires, temperature, faunal interactions, etc. Though these factors in the aggregate have changed over time, the changes have been gradual enough and buffered sufficiently by system complexity to allow gene pools to adapt. When changes occur rapidly, as they have in the postsettlement period, these conservative species on a given tract are reduced in accordance with the severity of the changes.

This attrition in conservative elements occurs even as the nonconservative elements, already suited to the changes, become increasingly preemptory. The conservative elements, supplanted in place, have neither refugia, effective migration routes, nor the time to adapt or relocate. Rather, their populations are decimated time and time again until their ultimate extirpation.

To have a healthy natural area, with potential of long-term viability, there must be a high degree of conservative floristic component present, and it must be present in sufficient diversity to form the framework around which all the other components of the ecosystem are based—invertebrates, soil microorganisms, food chain, etc. In our region today, very few such ecosystems approximate their presettlement condition.

Our flora now consists of two significant categories of plants—those native [autochthonous] to the region, and those naturalized [allochthonous] in the postsettlement period from provinces remote from the region. Of the 2,241 species of vascular plants known from the Chicago region, nearly one-third were not here prior to European settlement (Swink and Wilhelm, 1979). It is an artifact of our time, however, that floristic elements from this allochthonous flora dominate more than 95 percent of the vegetated landscape.

These allochthonous species, along with their nonconservative autochthonous counterparts, are the same ones that prevail throughout the north temperate regions of North America. They are highly adapted to the kinds of disturbances and landscape alterations that have accompanied sedentary, agricultural man since primitive times. Wherever natural conditions are altered traumatically, our conservative flora has been supplanted. Clearly, a tract of land occupied prevailingly by nonconservative species not only cannot be viewed as natural area, but is quite replaceable. Our interest, then, in natural area identification and assessment should focus on the extent to which constellations of conservative species are present.

The native species—those which lived for millennia here on the prairies and among the prairie timbers of this singular place on the continent—now are confined largely to minuscule tracts of unplowed, disturbed, grazed land. Such tracts occupy less than one-half of 1 percent of our total land area. Prairie/fen/savanna/sedge meadow matrices, and the animal population dynamics and diversity incumbent therein, no longer span vast, contiguous tracts. When obliterated, these now-isolated areas are invaded rapidly by the allochthonous elements prevalent in the surrounding landscape; such invasion literally preempts the successional healing seres that once included conservative elements. Even if native elements remained in the vicinity and were able to participate in "succession," the frequent fires to which these elements were accustomed and dependent are no longer a part of the biome. Indeed, without fire, it is inevitable that any successional confrontation between the Old World flora and the New World flora renders supreme advantage to the former.

Since less than 5 percent of our vegetated landscape in the Chicago region is populated to any extent at all by native vegetation. And since the degree to which conservative native floristic elements are present on a tract of land is an operative factor in our definition of natural area, an assessment method must be able to discriminate among such tracts. Even most tracts of natural area have been degraded and are infused to greater or lessor degrees by adventive or nonconservative species. An assessment method, therefore, must be able to identify which tracts have significant components of floristic conservatism and, hence, high natural quality, the loss of which would be irreplaceable.

The Method

This premise has led us to develop the basic tool of the assessment methodology—a complete checklist of the vascular plants of the Chicago region. Each species on the checklist has been given a coefficient of conservatism, which expresses its value relative to all other elements in the flora. As has been discussed earlier, the flora of the Chicago region is comprised of two principal groups of plants—autochthonous and allochthonous. Because the ecological contexts of these two groups are inherently disparate in character, separate rationales have been used in the assignment of numerical values to each group and in their application to land assessment. In effect, this assessment approach recognizes essentially 13 different categories of native plants—those valued 0–10, 15 and 20. Allochthonous species, as will be explained later, are excluded from natural area assessment. It is the extent to which a tract of land supports the higher valued elements that is being indexed. There is no emphasis on individual species. Rather, the Index is derived from a fundamental analysis of the community or community complex as a whole.

Native Species

Native species, including locally recognized varieties, have been given coefficients of conservatism in whole numbers ranging from 0 to 10, with special values of 15 and 20. The 0-value applies to those species nearly or quite ubiquitous under a broad set of disturbance conditions. The presence of a 0-rated species provides the observer with absolutely no confidence that the land on which it is growing has ancestral ties to any presettlement order. The 5-value applies to species that suggest a pronounced affinity to some native community. The 10-value is reserved for those plants that not only typify stable or near-climax conditions, but also exhibit relatively high degrees of fidelity to a narrow range of synecological parameters. A little more than two-thirds of the 1,542 species native to the Chicago region are in this spectrum. The remainder of our native species are valued at either 15 or 20. Table 1 shows the percentage of native flora in each coefficient category.

The 15-value is conceptually similar to the 10-value except that we regard such a plant to be quite rare in the Chicago region today; therefore, its continued survival in the region is of more imminent concern than that of those species with values of 10 or lower. A plant with the 20-value is one we feel is locally threatened, endangered or already fatally compromised. Though these 15 and 20 categories are arbitrarily applied, their importance relates to the rationale on which this evaluation system is based—the contemporary necessity to preserve as much of the conservative component in our local biota as possible. In practice, elements valued at 15 or 20 are so rarely encountered that their influence on natural area evaluations is usually insignificant. In circumstances in which there are several of these elements present, it is likely that the site is of very special or singular quality.

As one might imagine, the conceptual differences between a plant with 0-value and a 1-value are vaguely distinct, as are those differences between a 1 and a 2, a 2 and a 3, or a 10 and a 15. However, the conceptual differences between a 0-value and a 3-value are clearly distinct. Concern over whether or not a particular plant receives a 0 or a 2, rather than a 1-value, is ameliorated by the recognition that each species in the flora was valued under a common philosophy, with the effect that possible individual aberrations in rating are largely self-compensated through the averaging mechanism in the Rating Index. As will be seen, these coefficients of conservatism are treated as arithmetic means in the evaluation method, so the significance of individual valuations yields to the aggregate valuation of the species constellation of which it is a part.

The observed autecological characteristics of some native taxa do not conform well to the previously outlined general concept. For these taxa, while they are usually scarce or rare, we have been unable to discern any predilections for a particular ecological niche or set of niches for which a synecological common denominator can be demonstrated. This could be an artifact of their rarity combined with the mass destruction and desecration of natural lands; the roles of these homeless plants today being those of errant survivors in a world that no longer affords them their primal niche. For this reason, a compromise has been forced with respect to their valuation. In most such cases, we have tended to value these species highly, though a few value levels beneath a species of similar rarity but in which there has been observed

Table 1. Percentage of native flora in each coefficient category.

	Coefficients of conservatism												
	0	1	2	3	4	5	6	7	8	9	10	15	20
Percentage	2	2	3	3	5	11	7	8	8	3	13	17	16

more fidelity to a recognizable synecological order. Usually this value falls between 7 and 9, but this concept, while becoming more subtle in the lower levels, nevertheless operates nearly throughout the conceptual spectrum.

It is important to emphasize that the numerical values assigned to our native species are derived from the observed behavior of populations in the Chicago region. Clearly, as one travels away from the Chicago region, locally applied values may become decreasingly valid. For example, golden saxifrage (*Chrysosplenium americanum*) is locally confined to wet woods with boreal affinities. The wet, boreal woods habitat in the Chicago region is geographically restricted and in comparison with northern Michigan, a rarely occurring, very sensitive community. This species is also on Indiana's list of endangered and threatened species. Consequently, golden saxifrage rated a 15. Farther north, where wet boreal woods are more common and better developed as a community, golden saxifrage is more widespread and a little more resilient to disturbance. Our guess is that, in Michigan, it would rate somewhere among the 6, 7 or 8 levels. The reciprocal of this concept also exists.

Similar relationships, to one degree or another, can be assumed to exist for most if not all of our native species. A set of coefficients can be formulated for any given area, no matter how large or small. One must keep in mind, though, that the coefficients must be applied by considering the relative fidelity of each species with respect to all other species in the total area, and without regard to the abundance, distribution and ecology of the plant outside the area. This process of determining coefficients of conservation for a flora is the singlemost critical step in the development of an assessment system. An understanding of each species' ecological role in the local vegetation is required, and the coefficients must reflect only this, without regard for factors such as showiness, desirability, size, ease of identification and others that are wholly unrelated to natural area quality.

Introduced Species

Although not used in this Natural Area assessment scheme, allochthonous species are ranked and used in related but separate assessment rationales. The valuation of introduced species is based largely on concepts that are necessarily subjective. By the very nature of their introduced status, such species cannot be thought of in terms of the objective, more philosophical concepts applied to autochthonous elements. By definition, an allochthonous species must exist in some autecological role other than one that is an integral part of the presettlement scenario. Because of the immense and varied array of man-induced environmental alterations and floristic pertubations, these introduced species have numerous contemporary roles. A description of a valuation rationale for these plants in the Chicago region is provided in Swink and Wilhem (1979), but will be omitted here inasmuch as this paper is directed solely toward the identification and assessment of natural area.

Application of the Checklist

The partial checklist provided in Table 2 is a distillation of the checklist presented in Swink and Wilhelm (1979). For brevity, and insofar as this paper is concerned, it includes only those species known to be native to Kane County, Illinois, and includes only the first few pages as an example. The coefficients of conservation are those derived for the entire 22-county Chicago region as defined by Swink and Wilhelm.

Table 2. Partial checklist of native vaxcular plants of Kane County, Illinois, with coefficients of conservatisim for each species (from Swink and Wilhelm 1979).

ACALYPHA
0 *rhomboidea*
ACER
0 *negundo*
5 *nigrum*
0 *saccharinum*
5 *saccharum*
ACNIDA
0 *altissima*
ACORUS
7 *calamus*
ACTAEA
7 *pachypoda*
10 *rubra*
ACTINOMERIS
5 *alternifolia*
ADIANTUM
15 *pedatum*
AESCULUS
3 *glabra*
AGASTACHE
5 *nepetoides*
5 *scrophulariaefolia*
AGRIMONIA
2 *gryposepala*
8 *parviflora*
5 *pubescens*
AGROSTIS
1 *hyemalis*
1 *perennans*
ALISMA
4 *subcordatum*
4 *triviale*
ALLIUM
1 *canadense*
6 *cernuum*
7 *tricoccum*
6 *tricoccum burdickii*
ALNUS
8 *rugosa americana*
ALOPECURUS
6 *aequalis*
AMBROSIA
0 *artemisiifolia elatior*
0 *trifida*
AMELANCHIER
8 *arborea*
9 *humilis*
8 *laevis*
15 *sanguinea*
AMORPHA
10 *canescens*
6 *fruticosa*
AMPHICARPA
4 *bracteata*
4 *bracteata comosa*
ANDROPOGON
4 *gerardii*
5 *scoparius*
ANDROSACE
8 *occidentalis*
ANEMONE
4 *canadensis*
2 *cylindrica*
7 *quinquefolia interior*
2 *virginiana*
ANEMONELLA
7 *thalictroides*
ANGELICA
5 *atropurpurea*
ANTENNARIA
6 *neglecta*
6 *plantaginifolia*
APOCYNUM
5 *androsaemifolium*
4 *cannabinum*
2 *sibiricum*
AQUILEGIA
5 *canadensis*
ARABIS
20 *drummondii*
6 *glabra*
6 *hirsuta pycnocarpa*
3 *laevigata*
6 *perstellata shortii*
ARALIA
8 *nudicaulis*
15 *racemosa*
ARENARIA
9 *lateriflora*
10 *stricta*
ARISAEMA
5 *atrorubens*
8 *dracontium*
ARISTOLOCHIA
15 *serpentaria*
ARTEMISIA
5 *caudata*
20 *serrata*
ASARUM
5 *canadense*
ASCLEPIAS
10 *amplexicaulis*
10 *exaltata*
4 *incarnata*
20 *lanuginosa*
10 *purpurascens*
10 *sullivantii*
0 *syriaca*
10 *tuberosa*
1 *verticillata*
15 *viridiflora*
ASPLENIUM
6 *platyneuron*
ASTER
8 *azureus*
5 *ericoides*
20 *furcatus*
10 *junciformis*
8 *laevis*
4 *lateriflorus*
4 *novae-angliae*
5 *ontarionis*
1 *pilosus*
15 *ptarmicoides*
6 *puniceus*
5 *puniceus firmus*
5 *sagittifolius*
2 *sagittifolius drummondii*
15 *sericeus*
8 *shortii*
3 *simplex*
3 *simplex interior*
10 *umbellatus*

ASTRAGALUS	
15	*canadensis*
ATHYRIUM	
6	*filix-femina michauxii*
15	*pycnocarpon*
BAPTISIA	
8	*leucantha*
15	*leucophaea*
BERULA	
20	*pusilla*
BETULA	
15	*lutea*
6	*nigra*
15	*pumila*
BIDENS	
5	*cernua*
5	*comosa*
8	*connata*
8	*coronata*
1	*frondosa*
1	*vulgata*
BLEPHILIA	
15	*ciliata*
7	*hirsuta*
BOEHMERIA	
2	*cylindrica*
3	*cylindrica drummondiana*
BOTRYCHIUM	
15	*dissectum*
6	*virginianum*
BOUTELOUA	
7	*curtipendula*
BRACHYELYTRUM	
15	*erectum*
BRASENIA	
15	*schreberi*
BROMUS	
9	*ciliatus*
15	*kalmii*
10	*latiglumis*
5	*purgans*
CACALIA	
8	*artriplicifolia*
15	*tuberosa*
CALAMAGROSTIS	
3	*canadensis*
5	*inexpansa brevior*
CALLIRHOE	
15	*triangulata*
CALTHA	
5	*palustris*
CAMASSIA	
6	*scilloides*
CAMPUNULA	
2	*americana*
7	*aparinoides*
10	*uliginosa*
CAMPTOSORUS	
15	*rhizophyllus*
CARDAMINE	
5	*bulbosa*
6	*douglassii*
4	*pensylvanica*
CAREX	
8	*albolutescens*
10	*albursina*
2	*amphibola turgida*
7	*annectens xanthocarpa*
3	*bebbii*
10	*bicknellii*
3	*brevior*
2	*cephalophora*
5	*comosa*
10	*conjuncta*
15	*conoidea*
1	*convoluta*
4	*cristaella*
5	*davisii*
15	*diandra*
8	*emoryi*
10	*festucacea*
10	*gracillima*
5	*granularis*
3	*gravida*
7	*grayii*
4	*hirtifolia*
4	*hystricina*
10	*interior*
5	*jamesii*
10	*lacustris*
15	*laeviconica*
4	*lanuginosa*
8	*lasiocarpa americana*
15	*laxiculmis*
1	*laxiflora*
10	*leptalea*
10	*lupuliformis*
8	*lupulina*
9	*meadii*
8	*muskingumensis*
5	*normalis*
15	*oligocarpa*
15	*pedunculata*
5	*pensylvanica*
10	*prairea*
15	*retrorsa*
15	*richardsonii*
1	*rosea*
10	*rostrata utriculata*
10	*sartwellii*
3	*sparganioides*
8	*sterilis*
2	*stipata*
5	*stricta*
8	*tenera*
9	*tetanica*
3	*tribuloides*
2	*vulpinoidea*
CARPINUS	
8	*caroliniana virginiana*
CARYA	
7	*cordiformis*
5	*ovata*
CASSIA	
5	*fasciculata*
9	*hebecarpa*
CASTILLEJA	
15	*coccinea*
CAULOPHYLLUM	
8	*thalictroides*
CEANOTHUS	
8	*americanus*
CELASTRUS	
6	*scandens*

(continued)

Table 2. (continued)

CELTIS
- 3 *occidentalis*

CENCHRUS
- 0 *longispinus*

CEPHALANTHUS
- 7 *occidentalis*

CERASTIUM
- 6 *arvense villosum*

CERATOPHYLLUM
- 5 *demersum*

CERCIS
- 10 *canadensis*

CHAMAEDAPHNE
- 15 *calyculata angustifolia*

CHELONE
- 8 *glabra*

CHENOPODIUM
- 4 *boscianum*
- 3 *hybridum gigantospermum*

CICUTA
- 8 *bulbifera*
- 6 *maculata*

CINNA
- 5 *arundinacea*

CIRCAEA
- 15 *alpina*
- 0 *quadrisulcata canadensis*

CIRSIUM
- 6 *altissimum*
- 2 *discolor*
- 20 *hillii*
- 10 *muticum*

CLAYTONIA
- 2 *virginica*

CLEMATIS
- 4 *virginiana*

COLLINSIA
- 10 *verna*

COMANDRA
- 7 *richardsiana*

CONIOSELINUM
- 20 *chinense*

CONOPHOLIS
- 15 *americana*

CONVOLVULUS
- 1 *sepium*
- 10 *spithamaeus*

CORALLORHIZA
- 20 *odontorhiza*

COREOPSIS
- 7 *lanceolata*
- 8 *palmata*
- 5 *tripteris*

CORNUS
- 9 *alternifolia*
- 5 *obliqua*
- 1 *racemosa*
- 15 *rugosa*
- 6 *stolonifera*

CORYLUS
- 2 *americana*

CRATAEGUS
- 5 *coccinea*
- 1 crus-galli
- 5 *macrosperma*
- 2 *mollis*
- 1 *punctata*

CRYPTOTAENIA
- 0 *canadensis*

CUSCUTA
- 7 *glomerata*

CYCLOMA
- 7 *artriplicifolium*

CYPERUS
- 10 *diandrus*
- 3 *erythrorhizos*
- 1 *esculentus*
- 2 *ferruginescens*
- 5 *filiculmis*
- 5 *houghtonii*
- 7 *inflexus*
- 4 *rivularis*
- 5 *schweinitzii*
- 1 *strigosus*

CYPRIPEDIUM
- 20 *calceolus parviflorum*
- 20 *calceolus pubescens*
- 20 *candidum*
- 20 *reginae*

CYSTOPTERIS
- 8 *bulbifera*
- 6 *fragilis*

DANTHONIA
- 5 *spicata*

DENTARIA
- 5 *laciniata*

DESCHAMPSIA
- 15 *caespitosa*

DESMANTHUS
- 3 *illinoenis*

DESMODIUM
- 4 *canadense*
- 8 *cuspidatum*
- 6 *cuspidatum longifolium*
- 8 *glutinosum*
- 6 *illinoense*

DICENTRA
- 6 *cucullaria*

DIERVILLA
- 10 *lonicera*

DIOSCOREA
- 5 *villosa*

DIRCA
- 15 *palustris*

DODECATHEON
- 6 *meadia*

DRABA
- 8 *reptans*

DROSERA
- 15 *intermedia*

DRYOPTERIS
- 10 *cristata*
- 15 *goldiana*
- 15 *marginalis*
- 15 *noveboracensis*
- 6 *spinulosa*
- 6 *thelypteris pubescens*

ECHINACEA
- 8 *pallida*

ECHINOCHLOA
- 0 *crusgalli*
- 5 *walteri*

ECHINOCYSTIS
- 5 *lobata*

Table 2. (continued)

ELEOCHARIS	*ELODEA*	*EQUISETUM*
6 *acicularis*	5 *canadensis*	0 *arvense*
5 *calva*	*ELYMUS*	7 *fluviatile*
5 *compressa*	4 *canadensis*	4 *hyemale*
8 *elliptica*	5 *riparius*	*affine*
8 *intermedia*	5 *villosus*	3 *hyemale*
5 *obtusa*	4 *virginicus*	*intermedium*
5 *palustris*	*EPILOBIUM*	
major	10 *angustifolium*	*ERAGROSTIS*
5 *smallii*	3 *coloratum*	7 *frankii*
	3 *glandulosum*	5 *hypnoides*
ELLISIA	*adenocaulon*	0 *pectinacea*
2 *nyctelea*	8 *leptophyllum*	3 *spectabillis*

To utilize the checklist in Natural Area assessment, one uses the following procedure.

1. Compile a list of the plants growing in the area to be assessed without regard to individual plant community delineations. Immediate buffer and ecotonal areas should be included.
2. Assign coefficients of conservatism to each plant listed.
3. Sum the coefficients of all native plants recorded from the area and divide by the total number of native plants; this yields the mean coefficient for all the native plants in the assessment area.
4. Multiply the mean coefficient by the square root of the total number of native species. The product obtained is the Natural Area Index.

Expressed mathematically, the above steps can be represented as follows:

$$I = R/N \sqrt{N}$$

where I = the Natural Area Index, R = the sum of the valuation coefficients for all plants recorded in the area, and N = the number of different native species recorded. The Index is derived largely as a function of the mean quality (R/N). Note also that by treating diversity as the square root of N, increasing extremes of diversity are dampened to allow lower-diversity, specialized and often small areas of very high mean quality to rate favorably in relation to larger, often more diverse areas with lower overall mean qualities.

This relationship between the mean quality and the diversity allows a thorough but single survey, made during the growing season of the year, to be adequate for arriving at a "ball park" estimate with respect to the relative standing of a given area. During a natural area survey of Kane County (Wilhelm 1978), for example, Freeman's Kane woodland was surveyed during July, perhaps the poorest growing-season month in which to survey a contemporary woodland. During this survey, 38 species were recorded (N = 38), yielding an R/N value of 4.1. The Natural Area Index was calculated to be 25. In April, the following year, another survey was made, at which time N was increased by more than 40 percent, while R/N remained essentially the same; the resulting Index was 31—an increase of less than 25 percent. Given past experience, it is highly unlikely that N would ever be increased by as much as 40 percent again, but even if it were, and R/N remained about the same—as it tends to do—the Index would never go higher than 35. Inasmuch as we have found woodlands to rate as low as 10 and as high as 80 or more, it should be clear that one or two visits can be sufficient to determine a site's relative standing against other similar woodlands.

The reason a single survey can yield a fairly accurate Index is that the Index is so dependent on the R/N value, which value experience has demonstrated remains relatively constant after an initial survey. Compare the following relationships, and note the controlling influence of the mean.

A. R/N = 1.2, N = 64, I = 10
R/N = 1.2, N = 100, I = 12

B. R/N = 3.5, N = 64, I = 28
R/N = 3.5, N = 100, I = 35

C. R/N = 5.5, N = 64, I = 44
R/N = 5.5, N = 100, I = 55

Note that, in each of the above examples, while the Index value increases with an increase in richness, the amount of potential increase is restricted to a discrete range. Thus, it would, in a practical sense, be impossible for an area yielding the R/N value in example A to attain the Index range shown even in example B. For this to happen, N would have to be increased to 500!

Table 3 shows three actual examples of areas within the Chicago region—and old field, a degraded prairie and high quality prairie. Each example represents an area of similar size. Note that, while each of the two prairie remnants has similar native richness (N), the Index values vary considerably. The degraded prairie contains some conservative species, but the mean quality of the native species is notably lower than in the high quality prairie. Note also that, although the allochthonous weeds were not directly involved in the calculations, their presence correlates with a reduced Index value, despite higher overall site diversity. This effect is even more evident in the old field.

We have found that the most reliable way of determining to what extent an area reflects natural area quality is to apply the Evaluation Checklist as described above, but with the nonnative species excluded from the calculations. Plants considered nonnative to the Chicago region are not included because the nature of their role in a community is difficult to assess. They are allochthonous by definition, so cannot be integrated into a philosophy erected around autochthonous components. The mere presence of introduced species may or may not be significant as far as the ecological health of an area is concerned. Certainly, if one or more introduced species are occasional to common throughout a given area, a profound effect usually can be observed in the area's native diversity and its Natural Area Index. If introduced species are common in an area, it is almost axiomatic that serious disturbances have occurred in the past; in all such cases, not only is N depressed, but also the mean quality (R/N).

It should be emphasized that the Index values obtained through application of this system are neither ultimate nor mathematically absolute. Various factors influence

Table 3. Index values of flora from three Chicago region sites, each about 1 acre.

Old field		Degraded prairie		Quality prairie	
0	Acalypha rhomboidea	0	Acer negundo	6	Allium cernuum
	_Achillea millefolium_*		_Achillea millefolium_*	10	Amorpha canescens
	_Agrostis alba_*	1	Allium canadense	4	Andropogon gerardii
0	Ambrosia artemisiifolia	6	Allium cernuum	5	Andropogon scoparius
0	Asclepias syriaca	2	Anemone cylindrica	2	Anemone cylindrica
1	Aster pilosus	2	Anemone virginiana	6	Antennaria neglecta
2	Aster drummondii		_Arctium minus_*	5	Aquilegia canadensis
	_Barbarea vulgaris_*	1	Asclepias verticillata	15	Asclepias viridiflora
1	Carex laxiflora	5	Aster ericoides	5	Aster ericoides
	_Chrysanthemum leucanthemum_*	15	Astragalus canadensis	8	Aster laevis
	_Cichorium intybus_*		_Bromus inermis_*	15	Aster ptarmicoides
	_Cirsium arvense_*	5	Carya ovata	15	Aster sericeus
	_Cirsium vulgare_*	8	Coreopsis palmata	7	Bouteloua curtipendula
2	Crataegus mollis	4	Desmodium canadense	15	Carex richardsonii
	_Dactylis glomerata_*	1	Erigeron annuus	9	Carex tetanica
5	Danthonia spicata	3	Erigeron strigosus	7	Comandra richardsiana
	_Daucus carota_*	2	Euphorbia corollata	3	Equisetum hyemale
	_Festuca elatior_*	1	Fragaria virginiana	2	Euphorbia corollata
1	Fragaria virginiana	7	Galium boreale	10	Gentiana puberula
0	Geum canadense	5	Helianthus divaricatus	15	Gerardia aspera
1	Geum laciniatum	0	Juncus tenuis	8	Helianthus laetiflorus
	_Lonicera maackii_*		_Lactuca scariola_*	8	Liatris cylindracea
	_Medicago lupulina_*	4	Lespedeza capitata	8	Linum sulcatum
3	Panicum implicatum	6	Liatris pycnostachya	6	Lithospermum canescens
1	Parthenocissus inserta	6	Lithospermum canescens	7	Parthenium integrifolium
	_Phleum pratense_*	6	Lobelia spicata	9	Petalostemum purpureum
	_Plantago lanceolata_*		_Melilotus alba_*		_Poa compressa_*
	_Poa pratensis_*		_Melilotus officinalis_*	8	Polygala senega
3	Polygonatum canaliculatum	4	Monarda fistulosa	9	Potentilla arguta
4	Potentilla simplex		_Morus alba_*	15	Psoralea tenuiflora
0	Prunella vulgaris	7	Panicum oligosanthes	5	Pteridium aquilinum
1	Prunus serotina	15	Petalostemum candidum	4	Ratibida pinnata
1	Prunus virginiana	9	Petalostemum purpureum	1	Rhus glabra
2	Pyrus ioensis		_Poa compressa_*	5	Rosa carolina
	_Rhamnus cathartica_*		_Poa pratensis_*	5	Silphium integrifolium
	_Rosa multiflora_*	8	Polygala senega	5	Silphium laciniatum
2	Rubus occidentalis	2	Populus deltoides	7	Sisyrinchium albidum
	_Solanum dulcamara_*		_Potentilla recta_*	5	Smilacina stellata
1	Solidago altissima	0	Prunella vulgaris	4	Solidago nemoralis
4	Solidago nemoralis	4	Quercus alba	4	Solidago rigida
	_Taraxacum officinale_*	4	Quercus macrocarpa	5	Sorghastrum nutans
	_Trifolium pratense_*	4	Ratibida pinnata	9	Sporobolus heterolepis
3	Ulmus americana	1	Rhus glabra	10	Viola pedata
0	Viola papilionacea	1	Rudbeckia hirta	10	Viola pedatifida
4	Vitis riparia	6	Salix humilis	10	Zizia aptera
		1	Solidago altissima		[N = 44, R/N = 7.5, I = 50]
	[N = 25, R/N = 1.7, I = 9]	4	Solidago nemoralis		

(continued)

Table 3. (continued)

4	Solidago rigida
6	Stipa Spartea
2	Tradescantia ohiensis
	*Verbascum thapsus**
4	Verbena stricta
	[N = 41, R/N = 4.3, I = 28]

*Allohthonous species.

floristic surveys, including ability of the investigator, seasonality and random probability. Thus, additional taxa will be added periodically to the listing for a site. The damping effect of the R/N value, however, is increasingly effective in minimizing the change in Index values generated by these additions. Similarly, it would be misleading to infer a profound difference in natural quality between two sites' ranking, for example, 38 and 42. The rating system provides a general measure of site natural quality, but is not a precise numerical discriminator. Extensive application of this system to actual vegetative units has shown that discrete ranges of Index values are obtained and correlate closely with degrees of fundamental synecological integrity.

It might seem logical on first thought to give added weight or importance to conservative species that are locally abundant at a given site. Such an approach, however, would necessitate determining the real of actual abundance of each and every species during all seasons. Such a determination is decidedly impractical. The little yellow star grass (*Hypoxis hirsuta*), for example, may prove difficult to detect in August, even though the same place may have manifested thousands of its comely yellow flowers in spring. It is not clear, furthermore, what significance one could attach to a perceived relative abundance of individual members of a discrete community. Also, abundance seldomly is applied consistently—numerous individuals of plants with eye-catching flowers often are regarded with more interest than numerous individuals of inconspicuous sedges or plants in only vegetative condition.

This system is based on the mere presence of a plant and its rating coefficient, as its operative premises. The resultant set of coefficients reflects the degree to which conservatism is present. Systems based on so called "indicator" or "dominant" species are largely reliant on organisms that are large or showy or easy to identify, and often not particularly conservative. Such systems ignore the significance of a majority of the floristic elements from the assessment rationale. It would seem that a diminutive sedge with a coefficient of 7 is every bit as important to the biological and genetic diversity of a site as a large or common tree, especially since it is uncertain how abundant any particular organism *should* be. Again, since perceived abundance and dominance may vary seasonally and annually, even in healthy systems, attaching fundamental significance to these factors in assessing natural quality can generate misleading conclusions.

On any given site survey, the mere presence of a native plant speaks well enough for the conservatism it represents. An exaggerated abundance of any particular plant, valued high or low, often indicates that significant environmental alterations have occurred. The diversity (N) usually will be concomitantly low, for, if any one species is present in rank abundance, it seems obvious that is must be growing at the expense of other plants, depressing the value of N and the Index. In addition, our own experience has shown that when certain few plants are inordinately abundant, the mean quality R/N is also depressed.

Most natural areas have undergone decades of fire deprivation, grazing, mowing or some other postsettlement impact. These impacts have not always been severe enough to compromise the fundamental integrity of a natural area, but often they have been obvious enough to have changed its appearance. There is a tendency in natural area evaluation to view such areas at a level or two below their actual remnant potential. A long-unburned prairie or prairie timber, for example, might appear physiognomically to be ''low quality'' or ''poor,'' yet, after four or five years of regular fire, it can display itself as being of significantly higher quality, which fundamentally it was all along. When, however, an assessment rationale indexes the conservatism at a site and ignores ephemeral features such as apparent species abundance, physiognomy and preconceived notions of structure, natural areas can be evaluated in terms of their actual or potential condition.

There is a strong tendency to consider the importance of area in the calculation of an Index in which diversity is a factor. Some of the theoretical relationships between species diversity and sample size have been treated extensively in the ecological literature. Greig-Smith (1964) made a general observation: ''If the number of species present is recorded from a series of samples of increasing size in a stand and plotted against the areas sampled, a curve is obtained, the slope of which is at first steep but which gradually decreases.''

In practice, the concept of a decreasing or regressive relationship is most complete when applied to a set of very similar community types. Such a concept, however, does not lend itself to communities or community complexes of disparate character. Our field studies have shown quite clearly that a workable, general formula in which area can be treated as a discrete factor is beyond our capability to imagine—certainly plotting N against area in the Chicago region landscape reveals no meaningful relationship.

The Chicago region today is an area with vast expanses of waste land, depauperate fields, agricultural development, drained wetlands and concrete. Only here and there do small vignettes of native diversity remain. The diversity of conservative species itself is more often a correlative of intrinsic quality than the actual size of a given site. Note that a 640-acre farm field has absolutely no natural area significance, whereas a 1-acre prairie may be so rich in conservative species as to be irreplaceable. If, in fact, there was a 640-acre tract of prairie remnant, and this area provided the kind of habitat variability that produces increased species richness, the increase in diversity would distinguish it instantly from the 1-acre tract, and this would be reflected in the Index.

To the extent that area *per se* exerts a meaningful influence on diversity, the square root of N treats diversity as a regressive factor. It could be argued that some type of logarithmic regression would more closely approximate an idealized species area curve. However, the square root function emulates the logarithmic curve fairly closely over the range involved in these calculations and, in addition, provides a greater range of spread among site rankings.

Certainly, in communities that derive their integrity in part from a certain minimum spatial requirement, an apparent lack of critical area can be observed to have a strong negative influence on the general ecological health of the community. This is a size relationship that is, however, quite apart from that which involves area *per se*, and its importance in a given situation can be implied from an analysis of the existing diversity and mean quality. The contemporary Index of a site that recently has been reduced significantly in size may not, of course, reflect the long-term ability to retain its quality. Again, area is of little practical importance, at least in the Chicago region, as a discrete factor with regard to natural area evaluation. From a pragmatic standpoint, since our understanding of the relationship between area and long-term viability is weak, reality dictates that we work with what is left in order to preserve the best remaining natural areas.

One of the problems with natural area assessment has been the delineation of discrete natural communities. It is more often the rule rather than the exception that, in any given area, one can discern two to several plant communities of more or less definable character. It is, however, not always clear just where one community ends and another begins. Since presettlement community character is undeterminable, there is an inherent danger in attempting to classify and manage sites based on preconceived notions of their "ideal" structure, and we know that whatever it was in 1830, it has changed over the last 150 years. Yet there remains in all of us an intriguing tendency to classify these areas with respect to perceived integral units or vegetational components. If we treat a natural area in a total view, envisioning the component communities not as discrete entities but as vital organs comprising a whole, a clearer picture emerges. Such a view becomes possible if we evaluate areas using standards (as expressed in the relationship $I = R/N \sqrt{N}$ common to all plant communities—regardless of their individual hydrology, geology, exposure or specific aspects of their floristic composition.

Summary

Based on 10 years of application of this assessment system to all types of land in the Chicago region, certain patterns have emerged. The vast majority of land in the region ranks less than 20 and is of essentially no significance from a natural area perspective. Areas ranking above 35 possess sufficient conservatism and richness to be of profound importance from a regional perspective. Areas rating in the 50s and above are extremely rare and of paramount importance; they represent less than 0.02 percent of the land area in the Chicago region.

This assessment approach has proven useful in identifying natural areas and assessing the effects of management treatments on these areas (*i.e.*, Lampa 1982, Wilhelm 1978, Young 1986). Once a framework of coefficients of conservatism is established for an area, the system provides a dispassionate, cost-effective and repeatable methodology. Anyone with a reasonable field knowledge of vascular plants, now or a hundred years from now, can apply these techniques and obtain comparable evaluations.

The application of this system to the monitoring of natural areas is especially appealing. Clearly, a chronic decline in Index values over a period of years would indicate a dissipation of site quality and the need to modify management protocols. On the other hand, a steadily increasing Index value indicates that current management is optimizing the synecological potential of the site.

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Wildlife Habitat Assessment of Kane County, Illinois

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Introduction

Kane County is located in northeastern Illinois, and has been subjected to increasing demands on its remaining open spaces (Northeastern Illinois Planning Commission 1980). Land uses once compatible with wildlife in Kane County have been increasingly subjected to development. This continued loss of the county's open lands was of concern to the Kane County Development Department. County staff were keenly aware of the benefits (e.g., natural systems conservation, watershed protection and water quality enhancement, recreational opportunities, property value enhancement, etc.) attributed to open spaces. However, the County was not able to assess quantitatively the value of open spaces proposed for development. Questions raised by the Development Department included: (1) How do we objectively evaluate open space? (2) What assessment procedures exist for this purpose? (3) Can the Development Department staff conduct these assessments? (4) How can we use these results to protect ecologically important open spaces in Kane County?

Subsequently, two procedures were developed to assess the value of open spaces in Kane County. One such procedure (Wilhelm 1977, 1988) applied a floristic assessment to extant plant communities. Assemblages of native plant communities scored highest, reflecting the quality or environment integrity of undisturbed sites (Wilhelm 1978). A second procedure utilized avian communities to assess the importance of the County's remaining open spaces to wildlife (Byers et al. 1982). The purposes of this presentation are to focus on the results and practicality of the wildlife-assessment procedure and to discuss the application of this procedure to land-use planning in Kane County, Illinois.

Methods

Avian surveys were conducted in nine habitat types and designed to document the species composition of avifauna within each habitat type. The nine habitats (annotated below) were selected on the basis of whether each was representative of much of the County, such as cropfields, or were of known importance to wildlife.

1. *Undisturbed woodlands* were typically upland sites dominated by mature oaks *Quercus spp*. with a well-developed understory. There was little evidence of human disturbance.
2. *Disturbed woodlands* were similar to the above, except that the amount of canopy and extent of dominant trees were reduced. Understory vegetation was degraded by human-induced activities.
3. *Riparian woodlands* consisted of corridors of undisturbed woodlands adjacent to watercourses.

4. *Wetlands* were typically palustrine basins with an interspersion of open water and emergent vegetation.
5. *ROWs/greenbelts* were linear man-made habitats (e.g., recreational trails, hedgerows) with much spatial heterogeneity of herbaceous and woody cover. The vertical profile of the woody cover was highly variable.
6. *Unaltered, riparian greenbelts* were similar in structure to ROWs, except that these greenbelts paralleled small watercourses.
7. *Altered, riparian greenbelts* also paralleled small watercourses, but lacked woody cover.
8. *Hayfields* were agricultural crops of primarily legumes or cereal grains.
9. *Cropfields* were characterized by rowcrops.

Our assessment of the importance of each of these habitats to wildlife was based on the avian community present within each habitat. Graber and Graber (1976) established a precedent for the use of avian data in this regard, noting that birds occupy nearly all habitats and are more easily counted than other types of wildlife.

We chose to census birds using the strip-census technique (Graber and Graber 1963), which required two observers walking a parallel course, counting birds observed between them and to either side. Eight 0.5-mile (0.8 km) transects were established in each major habitat and surveyed once during the winter and twice during the breeding season (16 surveys per habitat). Avian surveys were normally initiated before sunrise, completed by mid-morning, and were conducted under favorable weather conditions.

Development of the Assessment Procedure

The Basic Wildlife Index

We chose to focus on two aspects of the avian community present within each habitat—species diversity and featured species enhancement—to derive the relative value of each habitat to wildlife. These two concepts were first espoused by Leopold (1933) as the twin goals of conservation management.

The first concept (species diversity) was addressed by calculating the bird species diversity (BSD) (Lloyd et al. 1968) and presenting mean BSD values for each habitat type by season. A number of investigators (Karr 1968, Shugart and James 1973, Balda 1975, Bond 1957) documented increasing BSD values associated with maturing habitats. Increased structural diversity inherent to mature habitats is frequently cited for this relationship (MacArthur and MacArthur 1961, Willson 1974). BSD values also have been shown to increase as the horizontal patchiness and interspersion of habitats increase (Roth 1976). Asherin et al. (1979) stated, and we concur, that BSD is a reliable approximation of the ecological niche potential for vertebrate species and, likewise, the relative value of different habitats to wildlife.

The second aspect of the avian assemblages, described by Leopold (1933) as featured species enhancement, addressed the habitat-specialist avifauna that are rare or in danger of extirpation in Illinois. We utilized Graber and Grabers' (1976) faunal scoring technique, which places greater emphasis on species that are either rare or with specific niche requirements, by assigning higher point values to those species. Point values ranged from 10 points for common or introduced species to 40–80 points for those species with specific niche requirements. Mean faunal scores (FS) were derived for each habitat from faunal scores calculated for each of the survey routes within each habitat type. Point values were assigned to those species observed within each habitat only if the habitat provided suitable nesting or brood-rearing cover (during the breeding survey) and if the habitat provided shelter during the winter.

The BSD and FS of avian communities within each habitat provide the basis for a mathematical expression that reflects the wildlife value (Basic Wildlife Index or BWI) for each of the nine habitats (Byers et al. 1982). The formula we derived to calculate BWI values is as follows:

$$BWI = [1\ (WBSD) + 0.005(WFS)] + [2(BBSD) + 0.025\ BFS)]$$

where WBSD is bird species diversity (BSD) during winter,
WFS is faunal score (FS) during winter,
BBSD is breeding BSD, and
BFS is breeding FS.

The various components of the BWI are modified by constants to (1) stress the importance of the breeding surveys, and (2) influence the relative magnitude of BSD (which ranged from 1–2.5) and BFS (which ranged from 30–830) in the final derivation of the BWI.

The Specific Wildlife Index

The original extent and integrity of the County's open spaces (especially wetlands, prairie and woodlands) have been greatly reduced and further impacted by degradation and fragmentation (Byers et al. 1982). Given this history of intensive land use, we selected two additional factors that addressed the importance of specific sites or parcels of land to wildlife.

Specific Wildlife Index (SWI) = BWI + Rarity + Size

The first factor (Rarity) is a consideration of how rare a specific habitat is within the County. Values range from 0 to 10 and are based on an approximation of the current acreage of each habitat extant within the County (Byers et al. 1982). These data were derived from aerial photography interpretation conducted by Northern Illinois University. Wetlands and undisturbed upland or riparian woodlands each represented less than 1.5 percent of the County and received the maximum score (10). Cropfields, however, represented approximately 55 percent of the County and received no score (0).

The second factor (Size) represents the ecological importance of larger blocks of habitat in maintaining species richness (Robbins 1979, Samson 1980). The effects of fragmentation of habitats, particularly woodlands, have been well-documented (Whitcomb et al. 1981). Specifically, we utilized species area curves—developed by Graber and Graber (1976) for avifauna in selected Illinois habitats—to assign Size values of 0 to 10. Acreages of contiguous habitat, both within and adjacent to the boundaries of specific sites, were used to assign values. For linear greenbelts, S values were assigned based on the width and presence of a vertical vegetational layer, and whether or not the greenbelt served to connect areas important to wildlife. Greenbelts that connect such areas may reduce the effects of habitat fragmentation (MacClintock et al. 1977). Cropfields were assigned S values of 0, regardless of size, because the functional value of this habitat to wildlife does not increase with size.

Results and Discussion

The Basic Wildlife Index

Winter and breeding bird surveys in Kane County documented 43 and 100 avian species, respectively. The species composition and density of avifauna within each habitat were compiled by Byers et al. (1982). Summaries of the mean BSD and mean FS for each habitat from that study are presented in Table 1. These data are necessary to calculate BWI values for each habitat.

BWI values ranged from a high of 26.8 for wetland habitats to a low of 4.3 for cropfields. Undisturbed upland and riparian woodlands scored higher than either the disturbed woodlands or the three types of greenbelts surveyed (Table 1). A review of Table 1 indicates that BFS values figured more prominently than BSD values in calculation of BWI scores for each habitat. For example, mean breeding BSD values for undisturbed upland (2.49) and riparian woodlands (2.37) were comparable to BSD values for those greenbelts with well-developed vertical vegetational profiles (2.42 and 2.37 for ROWs and unaltered greenbelts, respectively). Probst (1979) reported that a high level of constancy in the diversity of avifauna in woodlands can occur despite significant differences in the structural diversity of the vegetation. This constancy occurs because, as undisturbed woodlands are impacted by fragmentation and degradation, avian species not normally associated with woodland interiors are attracted to the increased amount of ''edge'' available in linear or disturbed wooded sites. However, the BWI scores for the undisturbed woodlands (16.5 and 16.29, Table 1) were greater than BWI scores calculated for the greenbelts because of the higher incidence of avifauna with specific niche requirements (e.g., higher faunal scores) in undisturbed woodlands. The high BWI for wetlands (26.8) can be directly attributed to the specific niche requirements (and resulting higher faunal scores) of many of the wetland avian communities.

Table 1. Mean bird species diversity (BSD), mean faunal scores (FS), and calculated Basic Wildlife Index (BWI) values for 9 habitats in Kane County, Illinois. Mean BSD and FS scores were derived from avian surveys conducted at eight representative sites for each habitat type. Surveys were conducted once during the winter and twice during the breeding season.

Habitat type	Winter		Breeding season		BWI
	WBSD	WFS	BSD	BFS	
Wetlands	1.18	106	2.18	830	26.8
Riparian woodlands	0.92	64	2.37	421	16.5
Undisturbed woodlands	0.99	88	2.49	398	16.3
Unaltered greenbelts	1.36	97	2.37	325	14.7
ROWs/greenbelts	1.11	84	2.42	306	14.0
Disturbed woodlands	1.19	87	2.21	268	12.7
Altered greenbelts	0.97	57	1.80	223	10.4
Hayfields	[a]	[a]	1.71	169	10.0
Cropfield	0.15	19	1.63	31	4.3

[a]Hayfields were not surveyed during the winter.

The Specific Wildlife Index

The SWI provides a quantitative measure of the value of a particular site or parcel of land to wildlife. SWI represents the summation of: (1) the inherent value of each habitat to wildlife (as expressed by BWI); (2) a consideration of how common or how rare (R value) the habitat is in Kane County; and (3) the functional value (S value) of the size of contiguous habitat blocks. SWI values for six habitat types of four size categories are presented in Table 2. Values ranged from a high of 46.8 for wetlands larger than 80 acres (32 ha) to a low of 4.3 for cropfields.

Practicality of the Assessment Procedure

Our intent is not to contrast or compare this assessment procedure with other published assessments. Indeed, assessments by Thomas (1982), Farmer et al. (1982), Nelson and Salwasser (1982), and Schamberger and Krohn (1982) suggest a variety of approaches to wildlife habitat assessment. Seitz et al. (1982) commented further on some of the difficulties associated with common assessment procedures. More recently, Graul and Miller (1984) contrasted the various approaches to habitat assessment procedures, and stressed the need for an ecosystem-management technique blending the attributes of the different approaches. We would simply submit that this procedure represents a blend of both the ecological-indicator approach and the habitat-diversity approach as described by Graul and Miller (1984).

We acknowledge the simplified approach of this assessment procedure and the problems inherent in inferring values for specific sites (e.g., proposed development sites) from avian surveys conducted at other sites but with similar habitats. This approach has resulted in some biases. Notably, BWI values assigned to woodlands and wetlands may be conservatively high. This is because BWI values were calculated from survey data from typically larger units of woodlands or in better quality wetlands with interspersion of open water and emergent vegetation.

However, this simplified approach does allow staff of the Kane County Development Department, who are not trained wildlife biologists, to utilize the procedure. The staff need only be able to recognize the habitat types within or adjacent to the boundaries of proposed developments. To assist with habitat identification, the characteristics of each habitat were clearly annotated (Byers et al. 1982)). The cost-

Table 2. Specific Wildlife Index (SWI) values calculated for selected hypothetical, contiguous blocks of habitat in Kane County, Illinois. SWI values may be used to ''score'' the importance of a specific site to wildlife.

	SWI values			
	Contiguous blocks of habitat (by size)			
Habitats	1-10 acres	11-40 acres	41-80 acres	>80 acres
Wetlands	40.8	42.8	44.8	46.8
Riparian woodlands	28.5	30.5	31.5	32.5
Undisturbed woodlands	28.3	30.3	31.3	32.3
Disturbed woodlands	17.7	19.7	20.7	21.7
Cropfield	4.3	4.3	4.3	4.3
Greenbelts[a]	16.4–27.7			

[a]Size values for greenbelts were based on the structure of the greenbelt and whether the greenbelt served to reduce habitat fragmentation.

effectiveness of this approach, which precludes the need for additional staff personnel or the need for wildlife surveys on each proposed development site, is self-evident.

Application of Assessment Procedure to Land-use Planning

Planning for the preservation of plant and animal communities is a goal that should be seriously pursued at every level of planning and design (Lyle 1986). Identified goals of this planning process include identification, preservation and enhancement of biotic communities. We believe this wildlife assessment procedure is an useful tool for local governments to identify important biotic communities. Bissell (1986) commented that local government involvement in identification and preservation of regionally important biotic communities is often more effective than are either state or federal efforts. We concur with Bissell (1986) that local government is best suited to implement zoning or other protective ordinances of biotic communities, if such actions reflect the concerns and interests of local citizens.

The Kane County Board formally adopted the County Land Use Plan (Kane County Development Department 1982), which includes preservation of sites within the County that, using this assessment procedure, score higher than 25 points. All remaining wetlands, undisturbed woodlands and selected greenbelts in the County would be protected (Table 2). Collectively, such high-scoring habitats represent less than 4.0 percent of the County.

This assessment procedure has been useful in both prioritizing sites for permanent acquisition by Kane County and for minimizing the impact of proposed development on high-scoring open spaces (Richard Young [Kane County Environmental Director] personal files: 1987). One identified problem, however, is that some municipalities in the County have exercised their land-use authority to circumvent the Kane County Board recommendations with regard to preservation of important biotic communities.

Nevertheless, we believe that this simplified approach, and that of Wilhelm (1978, 1988), to habitat assessment can be extremely useful tools for local governments to identify important biotic communities. Further, we believe local governments can be an effective advocate of biotic communities through local preservation initiatives. Additional comments regarding the usefulness of this assessment procedure to land-use planning in Kane County are presented by Bus (1988).

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Collaboration in Land Resource-management Planning and Wildlife Preservation

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Kane County, Illinois is located in northeastern Illinois, approximately 30 miles west of Chicago. The County includes a geographic area of approximately 522 square miles, with a current estimated population of 310,000. The dominant physical features of the County include the Fox River, which flows parallel to the County's eastern border, and woodlands associated with that drainage system and morainal ridges. The balance of the County is upland sites, which have been converted primarily to agriculture (representing approximately 70 percent of the total area).

Historically, settlement patterns were associated with towns and villages along the Fox River. That demographic pattern has continued to this day, with approximately 90 percent of the County's residents residing in cities and towns bordering the Fox River. Population trends demonstrates rapid growth, doubling in 30 years, from 150,000 in 1950 to a current estimate of 310,000. Projected population growth for the year 2010 is 434,000. Much of this growth stems from the encroachment of a growing Chicago metropolis. The County is within commuting distance of Chicago, by way of two interstate highways and by three commuting railroads.

Rapid population growth in Kane County since 1960, however, has caused major land-use changes. Beginning at that time, wooded and agricultural areas beyond the municipal boundaries of cities and towns in the Fox River valley were subjected to significant residential and urban development. This increased level of urbanization prompted the County Board in the early 1970s to initiate an on-going planning and development program. Initial efforts focused on traditional planning techniques, such as land-use ordinances, population forecasts, transportation studies, sewer and water facilities, etc.

In 1976, a preliminary land-use plan was adopted that presented a basic framework for land-use management and community development (Kane County Development Department 1975). Though progressive, that plan did not sufficiently address the preservation of prime farmland, wildlife habitats, natural areas or other environmental resources. A significant and subsequent activity was the preparation and publication in 1977 of a report entitled *Ecological Assessment of Open Land Areas in Kane County, Illinois* (Wilhelm 1977). That publication provided a system of numerical ratings for the County's 1,164 plant species, and a method for rating the ecological significance of existing plant communities. That effort was quickly followed by completion of the *Kane County Natural Area Survey* (Wilhelm 1978), which identified several extant natural plant communities within the County.

During the same period of time, the County Board implemented a large-scale, open space acquisition program aimed at preserving natural areas, wetlands, woodlands, and an extensive recreational trail system and greenbelt along the Fox River. The County has also been fortunate in having large areas of semi-public and private properties in "open space" areas. These include educational and recreational facilities, government research laboratories, national fraternal organizations, and conservation organizations, all of which manage open spaces for wildlife. All of these open spaces, both public and private, provide important amenities to Kane County residents. These amenities include natural systems conservation, watershed protection and water quality enhancement, recreational opportunities, and wildlife habitat.

In order to document further the relationship between open spaces and wildlife communities, Kane County authorized in 1979 extensive wildlife surveys and the development of a numerical rating system for wildlife habitats (Byers et al. 1982). That effort was undertaken in collaboration with the Max McGraw Wildlife Foundation and exemplifies the type of cooperation needed among public and private sectors to provide better land resource management and wildlife conservation. The County is routinely involved with federal, state and local units of government, as well as organizations and individuals from the private sector, to promote wise land-use policies.

The County's experience has been that collaborative efforts can be productive and are effective in implementing plans and policies for preserving natural areas and critical wildlife habitats in the face of increased urbanization. While much of this collaborative effort has been directed toward public acquisition of open space areas, this type of effort has also been effective in educating private property owners. For example, Kane County has used the results of floral (Wilhelm 1977) and faunal (Byers et al. 1982) assessments as guidelines for establishing a zoning category (or density) for individual development projects, as well as for special areas of the County that can be best be preserved by allowing large, "estate-type" lots. In other instances, the Planning Commission and County Board have required that existing habitats within proposed developments be protected and preserved through the use of conservation easements, restrictive covenants or homeowner associations that own or manage private open spaces. The results of these assessments have also been useful in prioritizing areas for purchase by the Kane County Forest Preserve District.

It is important to emphasize, however, that the floral and faunal assessment procedures do not operate in a vacuum. Their true effectiveness is achieved by Kane County when they are used in conjunction with other growth management and review techniques. These techniques include an adopted land-use plan (Kane County Development Department 1982) accompanied by *detailed* land-use maps and specific policies and ordinances for preserving open spaces (e.g., zoning, floodplain protection, stormwater and erosion control). Further, a land-evaluation and site-assessment system for determining the impact of a development proposal on preservation of agricultural land has been a useful tool (Kane County Development Department and Kane-DuPage Soil and Water Conservation District 1984). When part of a comprehensive land-use plan, both the floral and faunal assessments serve to complement existing policing and ordinances, and—in doing so—become more effective tools for managing growth and for managing wildlife and the habitats on which they depend for survival.

In summary, planning is a political process. Kane County has adopted its land-use plan, policies, ordinances, and the floral and faunistic assessments because the citizens of the County have determined that planning and the preservation of open spaces (including natural areas and areas critical to wildlife) are important to the quality of life in Kane County. The elected officials have responded accordingly. While growth and economic development are desirable to Kane County, a balanced approach has been taken, which will preserve for future generations many of the natural resources of the County.

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Cooperative Restoration of a Riverine Wetland in Missouri

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The Problem

The North American Waterfowl Management Plan (NAWMP) (1986) identifies habitat loss as the primary problem facing waterfowl managers today. Specifically, it recognizes that future waterfowl populations are dependent on the restoration and management of wetlands.

Wetland losses have been dramatic since European man settled the continent. For example, more than 50 percent of the original 215 million acres (87 million ha) of wetlands in the lower 48 states have been destroyed (Tiner 1984). Recent annual wetland losses averaged 458,000 acres (185,000 ha) primarily because of agricultural development (Frayer et al. 1983). In Missouri, 96 percent of the original 2.4 million acres (970,000 ha) of southeastern lowland forests have been drained and cleared (Korte and Fredrickson 1977), and 2,226 miles (3,582 km) of stream and riparian corridors have been lost to channelization (R. Wehnes [Missouri Department of Conservation] unpublished data).

Of particular concern is the degradation of riverine wetlands in the valleys of the state's great rivers—the Mississippi and Missouri. Along the Missouri River, about 93 percent of the shallow marshes, backwaters and sloughs have been converted to cropland or swift deep channels (U.S. Fish and Wildlife Service 1980). Likewise, the loss of bottomland hardwood habitats to agricultural uses along the Missouri is nearly complete. Lapse of the dynamic nature of many riverine wetlands also has been devastating. Natural meandering and flooding no longer maintain diverse wetlands within the river bottoms. Dams, levees and drainage have altered natural hydrologic processes sufficiently to leave the floodplains barely recognizable as wetlands.

Wetland Management Initiatives

Missouri Department of Conservation

The Missouri Department of Conservation (MDC) has been involved in wetland conservation for 51 years. A particularly aggressive land-acquisition program was initiated in 1977, with monies generated through the "Design for Conservation" program, which includes revenues from a one-eighth percent sales tax. In total, 75,000 acres (30,000 ha) of wetlands have been acquired. These wetlands are managed to provide habitats for concentrations of migratory and wintering waterfowl as well as other native and nonnative wildlife species (Fredrickson and Taylor 1982).

Ducks Unlimited

Ducks Unlimited (DU) also has been developing wetlands since 1937. Monies from sportsmen and conservationists enable DU to fund habitat-improvement programs from Canada to Mexico. About 3,700 wetland projects have been completed throughout North America, ranging in size from small prairie potholes to major undertakings of more than 500,000 acres (202,000 ha). In total, DU has reserved 4.4 million wetland acres (1,781,000 ha) and developed more than one-half of that area.

DU initiated a three-phase program known as "Wetlands America" in 1983, to develop waterfowl habitats in the United States. Phase I includes habitat inventory and evaluation of wetland basins in the region of primary waterfowl production (Koeln et al. 1987). Data collected through Landsat's Thematic Mapper will be completed in 1989 for these wetlands, followed by analysis of surrounding uplands.

Phase II involves engineering and enhancement of wetland habitats in five key waterfowl production states—Alaska, Montana, North Dakota, South Dakota and Minnesota. Approximately 90 percent of the waterfowl produced in the U.S. are hatched in these states. In addition, DU opened a regional office in the Central Valley of California to assist in critical western wetland improvements. These projects will be cooperative ventures located primarily on public lands. To date, DU has completed 127 projects involving 290,000 acres (117,000 ha); 150 other projects are in various stages of development.

Phase III of DU's U.S. habitat improvement effort is the Matching Aid to Restore States Habitat (MARSH) program. This program recognizes increased evidence that nonbreeding habitats are critical to duck populations (Heitmeyer and Fredrickson 1981) and provides funds to state resource agencies, based on local income generated by fund-raising efforts. States are eligible for 7.5 percent of DU's income raised in that state by volunteers. A total of $10 million has been made available through this program. The first three MARSH ventures were in Idaho, Iowa and Pennsylvania. The fourth, described below, is with MDC. One hundred and thirty additional MARSH projects now have been initiated in 48 states. These projects encompass more than 50,000 wetland acres (20,000 ha).

Missouri Department of Conservation in Cooperation with Ducks Unlimited

MDC and DU have cooperated to improve wetland habitats since 1979, when Missouri adopted a state waterfowl hunting stamp. Ten percent of annual income from sales of that stamp are devoted to research and administrative fees; the remaining 90 percent is shared equally between instate wetland projects and development of breeding ground habitat improvements sponsored by DU. To date, more than $0.5 million have been contributed by Missouri to four projects in Manitoba and Saskatchewan.

MDC also recently has joined with DU through the MARSH program. Cooperative funding for development of the Grand Pass Wildlife Area (GPWA), located on the Missouri River in west central Missouri, began in 1985. The GPWA MARSH project represents an opportunity to restore a Missouri River wetland that was drained and converted to cropland. The restored wetland area will provide traditional migration habitat for dabbling ducks and wintering habitat for Canada geese (*Branta canadensis*). This cooperative venture is the largest single project undertaken through MARSH, and also is the first commitment for multiyear funding.

GPWA MARSH Project: A Case History of an MDC/DU Cooperative Management Initiative

Acquisition

The NAWMP (1986) specifically calls for acquisition of critical migration and wintering habitats for long-term use by waterfowl. MDC began acquisition of GPWA in 1979 when 2,100 acres (850 ha) were purchased for $3.2 million. The area was expanded in 1984 when 2,611 acres (1,057 ha) were acquired for $3.6 million. In 1985, an additional 200 acres (81 ha) adjoining the area were leased for a nominal fee from a local drainage district. This lease arrangement substantially augmented the overall acquisition by providing a remnant emergent wetland.

The Missouri River forms the western and northern boundary of GPWA for about six miles (10 km). The topography of the area is generally flat, with remnant sloughs and potholes. At time of purchase, the area consisted of 750 acres (304 ha) of riverine timber, 3,661 acres (1,482 ha) of cropland, a 200-acre (81 ha) oxbow lake, and 300 acres (121 ha) of roads, levees, etc. One thousand six hundred and forty-four acres (665 ha) of the cropland historically had been shallow-water marshes frequented by waterfowl.

Restoration

An area management plan was developed by an MDC interdisciplinary team to guide restoration of GPWA. The plan explores the history and physiography of the area, and outlines expansion opportunities, resource management, recreational uses, personnel and development costs. The primary objective is to provide habitats for concentrations of migratory waterfowl and other wildlife, with emphasis on migration and wintering habitats for Canada geese of the Eastern Prairie Population and habitat for migrating dabbling ducks.

Because of the dramatic hydrologic changes caused by man along the MIssouri River, substantial water-control structures now are necessary to facilitate desired water management on GPWA. Nearly completed are nine miles (14 km) of levee, four miles (6 km) of water distribution canal, and 45 water-control structures. Three pumps will supply water from the river, and two pumps will remove water from the area. This system will provide about 500 acres (200 ha) of seasonally flooded wetlands each year. These wetlands will be in 10 separate units, several having multiple drainages that actually will allow manipulation of water levels in as many as 25 separate basins.

Emergent marshes, periodically flooded impoundments and terrestrial habitats will provide a diversity of habitat types at GPWA. Twenty-one impoundments will be managed for production of native moist-soil plants by timely manipulation of water levels and periodic soil disturbance as suggested by research findings of L. H. Fredrickson and others at the University of Missouri, Columbia (e.g., Fredrickson and Taylor 1982). Three different water-management regimes will be used for each group of seven pools distributed throughout the area. Each treatment will be rotated annually to a different set of pools. During the first year, or rejuvenation phase, the impoundment will be drained early in the year, dried and possibly planted to rowcrops. The second year, the moist-soil phase, typically will involve a fallow rotation when desired native plant species will dominate, especially if appropriate drawdown dates are observed. During the third year, the vegetation-control phase, there will be an option for spot treatment of undesirable plants. This management scheme, when employed in a scattered pattern throughout the area, will provide important habitat components for dabbling ducks and Canada geese as well as many other wetland wildlife species (Baskett 1988).

Substantial funding was needed for capital developments vital to this sophisticated habitat-management regime. Although MDC solely bore the acquisition costs of GPWA, the DU MARSH program was an important impetus for developing GPWA.

Implementation of construction projects outlined in the GPWA management plan will total $7 million upon completion. MARSH provided a significant contribution by pledging $577,000—adequate to purchase and install the intake pump station. This facility, capable of pumping 60,000 gallons (230,000 L) of water per minute from the Missouri River, will provide waters to flood marshes, crops and timberlands used by waterfowl, and will function as the heart of this wetland-restoration project. The cost of operating GPWA will be borne by MDC.

The cooperative-funding process began when the Missouri Conservation Commission met with DU representatives soon after the program was announced. A Memorandum of Understanding was signed in April 1985, and after detailed project proposals were approved, a site-specific agreement completed the required paperwork. In May 1987, a formal dedication ceremony was held to announce the cooperative venture officially. Annual installments averaging $75,000 will be paid to MDC until 1993, when the full commitment will be reached.

Future State/DU MARSH Opportunities

DU Projects in Canada, Mexico and the U.S. have a bright future. The GPWA MARSH project is just one element of DU's comprehensive approach to wetland conservation.

This project also is only part of Missouri's wetland program. Missouri has eight wetland areas totaling 36,380 acres (14,720 ha) that have developments necessary for intensive management similar to that planned for GPWA. An additional 20 areas totaling 38,430 acres (15,550 ha) are not yet developed for wetland management. Some of these areas are scheduled for intensive management, whereas others will be developed and managed less intensively.

Many other states have wetland conservation programs and use a variety of taxes and license fees to fund these initiatives. Now DU, through MARSH, is providing a complementary funding source. Our experience in Missouri demonstrates that MARSH can readily be used to augment important wetland projects, and we encourage other states to consider the benefits of the program.

A framework for future action by all agencies involved in wetland conservation is provided by NAWMP. This plan recognizes that maintenance of waterfowl populations is dependent on the protection, restoration and management of habitat. It also promotes cooperation among governmental agencies and private organizations to fund this massive wetland conservation effort.

The scope of NAWMP is grand, but the effort to conserve wetlands will succeed in a series of smaller steps. At GPWA, a state agency, a private conservation organization and a local levee district have cooperated to restore one wetland unit. We have high hopes for GPWA, both as a resource for the citizenry of Missouri and as a prototype for further riverine wetland restoration efforts.

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Maryland's Chesapeake Bay Critical Area Program: Implications for Wildlife

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The Chesapeake Bay is the largest estuary in the United States and one of the most biologically productive ecosystems in the world. The water and related land resources of the Bay serve nearly 12 million people in five states. However, the Bay has been stressed by an ever-increasing human population and related development within its watershed. The Bay has changed dramatically in the past century and this change has accelerated during the past 30 years (Environmental Protection Agency 1983).

Concerns expressed by scientists, environmentalists, watermen and other citizens interested in the Bay prompted the 94th U.S. Congress to direct the Environmental Protection Agency (EPA) to conduct a five-year study of the water quality and resources of the Bay, and to develop management strategies to restore and conserve it. The study was completed in 1983 and, among other findings, documented the serious impact of nutrients (i.e., nitrogen and phosphorus) and toxic chemicals on the health and abundance of the Bay's living resources. The conclusion was: "It is essential that we act now to control and alter human activities and practices on land if we are to halt the deterioration of the Bay and the subsequent losses of plant and animal life they produce" (Environmental Protection Agency 1983).

The Chesapeake Bay Critical Area Law (Natural Resources Article 8, Subtitle 18; Annotated Code of Maryland) was one of 10 bills passed by the 1984 Maryland General Assembly to begin implementing the recommendations made by EPA's study. The stated purposes of the Law are to: (1) establish a Resource Protection Program for the Bay and its tributaries by fostering more sensitive development activity for certain shoreline areas so as to minimize damage to water quality and natural habitats; and (2) implement the Resource Protection Program on a cooperative basis between the state and affected local governments [Natural Resources Article 8–1801(b)].

The law further mandated local jurisdictions to develop Critical Area Protection Programs which contain the elements necessary to meet the following goals: (1) minimize adverse impacts on water quality that result from pollutants that are discharged from structures or conveyances that have run off from surrounding lands; (2) conserve fish, wildlife and plant habitat; and (3) establish land-use policies for development in the Critical Area that accommodate growth and also address the fact that, even if pollution is controlled, the number, movement and activities of persons in that area can create adverse environmental impacts [Natural Resources Article 8–1808(b)].

The Critical Area Law has far-reaching implications for natural resource management. This paper outlines the Program and its corresponding regulations, which are of special importance to wildlife and wildlife management. Habitat protection measures and proposed programs for implementation of the Law are also discussed.

Geographic Area

The Law defines the Critical Area as all waters of and lands under the Chesapeake Bay and its tributaries to the head of tide, all state and private tidal wetlands, and all land and water within 1,000 feet (305 m) beyond the landward boundaries of wetlands and the heads of tide.

This area was adopted in recognition of the fact that, although the Bay is impacted by activities outside this narrow strip, development pressures are more intense and land-use changes more frequent here than in areas farther inland (Davis 1987).

The Critical Area encompasses parts of 16 of Maryland's 23 counties and 44 incorporated cities and towns, hereafter referred to as local jurisdictions. The Critical Area encompasses approximately 623,000 acres (249,200 ha), nearly 10 percent of the entire land area of the State. Types and percentages of land use within this Area are 11 percent developed, 28 percent agriculture, 30 percent forested and 31 percent wetlands (Department of State Planning 1985).

Critical Area Criteria

The Critical Area Law outlines in general the purpose, goals, are and administrative framework of the Critical Area Program. It also includes specific elements that the local jurisdictions must address in their Protection Plans.

The Chesapeake Bay Critical Area Commission Criteria for Local Critical Area Program Development (Code of Maryland Regulations, 14.15.10–14.15.11), hereafter referred to as the Criteria, are voluminous state regulations adopted in May 1986 detailing the requirements necessary to implement the Critical Area Law. The Criteria defined the minimum guidelines local jurisdictions were to follow when developing their Resource Protection Programs. The Criteria specifically addressed development, water-dependent facilities, shore erosion, agriculture, surface mining, natural parks and habitat protection in the Critical Area. This paper focuses on those regulations with direct implications for wildlife.

Development

As stated above, the Critical Area Law directed local jurisdictions to develop Critical Area Protection Programs that accommodate growth and, at the same time, conserve habitat and protect water quality. As the first step in achieving this goal, the Criteria established three categories of land use: (1) Intensely Developed Areas; (2) Limited Development Areas; and (3) Resource Conservation Areas. Intensely Developed Areas (IDA) are characterized as areas where housing, commercial or industrial uses predominate, and where relatively little natural habitat is found. Housing density is equal to or greater than 4 units per acre (0.4 ha). Limited Development Areas (LDA) contain low or moderate development with some plant and wildlife habitat. Housing density ranges is 0.2–4 dwellings per acre (0.4 ha). Resource Conservation Areas (RCA) are those in which natural features predominate and where resource utilization such as forestry, fishing and agriculture is found. Housing density is less than 0.2 dwelling per acre (0.4 ha).

Local jurisdictions classified their Critical Areas according to these land-use categories. Then, the Criteria required the local jurisdictions to adopt policies that limit the intensity of development in LDA and RCA so that the prevailing character as identified by land use and density does not change. Future development in RCA is limited to a residential density of one unit per 20 acres (8 ha), with minimum lot size determined by the local jurisdiction.

The Criteria also require that development must be subject to the Habitat Protection Area Provisions within all three land-use categories. This single requirement is ultimately the most important regulation for ensuring wildlife habitat protection. Another standard requires that wildlife corridor systems be incorporated into development sites. The wildlife corridors must connect the largest undeveloped or most vegetated tracts within the parcel to similar tracts on adjacent parcels. An additional measure, in RCA, requires that adequate breeding, feeding and wintering habitats must be provided for those wildlife populations that utilize the Bay, its tributaries or coastal habitat.

Forest and Woodlands

The Criteria recognizes forests as a protective land use because of their role in improving water quality and providing wildlife habitat. Forests are protected through a number of measures. The Criteria require that the local jurisdictions adopt programs that assure that forested acreage in LDA and RCA is maintained or increased. Restrictive standards for developing woodlands and mandatory afforestation and reforestation regulations must be adopted to meet these goals. In addition, Forest Management Plans are required for all timber harvesting affecting one acre (0.4 ha) or more of woodland. These plans must include measures to protect surface water and groundwater quality and incorporate protection measures for those forests supporting other protected habitats, such as endangered species habitat. These plans must also provide continuity of habitat through consideration of timing, size and intensity of harvests and afforestation and reforestation.

The Buffer

Each jurisdiction is required to establish a minimum 100-foot (30.5 m) buffer landward from mean high tide and which will serve the following purposes: (1) provide for the removal or reduction of sediments, nutrients, and potentially harmful or toxic substances in runoff entering the Bay and its tributaries; (2) minimize the adverse effects of human activities on wetlands, shorelines, stream banks, tidal waters and aquatic resources; (3) maintain an area of transitional habitat between aquatic and upland communities; (4) maintain the natural environment of streams; and (5) protect riparian wildlife habitat.

This buffer must be expanded in certain circumstances to include contiguous, sensitive areas, such as steep slopes, hydric soils or highly erodible soils. The buffer must be maintained in natural vegetation, but may include planted vegetation where necessary to protect, stabilize or enhance the shoreline. Other than a few exceptions to accommodate existing development, existing agriculture and limited timber management, this buffer must remain undisturbed.

Nontidal Wetlands

Nontidal wetlands are defined as lands (except officially designated tidal wetlands) where the water table is usually at or near the surface, or lands where the soil or substrate is covered by shallow water at some time during the growing season. They are characterized by one or both of the following: (1) the land supports predominantly hydrophytic vegetation periodically; and/or (2) the substrate is predominantly undrained hydric soils. Protection is achieved by establishing a 25-foot (7.6 m) buffer around the wetland and by restricting development and other activities so that the hydrologic regime and water quality of the wetlands are preserved. Plant and wildlife habitat values of the wetland must not be impaired.

Threatened and Endangered Species

Threatened and endangered species and species in need of conservation are to receive special protection in the Critical Area. ''Species in need of conservation'' is a legal definition for those fish and wildlife whose continued existence as part of the State's resources are in question, but not to the point of warranting official threatened or endangered designation.

The Criteria require local jurisdictions to develop programs for the protection of the habitats of this group of species. Designation of a protection area around each habitat supporting threatened and endangered species, within which development and other disturbances shall be prohibited, is required. Determination of the existence and extent of these habitats and protection areas shall result from a cooperative effort between local jurisdictions and state, federal and private agencies. Public comment is required before designation can be finalized. Habitat protection may include acquisition, conservation easements, cooperative agreements, special provisions in other required management plans, and special provisions in subdivision or zoning regulations.

Information on the locations of threatened and endangered species was provided to the local jurisdictions for inclusion into their protection programs from the Maryland Natural Heritage Program and the Nongame and Endangered Species Program. A recommended protection area around each habitat also was provided. The size if the areas to be protected varied with the species present at the site. For various endangered wetland plants, for example, the wetland in which the plants occurred, plus an upland buffer zone around the wetland, were designated. Minimum guidelines for protection zones were provided by the Maryland Natural Heritage Program for most threatened and endangered species in the Critical Area, with the following exceptions:

- Protection of bald eagle (*Haliaeetus leucocephalus*) habitat was targeted at nesting sites. A protection zone of 0.25-mile (0.5 km) radius was designated around each known nest tree. If development activities or other changes in land use are proposed within this protection zone, the local jurisdiction consults with the State's Nongame and Endangered Species Program for recommendations. Guidelines used to protect these sites are based on the recommendations by Cline

(1985). Basically, no land clearing or other adverse activities will be permitted within 330 feet (100 m) of the nest tree, while slightly less stringent restrictions will be imposed to a distance of 0.25 mile (0.4 km) from the tree.

- Protection for habitat of the Delmarva fox squirrel (*Sciurus niger cinereus*), another endangered species, was handled differently. This squirrel can be found in appropriate woodlands throughout Maryland's Eastern Shore. To designate every woodland in which this squirrel occurs would have been an enormous task, especially since its occurrence in many woodlands is suspected but unconfirmed. Since a Forest Management Plan is required before timber removal can occur, our approach to protecting Delmarva fox squirrel habitat is to work with the state foresters in their plan-review process and assure habitat protection measures through that mechanism.

Protection of endangered species habitat through the Critical Area Program provides more legal protection of habitats for these species then does either Maryland's endangered species law or the federal law. Since the Criteria protect the habitat and not the species themselves, they afford the extra protection needed to ensure the species continued existence.

Colonial-nesting Waterbirds

Colonial-nesting waterbirds are those species of herons, egrets, gulls and terns that nest collectively in colonies. This group was selected for special protection because these birds' reproductive energies are concentrated in a few locations and disturbances to these colony sites could impact population status locally or on a statewide basis.

Local jurisdictions are required to identify, with the cooperation of state and federal expertise, the site locations of waterbird colonies. A buffer area is required to protect these sites from the adverse impacts of development activities and from disturbances during the breeding season.

The locations of all known colony sites were provided to the local jurisdictions and a protection zone of 0.25-mile (0.4 km) radius was recommended around each site. Consultation with the Maryland Forest, Park and Wildlife Service is recommended when changes in land use or diverse impacts are proposed within the zone. Recommendations shall be provided on a case-by-case basis and will depend on the species affected, size of the colony, the activity proposed, and distances between the colony and potential disturbance.

This may mark the first time that the colony sites of this group of birds has been afforded legal protection in North America.

Waterfowl

The Chesapeake Bay is famous for its wintering waterfowl populations. Much recreational opportunity is afforded by this resource, and its economic contributions to the State, particularly the Eastern Shore, are significant.

Since existing state laws adequately protect tidal wetlands, which serve as both breeding and wintering areas for waterfowl, the Criteria targets protection of waterfowl staging and concentration areas for new water-dependent facilities. These include those structures or works associated with industrial, maritime, recreational, educational or fisheries activities that require location at or near the shoreline. Thus, a new marina or water-discharge facility will have to be located in an area where it does not disturb waterfowl staging or concentration.

Waterfowl should also benefit indirectly by improvements in water quality that result from the Program.

Forest Interior Dwelling Birds

Recent research in Maryland (Robbins 1979, Whitcomb et al. 1981, Lynch and Whigham 1984) indicated problems with breeding bird species whose populations depend on large, contiguous tracts of forest for successful reproduction. Since much of the forests of Maryland's Coastal Plan are fragmented and the potential for this loss of contiguous forest land continues, protection of this habitat in the Critical Area was incorporated into the Criteria.

Local jurisdictions are required to protect and conserve existing riparian forests of at least 300 feet (91 m) in width and which occur adjacent to streams, wetlands, or the Bay shoreline and relatively mature forested areas of 100 acres (40.5 ha) or more in size, both of which are documented breeding areas for forest interior dwelling birds. Local programs are to ensure that development activities or the clearing or cutting of trees that might occur in these areas are conducted so as to conserve habitat for these species.

Nineteen species of birds—many neotropical migrants including 11 warbler species—were targeted to receive special considerations. The breeding presence or absence of these species must be determined in forests as described above before changes to the forest will be permitted. If at least four different species of these interior dwelling specialists are determined breeding in the forest, or if one species considered especially sensitive to disturbance is documented, the appropriate conservation measures must be practiced in order to minimize impact.

Protective measures recommended include: (1) minimizing disturbance during the breeding season; (2) focusing development on the periphery of the forest; (3) retaining a closed canopy as much as possible; (4) retaining snags; (5) discouraging small clearings and disproportionate expansion of forest edge; (6) encouraging regeneration of hardwood forests; (7) adopting timber-harvesting techniques conducive to forest interior birds; and (8) incorporating protection measures into Forest Management Plans.

As with colonial waterbirds, this may be the first time in North America that a group of nongame birds has received habitat protection through local planning and zoning restrictions.

Anadromous Fish

Many tributaries of the Chesapeake Bay serve as spawning areas for anadromous fish. Local jurisdictions are required to protect the instream and streambank habitat of propagation waters, promote land-use practices that will minimize adverse impacts in the watershed of spawning streams, and provide for the unobstructed movement of spawning and larval forms of anadromous fish. Channelization, installation of concrete riprap and construction of dams are prohibited. Local programs are to minimize development activities in the watershed, maintain or improve water quality, minimize the discharge of sediments into streams, and maintain or increase the natural vegetation of the watershed.

Natural Heritage Areas

Natural Heritage Areas are officially designated communities of plants and animals that contain one or more threatened or endangered species or species in need of conservation, are a unique blend of geological, hydrological, climatological or biological features, and are considered to be among the best statewide examples of their kind. Twenty-three such areas occur in the Critical Area.

The Criteria require protection of these areas from alteration due to development activities or cutting or clearing, so that the structure and species composition of these areas are maintained.

The boundaries of these areas were provided to the local jurisdictions by the Maryland Natural Heritage Program. Consultation with this Program for protection of these areas is required. Technical assistance to private and public landowners is being provided.

Implementation of the Criteria

As required by the Critical Area Law, local jurisdictions were to incorporate the policies and standards outlined by the Criteria into their comprehensive plans, ordinances and subdivision regulations. The ordinances establish processes that provide for the review of proposed development, redevelopment and other activities (e.g., timber harvesting, agriculture and surface mining) to ensure compliance with these standards. Details of the processes vary with each jurisdiction, but in general, review procedures follow the description below.

Plan proposals for development and/or redevelopment sites are reviewed by the local planning and zoning office. The jurisdictions have included appropriate State and federal agencies, such as the Department of Natural Resources, Department of the Environment, and the U.S. Fish and Wildlife Service, in their review process. This process ensures that the local jurisdictions have ready access to the technical expertise available from these agencies.

The final approval authority rests with the local jurisdiction. However, a provision of the Critical Area Law allows the chairman of the Critical Area Commission to notify the local jurisdiction when there is reason to believe that the local jurisdiction is failing to enforce requirements of the Critical Area Criteria. If the local jurisdiction does not act to remedy or punish the violation, the chairman may refer the problem to the State's Attorney General, who may then prosecute the violator.

Timber harvesting, agriculture and surface mining have separate review processes. Forest Management Plans must be approved by the local county forestry board, which consists of members who represent a variety of forestry interests within the county, and the local state forester. After approval, the plans are filed with the local jurisdiction. Agriculture must be conducted under a Soil Conservation and Water Quality Plan approved by the local Soil Conservation District. Farms not operating under a Soil Conservation and Water Quality Plan by May 1991 may be subject to legal action if they are in violation of water quality requirements.

Most jurisdictions have classified new surface mining as a variance and, as such, those proposals must go through a special review.

The local Resource Protection Programs were to be filed with the Critical Area Commission for review by August 1987. The Commission was to review the plans for compliance with the Criteria, and return them to the local jurisdictions for revision if necessary. Implementation of the local plans must occur by June 1988.

The Maryland Forest, Park and Wildlife Service assisted the local jurisdictions with their program development by providing technical assistance in a number of ways. Maps depicting known locations of habitat of species of concern were provided, as were recommended protection measures. Also, state foresters helped local jurisdictions identify and map their forest lands. This process established a working relationship between local planning and zoning offices and our staff, opening the door to influencing local land-use decisions with special wildlife concerns.

Also, four wildlife biologists were hired to work specifically within the Critical Area. Three positions were assigned to work with local jurisdictions providing technical assistance and reviewing development site plans. These biologists are also making wildlife recommendations to landowners within the Critical Area. The fourth position reviews existing programs and conducts research to determine management practices and approaches that best apply to this area.

Implications for Wildlife Management

Though the full effects of the Critical Area Program have not been realized yet, some new avenues for wildlife management in Maryland are being established as a result of the Program.

A direct line of communication between local planning and zoning offices and our wildlife and forestry staffs has been established. Now, the mitigation of development on wildlife resources is a routine part of the planning and zoning office's though process. Since zoning decisions ultimately determine the fate of wildlife habitat, at least on privately owned land, a better understanding and appreciation for wildlife by these local offices will potentially benefit the wildlife resource indefinitely. Though these considerations are only legally mandated in the Critical Area, a planning and zoning office sympathetic to wildlife concerns could affect land-use decisions outside the Critical Area to wildlife's benefit.

Since the enforcement powers of the Critical Area Program are in the hands of the local jurisdictions, it behooves us to continue working with those offices. In addition to regular reviews of development proposals, we will keep them abreast of new locations of species of special concern, as well as new advances in the management and protection of these species.

In addition to developing relations with planning and zoning offices, the Program is forcing developers to consult with us on a regular basis. Not only will developers have to become more cognizant of wildlife needs, but we will have to learn to manage for wildlife in nontraditional ways. This will force us to broaden our perspectives on wildlife management also.

Direct benefits of the Critical Area Program to those species receiving special protection are obvious. By providing protection to the habitats of these species, the Critical Area Law adds the missing element of protection that traditional wildlife laws lack. Now, the species *and its habitat* are afforded legal protection, not just the species.

Challenges to the legality of restricting land uses as a result of habitat protection have already occurred and will probably continue to do so. Taking of landowner's rights with undue compensation was the focus of a law suit filed by a developer after restrictions were placed on his subdivision due to the presence of two endangered species. The outcome of this litigation has not been finalized as yet. The outcome could have far-reaching implications for the Critical Area Program as a whole. With the potential for wildlife habitat-protection decisions being decided in a court of law, we, as biologists, need to be sure our recommendations are based on sound scientific facts that are defendable. Where data are lacking, research is needed to find the answers.

The indirect benefits to wildlife from this Program are immense. Improvement of water quality will provide a cleaner, healthier environment for our fish and wildlife resources. A better, more diverse prey base will benefit many game fish, waterfowl, raptors, wading birds and many other wildlife species. The threat of contaminants will be less, making the Bay a safer place to live.

The 100-foot (30.5 m) wooded buffer should provide habitat for many wildlife species. Species that nest along the shoreline, such as bald eagle, osprey (*Pandion haliaetus*) and great blue heron (*Ardea herodias*), will benefit by the continued availability of potential nesting habitat. This buffer will also serve as corridors of travel for animals moving between areas.

The protection of nontidal wetlands should benefit plant and wildlife species dependent on that habitat type for survival. Breeding amphibians and reptiles, as well as many invertebrates, should benefit from this protection. Wildlife dependent on forests and agricultural lands should benefit likewise from their conservation programs.

The Critical Area Program has also opened the way for our biologists and foresters to effect management on more private lands. Our staff has the opportunity to provide input to those conservation plans required by the Program. Their management recommendations will address any species receiving special protection, but can also address species not targeted for special considerations. Though these recommendations will not be required to be implemented by the landowner, hopefully if the interest is there, the landowner will voluntarily implement our wildlife recommendations.

Summary

Concerns about the Chesapeake Bay by the Environmental Protection Agency, other scientists, environmentalists, watermen and the citizens of Maryland prompted the Maryland General Assembly to pass the Chesapeake Bay Critical Area Law in 1984. This law established the Critical Area as the Bay, its tidal tributaries and all lands within 1,000 feet (305 m) of mean high tide. It requires local jurisdictions to develop a Resource Protection Program to minimize adverse impacts on water quality and establish land-use policies controlling growth and development. The conservation of fish, wildlife and plant habitat is also a goal of the Law.

An elaborate set of regulations, known as the Critical Area Criteria, outlines strategies that local jurisdictions must incorporate into their protection programs. This paper highlighted those regulations with direct implications for wildlife, including those that address development, forest and woodlands, the buffer, nontidal wetlands, threatened and endangered species, colonial-nesting waterbirds, waterfowl, forest interior dwelling birds, anadromous fish, and Natural Heritage Areas. Implementation strategy was discussed, including the involvement by the State's wildlife agency. The Critical Area Program has many direct and indirect implications for wildlife and its management in Maryland.

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Nongame and Nursing Homes: Evaluation of a Multiple-benefit Program in Kansas

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Introduction

Since 1981, the Kansas Fish and Game Commission Nongame Program has been supplying bird feeders and bird seed to nursing homes in Kansas. Bird books and bird posters have also been provided to help residents learn to identify birds. The primary objective of this research is to evaluate this program's effectiveness to provide feedback to nongame wildlife officials. This information can then be used to set priorities and make other administrative decisions about such programs. A secondary objective is to explore the potential for future research in the area of therapeutic effects of wildlife observation.

A literature review revealed that there has been much interest in studying wildlife-human interaction. For example, Kellert and Berry (1985) compiled 3,861 citations in a bibliography of human/animal relations. Although most facets of possible interaction were represented in the wildlife literature, the study of therapeutic effects of wildlife was conspicuously absent.

The literature review also found that much research already is addressing therapeutic effects of domestic animals. Animal-enhanced therapy is becoming common in nursing homes, and the study of human/animal bonding currently is one of the most active and fruitful areas of veterinary medical research (McCulloch 1983). Allen (1985) compiled a bibliography of human/animal bonding, containing 819 citations and listing numerous professional organizations and informal, interdisciplinary, working groups that deal specifically with animal/human relations. Although the therapeutic use of wild animals is alluded to in this body of literature (e.g., Bustad 1980), studies of such use are notably absent. The success associated with pet-enhanced therapy may be an indication of the potential of providing wildlife therapy through nongame wildlife programs.

Methods

During the fall of 1986, questionnaires were sent to administrators at each of the 42 nursing homes that had received materials from the Kansas Nongame Wildlife Program. The survey instrument gathered data on: types of materials received; amount and type of use; and benefits associated with use of these materials. Benefits were evaluated by six-point Likert type responses to four questions. Potential responses ranged from strongly agree (+3) to strongly disagree (−3). Respondents were also invited to comment on the program and relate any positive or negative experiences resulting from the program.

Results

Twenty-one responses were received from the initial mailing. A second mailing to nonrespondents resulted in eight additional responses, giving a total response rate of 69.0 percent.

Use of Materials

The nursing homes had been using the materials for an average of 2.75 years. Ninety-two percent of the bird feeders were still in use. One was reported to have worn out and one had run out of seed.

An average of 52.8 percent of the residents watched birds at the feeders. The percentage ranged from 10.0 percent at one nursing home to 100.0 percent at another facility. The average time spent watching birds ranged from 0.25 to 5.0 hours per day; average for all sites was 1.4 hours per day.

Bird books were received by 26.9 percent of the nursing homes and 53.8 percent received bird posters. All of these materials were still being used. The percentage of residents using these materials ranged from 0.0 percent at four facilities to 60.0 percent at two nursing homes. The average percentage of residents using bird books and posters was 30.0 percent.

Program Effectiveness

When asked if the residents enjoy the program, 69.0 percent strongly agreed, 27.0 percent moderately agreed and 4.0 percent slightly agreed. The average response on the $+3$ to -3 scale was 2.65.

Sixty-five percent of the respondents strongly agreed that the program has a positive affect on resident morale. Twenty-seven percent moderately agreed, and 8.0 percent slightly agreed that the program was enhancing morale. The average response was 2.58.

When asked if the program had a positive therapeutic effect on the residents, 65.0 percent strongly agreed, 27.0 percent moderately agreed and 4.0 percent slightly agreed. The average score was 2.62.

Respondents were also asked if the staff benefited from the program. Forty-two percent strongly agreed, 35.0 percent moderately agreed and 23.0 percent slightly agreed. The average response was 2.19 on the $+3$ to -3 scale.

Respondents volunteered 18 comments, all of which took the forms of either testimonials that elaborated on the positive effects of the program and/or requests for additional materials.

Discussion and Conclusions

Administrators of participating nursing homes clearly believe this nongame wildlife program is beneficial. The materials are being used, and many administrators desire more materials. All respondents agreed that (1) residents enjoyed the program; (2) the program had a positive effect on resident morale; (3) the program had a positive therapeutic effect; and (4) the nursing home staff also benefited from the program. The level of agreement among administrators was most strong for the question of residents enjoying the program. Intensity of agreement was weakest for the question of benefits to the staff. This may be expected in light of the program objective, which focuses on improving the quality of life for the residents.

The most direct conclusion that can be drawn from this evaluation is that nursing home administrators endorse the program on the belief that it enhances enjoyment, morale and the health of residents. Such positive feedback is relevant for consideration by Kansas Nongame Program officials in determining nongame program priorities. To the extent to which the sampled nursing home populations are representative of other nursing homes, the results are generalizable and serve as an endorsement of similar programs in other states.

A second conclusion is that additional study of the therapeutic and psychological effects of wildlife/human interaction is warranted. This conclusion is based on the positive program evaluation by health care administrators and on the review of the literature. Specifically, future surveys should focus on measuring the perceptions of the nursing home residents. Their evaluation of program effectiveness may be more relevant than the evaluation of administrators. Also, empirical studies, using control groups, should also be carried out to provide clinical documentation of benefits.

The objective of using wildlife to improve the welfare of nursing home residents can be justified solely on humanitarian grounds. A second, less altruistic objective may be to develop more public support for wildlife programs among the residents, their families, the staff and the general public. Future empirical research on the therapeutic and psychological effects of observing birds and other wildlife will enhance the degree to which both of these objectives are met.

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Approaches to River Otter Restoration in Missouri

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Introduction

The river otter (*Lutra canadensis*) disappeared from all except a small portion of its presettlement range in Missouri during the approximate period 1860–1910. Unregulated otter harvest appears primarily responsible for this extirpation, which occurred despite the species' former abundance (Bennitt and Nagel 1937, Schwartz and Schwartz 1981). Significant habitat loss (Funk and Robinson 1974, Korte and Fredrickson 1977) occurred more recently and undoubtedly will limit population recovery in some areas. However, habitat loss does not appear to have precipitated the otter's decline because most adverse changes occurred after the species disappeared.

Long-standing interest in otter conservation has existed in Missouri. As early as 1937, Bennitt and Nagel (1937:135) reported, "The otter is virtually extinct in Missouri. Unless immediate and effective protection is given to it, the last survivors will be gone within the next few years." Legal protection came in 1937, the same year as Bennitt's and Nagel's historic survey of resident game and furbearers. The authors also suggested that restocking be considered if a source of otters from outside Missouri could be located. However, none was found, and no restocking followed. A similar recommendation was later offered by Schwartz and Schwartz (1959:311). The Missouri Department of Conservation renewed consideration of otter translocations in the mid-1970s. This effort languished due to difficulties obtaining otters. Acquiring adequate numbers of otters presented a problem for each of these translocation proposals.

The obstacle of otter unavailability was surmounted in 1981, when the Missouri Department of Conservation and Kentucky Department of Fish and Wildlife Resources negotiated an initial exchange of 32 eastern wild turkeys (*Meleagris gallopavo sylvestris*) from Missouri for 20 wild river otters from Louisiana. Trades that followed with Kentucky and other agencies have supplied animals for what has become the most active otter restoration program in North America.

This report highlights the approaches adopted in Missouri's river otter restoration program. Program direction has been based on initial studies with native and translocated animals (Choromanski and Fritzell 1982, Erickson et al. 1984, Erickson and McCullough 1987), and growing experience with processing and liberating otters. A comprehensive management plan was developed to guide the operational phase of the restoration program as well as other management and public information activities (Missouri Department of Conservation 1986a). This plan calls for releasing approximately 800 otters at 40 sites during the period 1982–1991. Although some strategies described in this report are based on professional judgments, we believe we have made practical use of available information. In this regard, our experience may prove useful to agencies contemplating similar efforts elsewhere in the otter's range.

We appreciate the efforts of many personnel of the Missouri Department of Conservation, University of Missouri, and U. S. Fish and Wildlife Service in conducting the various aspects of the otter program. Portions of the program have been supported by Missouri Federal Aid Project W-13-R. N. F. Giessman, D. D. Humburg, D. Urich and D. J. Witter provided helpful reviews of this report.

Preliminary Investigations

Status of Native Otters

The range and status of native otters were determined prior to initiating translocations (Choromanski and Fritzell 1982). This study confirmed population growth in the Mississippi Lowlands of southeastern Missouri, despite extensive wetland drainage and near total loss of lowland hardwood forests in that region (Korte and Fredrickson 1977). A second, smaller population was located in the Osage River watershed in westcentral Missouri. No other populations were identified. Infrequent, unrepeated observations of otters in the Missouri River and its tributaries were believed to be transients.

Experimental Translocations

The simplest approach for initial translocations would have been merely to liberate otters in suitable-looking habitat. However, the need to determine fates of translocated otters dictated a more intensive follow-up. An investigation was initiated to monitor the postrelease survival, movement, interaction and reproduction of 39 translocated river otters released in two markedly different habitat systems thought to typify the range of habitat conditions that otters would encounter in Missouri.

The results of experimental translocations were encouraging (Erickson and McCullough 1987), and provided a planning basis for the statewide restoration program. Radio-tracking confirmed the survival of 81 percent (25 of 31) of the otters monitored at the Swan Lake National Wildlife Refuge (SLNWR) and Lamine River Wildlife Area (LRWA) for at least one year. Translocation stress and human conflicts were primary sources of mortality for six animals that died during the 12 months after release. Otter movements during the year following release were modest but variable. Otters in the diverse, wetland habitats at SLNWR dispersed less [$\bar{x}$ = 1.73 ± 2.27 miles (2.79 ± 3.65 km)] than did animals in the more riverine habitats of LRWA [$\bar{x}$ = 3.65 ± 3.12 miles (5.88 ± 5.03 km)]. A small number of animals at both study locations dispersed sufficiently from core areas of otter activity that they became spatially isolated. These otters did not appear to interact with other otters and likely were not reproductively involved in any subsequent population reestablishment. Associations among otters were recorded routinely at SLNWR and LRWA, and most individual's home ranges overlapped extensively. Thus, we were optimistic that an adequate social framework was established to permit breeding encounters and sufficient allocation of habitat. Reproduction was not confirmed during periods of radio monitoring (usually 14–16 months), but offspring were observed at both areas following the second reproductive period after liberation. A spring translocation timing appeared to create a two-year delay in reproduction.

Otters apparently bred after nearly one year and, following delayed implantation, produced litters after two years.

Restoration Approaches

Investigations at SLNWR and LRWA were encouraging, and an operational restoration program was developed. The following describes the approaches of this program.

River Otter Sources

Two acquisition alternatives were considered. Continued interest in Missouri wild turkeys to restore populations in other states provided a wildlife trade option. In addition, otters from established native populations in southeastern Missouri were considered for relocation to unoccupied habitat. Although in-state translocations may have future application, advantages of interstate wildlife trades were evident, including: (1) ability to produce larger numbers of otters than could be obtained from native populations; (2) improved logistical efficiency of transporting, processing and releasing larger shipments of animals; (3) ability to capitalize on Missouri's abundant wild turkey population through an established turkey trapping program; and (4) reduced expense of trapping turkeys when considered versus projected costs of Department personnel trapping native otters (although purchases of live otters from private trappers in Missouri may be cost-effective).

We realized that exact genetic duplicates of extirpated populations of Missouri otters could not be obtained. Nonetheless, it was desirable to obtain otters that were taxonomically similar to native subspecies. Recent classification (van Zyll de Jong 1972) identified *L. c. lataxina* as the subspecies native to Missouri and much of the southcentral United States. Consequently, this subspecies assumed priority over others in trade negotiations.

Shipment

Otters have been shipped to Missouri by agency truck, commercial aircraft and agency (or agency-hired) aircraft. Trade terms usually specify that the supplying agency is responsible for transporting the animals it provides. Otters have been transported from coastal Louisiana to Missouri by truck and arrived in excellent condition. In contrast, relatively high mortality (>50 percent) occurred among some shipments of animals air-shipped from Arkansas to Missouri. Variation in capture, handling and confinement methods prior to shipment appears to influence the condition of animals more than does shipping method. Also, the shipment of otters in small and enclosed wooden crates may have contributed to high initial mortality among Arkansas otters. River otters that are carefully captured, handled and confined appear fully capable of surviving translocation. As demonstrated during experimental translocations, however, a small percentage of otherwise healthy-appearing otters may succumb to stress effects following release.

Processing

River otters are processed before release to aid translocation follow-up. All individuals are closely examined and individually marked. Tagging is essential to identify recovered otters as either liberated individuals or Missouri-born offspring.

An assembly line processing system enables simultaneous handling of several animals, and a complete processing requires approximately 15 minutes. Experienced personnel are used when possible to maintain efficiency, reduce prospects for handler injury and minimize animal stress. During processing, we immobilize the otter, confirm its sex, examine teeth for wear and breakage, identify and assess injuries (particularly foot injuries from trapping), obtain body measurements (weight, length, girth), and tag ears and rear foot webbing with size 1 and 3 Monel metal tags, respectively. During some early processing sessions, blood and feces were collected for analyses.

Long-handled nets (Shirley et al. 1983) were initially used to restrain otters for drugging. A handling box (McCullough et al. 1986) is currently employed to reduce chances for handler injury and minimize stress on animals. Otters are immobilized for processing with ketamine hydrochloride [10 mg/pound (22 mg/kg), Melquist and Hornocker 1979]. A ketamine hydrochloride/diazepam combination (Elmore et al. 1985) was used during the experimental translocations to facilitate transmitter implantation surgery (*see* Erickson et al. 1984, Erickson and McCullough 1987).

Otters for experimental releases were confined for five days after processing to assess their condition. However, animals included in operational releases since 1983 have been held only overnight, and transported and released on the day following processing. Otters are afforded water *ad libitum*, and fed ground beef or ground venison, fish, crayfish or a formulated diet recommended by the Louisiana otter supplier (Lee Roy Sevin [Bayou Otter Farm, Theriot, Louisiana] personal communication: 1983).

Release Strategies

A major objective of the translocation effort is to maximize otter survival and reproduction. To accomplish this objective, we feel it is necessary to: (1) release an adequate number of otters to ensure population establishment and range expansion; (2) ensure that sex ratios are adequate for reproductive encounters; (3) space release sites so that reestablished populations eventually merge; and (4) rank potential sites in priority order, and stock those with the greatest potential for population growth first and others according to their ranked potential as otter habitat.

Little information existed to assess the suitability of Missouri habitats for otters. Based on the adaptability we observed during the experimental translocations and the variety of habitats used by otters in North America, virtually all watersheds of Missouri are considered potential habitat for the species.

Major watershed units (Figure 1) have been prioritized using the following criteria; (1) proximity to prior releases and native populations with spacing established at 100 river-mile (161 km) minimums in most instances; (2) types and amounts of human disturbance, with minimal direct disturbance by humans or adverse human impacts on habitat most important; (3) water quality characteristics, with watersheds having high water quality given priority; (4) habitat diversity, with watersheds having varied in-stream features and numerous off-drainage wetlands given priority; and (5) prey status, with watersheds having high biomass of fish and crayfish and moderate-to-high species diversity selected first. We do not release animals near known populations of native otters.

Criteria for selecting actual points of release within watersheds include: (1) upstream tributary locations selected when possible to minimize opportunities for exaggerated

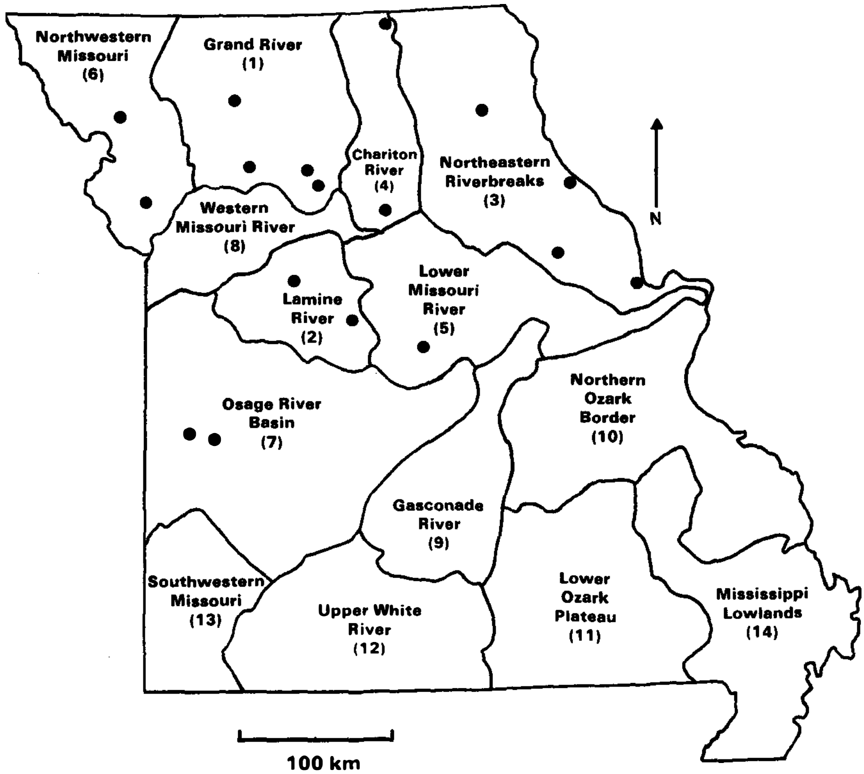

Figure 1. Watershed units and respective priorities (in parenthesis) for otter translocations in Missouri, and locations of release sites, 1982–1987.

postrelease movement; (2) areas with clusters of oxbows, sloughs and other wetlands in addition to the drainage; (3) stream channelized portions avoided; (4) presence of continuous woody riparian corridors; (5) high degree of stream meander; (6) existence of well-established beaver (*Castor canadensis*) populations; (7) presence of log jams and woody debris in or adjacent to the stream; and (8) public lands given priority over private lands if other criteria are equal. Sites are selected to maximize these attributes, although each criterion is not always met.

A release of 20 otters with an even or slightly female-biased sex ratio (Berg 1982) represents the target number of animals for each release. This number is based on favorable survival and interaction observations noted during the Missouri experimental translocations, and an earlier recommendation from Colorado (Steven Bissell personal communication: 1981). If possible, all otters scheduled for a specific site are released on the same day. When this is not possible, animals are released successively as they become available and until the 20 animal target is achieved. Typically, all otters are released at the same location, allowing them to space themselves following liberation. This strategy promotes postrelease interaction and allows social behavior and habitat to determine spacing.

River otters translocated thus far have been liberated during the period December–May. Although a spring (March–May) release appears to result in a two-year delay in reproduction (Erickson and McCullough 1987), it may enhance otter survival by extending time for acclimation prior to winter's onset. If viewed solely from a reproduction standpoint, an early winter release would be ideal. Pregnant females would potentially bear young within two months after release. However, adequate numbers of animals are difficult to obtain during this period, and survival may be jeopardized if otters are translocated to unfamiliar environments during or shortly prior to stressful winter periods.

Public Involvement

Public interest in the restoration program has been substantial. We have encouraged public attendance at release activities since our earliest experimental effort in 1982. Attendance, sometimes exceeding several hundred people, has become routine and is augmented by local, state and even national media coverage. Public sightings of otters after releases have provided an important source of follow-up information.

The Missouri Trappers Association (MTA) has been especially supportive. Funds generated by the sale of "Bring 'Em Back to Missouri" otter t-shirts were used to purchase additional radio-telemetry equipment during the research phase of the program. The group also purchased male otters to complement a release of female otters. Moreover, the MTA notified members and other trappers about the presence of otters in select watersheds, and issued trapping precautions to minimize unintended captures.

River otters are extremely popular and elicit considerable favorable public sentiment. Our approach has been to involve Missouri citizens in the restoration program, and the resulting public support benefits have been substantial.

Regulatory Provisions

River otters in Missouri are dually classified as "furbearers" and "game mammals" (Missouri Department of Conservation 1986b). However, regulations have not permitted otter harvests since before 1937. The river otter is also classified as "rare" on Missouri's list of rare and endangered species (Missouri Department of Conservation 1986c).

Occasional captures of native otters in southeastern Missouri during the 1960s and 1970s (Missouri Department of Conservation unpublished data) provided early evidence that translocated otters might be captured in traps legally set for other species. We were especially apprehensive about hazards from beaver trapping because of evidence linking otter harvests to beaver trapping (Bottorff et al. 1976, Lehman 1979), and because drowning sets and kill-type traps are normally employed. We considered but elected not to restrict trapping in release watersheds because of long-standing trapping traditions in Missouri, recognized needs for trapping to aid control of beaver numbers, and the experimental nature of the early translocations. It also became apparent that severe trapping restrictions would be necessary to protect otters fully from capture. When animals are released on Department-owned lands, trapping on those lands is prohibited or restricted to nonaquatic sites to minimize losses. Illustrated posters that alert outdoor users, especially trappers, about the otters' presence are displayed at access points, sporting goods stores, fur-buying establishments and other locations. From Department field personnel, we also obtain names and addresses of trappers within a 50-mile (80 km) radius of release sites and send each a letter providing information on otters, the release program and descriptions of otter sign. Trappers are asked to restrict beaver trapping voluntarily within 10 miles (16 km) of release sites for two years after the release, and to exercise caution in trapping other furbearers if otter sign is observed in trapping areas. They are given advice on releasing live otters from traps and procedures to follow in the event an otter is killed. Cooperation by local trappers has been excellent; a few discontinued trapping entirely in release localities, especially if otter sign was encountered. Trappers have also been an important source of information on otter distribution.

Postrelease Monitoring

Monitoring otter numbers is difficult because of their low density, secretive behavior and poorly accessible habitat. Nonetheless, it is necessary to determine the animals' status following translocation. We have not attempted to estimate changing abundance. We feel we can efficiently gauge otter status by confirming their presence or absence and distribution in release areas using annual aerial surveys of winter track evidence. The technique enables coverage of several release watersheds during a single day, provided ice and snow conditions are favorable. Surveys require near complete coverage with at least one inch (2.5 cm) of ice and standing snow greater than one inch (2.5 cm) in depth for a minimum of three days. Distinct otter track and slide marks are easily visible from fixed-wing aircraft at a height of approximately 500 feet (152 m). Detection is aided by cloudless conditions that create a conspicuous shadowing in the tracks. The technique enables rapid confirmation of otter occurrence and delineation of distribution. In Missouri, the technique has greatest application in northern regions where colder temperatures prevail. Aerial surveys have been limited by failure of necessary ice/snow conditions to develop consistently each winter. Thus, we are unable to conduct surveys during some winters.

Aerial surveys are augmented by observational records from Department staff and the public. These accounts are especially useful in documenting occurrence in areas beyond the original release site, and in confirming reproduction through sightings of otter family groups. A formalized sighting-reporting system has been developed and is being implemented. The recovery of carcasses provides additional insight on postrelease movements and reproduction.

Progress

Three-hundred thirty-seven otters have been released at 17 sites in 12 watershed units since 1982 (Figure 1). Otters were supplied by four agencies and originated from Louisiana, Arkansas and Ontario (Table 1). All except 14 otters from Ontario were the subspecies, *L. c. lataxina*. Six animals died prior to release. Approximately 460 additional animals will be required by 1991 to complete the statewide program in accordance with the otter plan (Missouri Department of Conservation 1986a), and trades to supply these have already been negotiated.

Survival rates of otters released without radio-implants are unknown; however, recoveries of 37 tagged otters (11.0 percent of total released to date) provide a basis for evaluating sources of mortality and degree of dispersal. Eighteen tagged otters were inadvertently trapped during open furbearer seasons (15 by body-gripping traps,

Table 1. Sources of river otters used for translocation in Missouri, 1982–1987.

Trading agency	River otters		
	Number received	Number released	State of origin
Arkansas Game and Fish Commission	60	60	Arkansas
Kentucky Department of Fish and Wildlife Resources	249	245[a]	Louisiana
Ontario Ministry of Natural Resources	14	13	Ontario
Louisiana Department of Wildlife and Fisheries	20	19	Louisiana
Total	343	337	

[a]Two provided to the St. Louis Zoological Park.

3 in leg-hold traps). Fifty percent of the captures (9 of 18) occurred during an extended beaver trapping season (January 6–March 31). Four otters including three untagged individuals were trapped or snared in beaver damage-control operations. Other mortality sources included stress (7), highway deaths (7), commercial fishing nets (3), and shooting or others (2). Trapping is clearly the most significant known cause of mortality among translocated otters, but does not appear to have limited prospects for population reestablishment. Recent beaver fur markets may increase the impact of trapping if a rising demand trend continues and trappers respond with a greatly expanded trapping effort.

Erickson and McCullough (1987) described fates of otters during experimental translocations and indicated that otters dispersing long distances suffered unusually high mortality. Tagged otter carcasses have been recovered as far as 186 miles (300 km) from release sites, and several dispersed more than 15 miles (25 km) before death. However, most (25) have been recovered within 6 miles (10 km) of the point of release, and 5 of those were recovered three to four years after release within 3 miles (5 km) of release sites.

Observational records and track evidence indicate that reproduction has occurred at seven sites. In all cases, reported sightings of young among otter family groups occurred two years after release (five sites) or three years after release (two sites). Assuming that otters released in early spring undergo a two-year reproductive delay (Erickson and McCullough 1987), the timing of these reports is consistent with our knowledge of otter reproduction. The recovery of six untagged otters near release sites confirmed earlier reports of young otters at five areas. Two untagged adult female otters were recovered at SLNWR during 1987; one was captured in a snare set to control problem beavers and the other was a highway mortality. Both showed signs of recent reproduction (lactation evidence and fresh uterine scars). The recovered individuals were most likely born in 1984, and considering reproductive delays caused by spring release timing, 1987 was the earliest likely date for reproduction by offspring of otters initially liberated at SLNWR in 1982. An untagged juvenile male was trapped on Lamine River in 1987, confirming numerous sightings of young otters in that watershed. An additional untagged otter was captured in the same area, but was released. Two untagged otters were inadvertently captured in northcentral Missouri in the fall of 1987, one of which was released. These captures confirmed earlier reports of young otters at the Fountain Grove Wildlife Management Area and on Big Creek in Harrison County.

One hundred sixteen sightings of otters and winter track evidence confirm that otters survive at 15 of 17 release sites. Only the most recent releases have generated no reports of sightings or sign, but survival is suspected in these areas as well. Winter surveys of otter sign have been helpful in delineating areas of otter occurrence at several central and northern release sites, and the more formal otter sighting-reporting system should aid future monitoring efforts.

Additional reports of otters, some considerable distance from any release site, may indicate large dispersal by liberated otters or their offspring, or transient native otters dispersing from other areas. Since 1982, we have had 13 additional reports of 19 otters, and highway mortalities of 2 untagged otters, all considerable distances from release areas.

Conclusions

Missouri's river otter restoration program has been both active and ambitious. Our enthusiasm for the program is buoyed by (1) favorable preliminary research with otters, (2) evidence of successful otter adaptation to Missouri habitats, continued survival and reproduction, (3) strong public support, and (4) historical knowledge that this generalist species once flourished in our state and would likely occur throughout Missouri today were it not for past human excesses. The greatly altered habitats of the 1980s will not support otters in numbers approaching presettlement populations. Nonetheless, it appears likely that populations at lower levels can exist, and that a planned program of otter translocations will greatly hasten the species' recovery of its former Missouri range.

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Stimulating Tourism and Economic Growth by Featuring New Wildlife Recreation Opportunities

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Introduction

Wildlife conservation in the 1980s has not been easy. A number of political, economic and demographic changes have precipitated a crisis for fish and wildlife agencies, which could permanently hamper efforts to protect the resource if some new approaches are not effectively implemented.

One response to this crisis is to make do with less. Another is to shift the responsibility for conservation to the private sector. While these approaches may alleviate a few short-term problems, fundamental changes are needed in the structure and funding of wildlife conservation in America in order to ensure healthy and abundant populations of all wildlife species for future generations. In order to bring about such changes, it is necessary for wildlife managers and interested members of the public to recognize how larger social and economic trends affect resource management and how they can be accommodated to benefit wildlife.

One of the most significant trends is a shift in the demand for wildlife-oriented recreation. Historically, interest in hunting and fishing preoccupied the wildlife-oriented public and shaped agency conservation programs to emphasize consumptive use. In recent years, however, the percentage of Americans interested in hunting has declined to about 9 percent, while participation in nonconsumptive wildlife recreation has increased to include nearly three-quarters of the U.S. population (USFWS 1988). This growing interest in wildlife presents an outstanding opportunity for wildlife managers to capitalize on the economic benefits associated with nonconsumptive use in regions with exceptional wildlife resources.

Most of the western states have been historically dependent on the extraction of resources. Mining, logging, grazing, commercial fishing and agriculture are still important economically, but several of the states with exceptional natural values recognize the potential for tourism to supplement traditional industries in economic growth and employment. According to the Travel Industry Association of America, the travel-recreation industry is the largest private employer in Arizona, Colorado, Idaho, Nevada, New Mexico, Utah and Wyoming (Reid 1987).

This trend has generated some interest in the protection of natural values, so that they will remain attractive to tourists. Senator Tim Wirth, a Democrat from Colorado, explained to a reporter: ''It's a whole new way of looking at our resources. People see that you can make more money by leaving the forest alone and letting people hike through it than you can by cutting down trees and shipping out the timber'' (Reid 1987). Since wildlife is an important component of any outdoor experience, the overall impact of this trend could be overwhelmingly positive from a conservation perspective, if the states effectively identify recreational demands and respond appropriately.

However, there is still a wide discrepancy between the potential for integrating wildlife conservation programs with economic activity, and the level of effort devoted to this goal. This paper will provide examples of several emerging strategies that focus on wildlife viewing opportunities in the promotion of tourism, particularly in Alaska, Oregon and Wyoming. A number of obstacles persist and will be discussed. Recommendations will be offered to help overcome some of the most serious problems.

Wildlife and Tourism

Alaska

Without question, the tourist industry has done more in Alaska than in any other state to promote wildlife values in the marketing of travel and adventure. Advertising by cruise lines, airlines, the State Division of Tourism and private resorts regularly feature animals and birds. Alaska Vacations, a division of Glacier Bay Yacht Tours, promotes Katmai and Denali Parks for ''close-up encounters with caribou, fox, Dall sheep, moose, and bear.'' A cruise on Glacier Bay offers the chance to see ''seal, goats, eagles, and whales.'' The Pribilof Islands are touted for ''world-famous seal herds and bird rookeries.''

In 1985, the Alaska Department of Fish and Game published a flashy, 170-page wildlife viewing guide, printed in full color. It offers information about wildlife habitats, specific viewing sites and optimum seasons for locating certain species (Quinlan 1983). Individual copies of the guide sell for $13.00. Unfortunately, distribution of the guide has been limited by the selling price and the fact that promotional expenses are borne by the Department of Fish and Game. Profits are deposited in the general fund.

However, the state is fully aware of the contribution wildlife makes to Alaska's economy. According to a report prepared by the State Division of Tourism, nearly one-third of the potential visitors are interested in guided birding, wildlife or photography tours (Table 1).

In response to an inquiry by Defenders of Wildlife, the Division of Tourism reported that 30–40 percent of the people who contact the agency want information about wildlife. However, even though a specific request was made to include information on wildlife viewing, there was no mention of the outstanding guide published by the Department of Game and Fish. About 24,000 copies remain unsold,

Table 1. Tourist interest in guide viewing of wildlife in six regions of Alaska (from Klugherz 1986).

Region	Tourists interested in viewing wildlife (percent)	Tourists interested in viewing birds (percent)
Southeast	31	25
Southcentral	35	22
Interior/Northern	35	15
Southwest	44	26
Denali	52	30

and a brochure is available to promote the guide. The only information provided was an Alaska "Vacation Planner," with a section on guide books, charts and maps. The viewing guide was not even listed.

Oregon

Oregon is a special case which deserves some attention. Several events following the 1986 election created unusually favorable conditions for a major effort to focus on the state's wildlife values as they relate to economic development. The first was the election of Democratic Governor Neil Goldschmidt, whose campaign featured the "Oregon Comeback" plan. It appealed to residents of a state recovering slowly from a prolonged recession. At the same time, the Oregon environmental ethic moderated a growth-at-any-price strategy. Coincidentally, the Fish and Wildlife Commission selected a new director, Randy Fisher, who has a receptive attitude toward nontraditional wildlife programs. Finally, the conservation community focused on the tourism industry as a potential ally in the effort to prevent the destruction of Oregon's natural values.

Several bills relating to wildlife and tourism were introduced in the 1987 Oregon Legislature and which generated considerable interest. The conceptual framework was presented in a booklet entitled "Oregon's Wildlife and Economic Recovery." It contained beautiful color photos of nongame wildlife in natural habitats, and outlined a plan for establishing and funding a series of projects intended to increase dramatically the visibility and level of participation in nonconsumptive wildlife recreation. The plan also had a strong habitat acquisition and protection component, effectively integrating the recreational and ecological elements of nongame management. The bills to implement the plan were lobbied primarily by The Oregon Chapter of the Nature Conservancy and Defenders of Wildlife, and had several objectives. The first was to create a link between the State Parks Department and the Department of Fish and Wildlife—the primary recipients of the funds. The second was to earmark the use of the funds for the conservation and appreciation of nongame wildlife, and for both agencies to provide interpretive materials to the public involved in wildlife viewing. The funds were also to be used for the acquisition and management of habitats of ecological or recreational significance, and for research and monitoring of nongame wildlife populations.

Even though the Oregon bills did not pass in 1987, the Governor's staff and several of the agencies were interested enough in the concept to implement some of the projects in the interim. The Department of Fish and Wildlife established task forces to consider nonconsumptive wildlife recreation and the diversification of the agency's budget to accommodate a wide range of underfunded projects, including the nongame and "Watchable Wildlife" programs. The Division of State Parks and Recreation incorporated wildlife viewing in its long-range planning process. The Oregon Transportation Department included several wildlife-viewing sites on the new state highway map.

Working in cooperation with state and federal agencies, the Governor's office, and private donors, Defenders of Wildlife initiated another project to publicize wildlife viewing opportunities. With financial and in-kind support from the U.S. Bureau of Land Management, Forest Service, Fish and Wildlife Service, Oregon Department of Fish and Wildlife, State Tourism Division, and the Oregon Division of State Parks and Recreation, a statewide viewing guide is being developed for distribution in the summer of 1988. The guide will identify more than 100 reasonably accessible wildlife-viewing sites now in public ownership. Each site will be designated by a state highway sign, to be provided by the Department of Transportation.

The viewing guide is the first step in a long-term strategy to demonstrate that protecting wildlife habitat and ensuring abundant populations is consistent with the state's economic goals. A related project, also initiated by Defenders of Wildlife and supported by public agencies and private donors, is to conduct research on the economic value of nonconsumptive wildlife recreation in the state, determine the potential economic impact on tourism, and to find out what method of funding the state's residents prefer to supplement consumptive user fees. Results are expected in late spring of 1988.

The next step is to develop a coordinated strategy for the protection of wildlife populations and their essential habitats. A primary goal of the plan is to secure new funding sources that are not dependent on the shrinking number of consumptive uses. The effort will involve a much wider range of organizations and agencies than the traditional wildlife management interests.

Wyoming

The third state that has made considerable progress in attracting visitors to view wildlife is Wyoming. The Department of Game and Fish invented a slogan, "Wyoming's Wildlife—Worth the Watching," and is beginning to incorporate nonconsumptive wildlife recreation into the agency's plans. For example, the Department's magazine has a regular feature showing where to view certain species. The animal featured in January 1988, for example, was a badger. The Department also appears to have an effective working relationship with the Wyoming Travel Commission, and is in the process of designating some viewing sites, developing some interpretive displays and publishing some promotional materials. The Wyoming Nonconsumptive Use Plan extrapolates from data on travel and expenditures and estimates that the economic impact of nonconsumptive wildlife recreation in Wyoming is $678 million annually. The goal is to increase expenditures to more than $1 billion by 1991 (WGFD 1986).

Wyoming is one of the few states that has at least contemplated linking nonconsumptive wildlife recreation, economic benefits and conservation goals. The Game and Fish Commission endorsed the Department's plan to increase expenditures on nongame projects, using predominately hunting and fishing license revenues, at least initially. Although some commissioners expressed reluctance to do so, it was pointed out that a majority of Wyoming's consumptive users support the expenditure of 10–20 percent of their fees on nongame projects (Neal 1987).

Members of the Joint Travel, Recreation, and Wildlife Interim Committee of the Wyoming Legislature also have expressed some interest in designating the Red Desert in southwestern Wyoming as a tourist area. The Red Desert features pronghorn, deer, elk and raptors for viewing enthusiasts (Collins 1987).

Other States

In order to assess the current status of wildlife viewing and tourism, the author sent inquiries to all state and provincial travel bureaus in the United States and Canada in late 1987. The letter and questionnaire requested information on viewing opportunities in the state or province, number of visitor inquiries about wildlife, and the degree to which the fish and wildlife agency and tourism department work cooperatively in promoting the state's wildlife values. The responses, or lack thereof, were illustrative. The most impressive materials came from Wisconsin, Nebraska, Washington and Minnesota. However, no state offered a guide or map specifically for wildlife viewing except Wisconsin, and in that case, the viewing guide was not provided directly by the travel bureau. Its availability was noted via photocopy of an internal memorandum and had to be ordered from the Wisconsin Department of Natural Resources for $3.00. It is actually a special edition of DNR's 1987 November/December magazine (WDNR 1987). Nebraska provided some attractive brochures depicting cranes along the Platte River. Washington State sent several pamphlets on whale-watching and other wildlife cruises. Minnesota incorporated wildlife-viewing opportunities into the seasonal publication entitled *Minnesota Explorer*. The Fall 1987 issue included a section of "birding," which listed eight areas for visitors to enjoy the fall migration of hawks and other birds. Maine sent information on moose viewing.

Several states with high wildlife values and thriving tourism industries failed to respond at all—most notable were California, Hawaii, Colorado, Texas and Arizona, which were unprepared to handle the request, even when follow-up phone calls were made. A California tourism official explained that wildlife inquiries get lost, because nobody in the agency is responsible for them. Although Colorado's Wildlife Department Director Jim Ruch is an advisor to the Tourism Board, the Colorado Tourism Department neglected to respond. The most remarkable answer came from the person in Hawaii's tourist bureau, who explained that it isn't necessary to go anywhere special to see birds in Hawaii because "people just see them walking around." She also expressed uncertainty as to whether the state has a wildlife agency.

Several states, such as Connecticut and Georgia, simply referred the request to the fish and wildlife agency. Ohio bent over backwards by having both agencies send materials. Others, such as Mississippi and Nevada, simply ignored the questions about viewing and sent information on hunting and fishing.

Canadian provinces were slow to respond, but at least two of them recognize some potential to attract wildlife enthusiasts as tourists. New Brunswick has published a guide to bird watching in the province, and the British Columbia Ministry of Tourism, Recreation and Culture has commissioned research on the potential impact of wildlife viewing to its tourist economy. Results are expected in the spring of 1988.

Survey of Viewing Preferences

Defenders of Wildlife conducted a member survey in the December 1987 issue of the *Activist News*. The respondents—a small, self-selected sample of wildlife enthusiasts—listed the areas they usually go to view wildlife, places they have actually travelled out-of-state to do so and places they would like to go. While not statistically valid, responses offer some indication as to where people with an interest in wildlife perceive the best viewing to be.

The states are listed below in order of the preference expressed by Defenders members. The percentage of respondents who had either visited or would like to visit the state were combined to establish the ranking. Alaska was the first choice, with 65 percent. However, about five times as many people expressed a desire to see Alaska's wildlife than had actually done so. Florida and California were next, with about twice as many people having visited the states as being interested in doing so. About a third of those responding mentioned Wyoming, Arizona and Montana, followed by about a quarter expressing an interest in Washington, Oregon, Texas and Maine. There was some interest in Michigan, Hawaii, Idaho, New Mexico and Minnesota. States mentioned by 10 percent or fewer of the people responding included Pennsylvania, North Carolina, New York, Virginia, Wisconsin, Louisiana, new Jersey, South Dakota, Utah, Georgia, Tennessee, Massachusetts, Arkansas, Indiana, Nebraska, Missouri, Illinois, Kentucky, Iowa, Connecticut, Delaware, Vermont, New Hampshire, and South Carolina (listed in order of frequency mentioned). States not listed at all were Alabama, Kansas, Maryland, Mississippi, North Dakota, Ohio, Oklahoma, Rhode Island and West Virginia.

The wildlife attractions alluring most travellers were birds. Raptors, cranes, and coastal, desert and subtropical species seemed to have the greatest appeal. Ungulates were next, with elk and moose being the most popular game animals. Predators as a group followed, with an intense interest expressed in bears of all kinds and wolves. Marine mammals, especially whales and seals, are highly desired viewing subjects. Reptiles, particularly alligators, have some appeal, as do small mammals and fish.

The most popular ecosystems, listed in order,were everglades, mountains, forests, coastal areas and deserts. Yellowstone National Park topped the list of specific sites mentioned, followed by other parks, refuges and assorted public lands.

Economic Value of Nonconsumptive Wildlife Recreation

Every five years, the U.S. Fish and Wildlife Service (USFWS) conducts research on participation in fishing, hunting and other forms of wildlife recreation. However, data on nonconsumptive use and its economic value have been included only since 1980, and are much less extensive than the information on hunting and fishing. Nevertheless, the numbers are significant. The USFWS preliminary 1985 data show Americans spending about $14 billion annually on wildlife viewing, photography, travel and feeding of wild animals. More than $4 billion dollars are spent on travel-related expenses (USFWS 1988). However, there is reason to believe that the total impact of nonconsumptive wildlife recreation on the economy is underestimated. The data are of limited value to states interested in the economic impact of nonconsumptive wildlife recreation on tourism, because information on expenditures generated by the USFWS survey is listed by state of residence and does not indicate where the money is spent. Even more significantly, the survey only includes economic data for trips taken *primarily* for wildlife viewing. If appropriate percentages of the expenses for trips in which wildlife viewing was an important but not the primary focus were included, the impact would be much larger.

There are also limitations of the USFWS data as they relate to expenditures on nonconsumptive wildlife recreation relative to areas of the economy other than travel. For example, an informal Defenders survey of wildlife enthusiasts in the Northwest suggests that the presence of suitable habitat for birds and other wildlife in close proximity to home may influence the price people are willing to pay for residential real estate. Although the USFWS survey shows that bird seed sales soared from about $500 million in 1980 to about $1 billion in 1985, there is insufficient information on the amount of money Americans spend on other wildlife feed (e.g., dog food for raccoons), wildlife art, books, and various other equipment used for watching wildlife, such as boats, and gear for diving and snorkelling.

It is important to document fully the economic impact of wildlife viewing, photography and similar forms of recreation to cultivate new sources of political support for wildlife conservation. Although many surveys demonstrate a high level of public interest in wildlife, the political process does not give wildlife conservation much consideration. If protecting wildlife is perceived as being good for the economy, and political support comes from the beneficiaries of massive expenditures on wildlife recreation, then increased funding for wildlife programs is more likely.

Funding Nongame and Nonconsumptive Wildlife Programs

Unfortunately, the economic benefits associated with nonconsumptive wildlife recreation will never be fully realized unless the public is willing to "invest" in the program. In the short run, it is necessary and appropriate to tap nontraditional funding sources, such as soliciting contributions and selling wildlife-oriented merchandise. It also may be necessary to use some of the hunting and fishing license revenue and federal excise tax dollars for nonconsumptive and nongame programs, as many states do now. However, in the long run, it is critical to secure substantial new sources of revenue for the conservation of habitat and development of viewing opportunities. There has been considerable discussion about how this might be accomplished. Defenders of Wildlife conducts an annual survey of the funding of nongame programs in each state, and has identified several viable funding schemes. The following information is taken from this survey.

The options can be divided into several broad categories. The first is general revenue. Several states, including Nevada and Illinois, depend heavily on direct appropriations from the legislature for nongame programs. Missouri established a one-eighth of 1 percent sales tax earmarked for conservation. Another option is the general obligation bond, typically used for habitat acquisition. For example, California voters approved an $85 million bond in 1985 to fund a variety of land purchases. More recently, a $776 million initiative has qualified for the June 1988 ballot. If passed, the funds will be used for the purchase of wildlife habitat, parks and coastal areas. New York voters also approved a bond that includes $250 million for habitat acquisition. Another passed in Maine, and a bond initiative is under consideration in Georgia.

A slightly different strategy is to generate money through "abuser fees" to mitigate the harm caused by certain activities to wildlife and/or its habitat. For example, many states now have real estate transfer taxes, which are easily justified since land development destroys wildlife habitat. The severance tax on minerals, sand and gravel, or other resources is also a mitigation fee. Many other opportunities exist to establish taxes or fees charged for the use of harmful products. The 1987 Oregon Legislature considered several mitigation proposals. One would have imposed a 2-percent excise tax on plastic products that are harmful to wildlife in the marine environment. An amended version would have established a litter tax on all packaging.

Mitigation funds can also be generated through creative interagency billing for fish and wildlife department review and consultation concerning land use, timber management plans, dredge, fill and removal permits, and other development activities that may adversely affect wildlife and demand significant attention.

A third category is the "user fee." This strategy is preferred by many of the traditional wildlife managers since it has been used so successfully in funding wildlife programs through the sale of hunting and fishing licenses and federal excise taxes on related equipment. The nonconsumptive equivalent is to impose taxes on bird seed, bird baths, binoculars, spotting scopes, cameras, film, camping gear and other wildlife-related products.

Several innovative extensions of the user fee include taxing pet food and nursery stock. Plants and special landscaping are used to attract wildlife. Pet food is desirable as both a user and mitigation fee, since domestic animals often kill wildlife. Several states that offer exceptional wildlife viewing opportunities, such as Alaska and New Mexico, have explored taxes or fees aimed at tourists. Others, including California, have proposed the collection of entrance fees at wildlife areas.

Establishing fees associated with the use of vehicles has special appeal because the money comes from the "users" and the "abusers." Automobiles, highways and parking lots contribute to habitat destruction, and direct vehicle mortality is a serious problem for some wildlife species. Florida has successfully implemented a $4.00 surcharge on the registration of vehicles for new residents, and supplements the mandatory fee with a $1.00 checkoff option on all vehicle registration renewals, raising more than $1.5 million per year.

A similar set of circumstances applies to boats, which cause some wildlife disturbance, contribute to the destruction of estuarine and riparian habitats, and provide transportation for fishing, hunting and wildlife viewing. Boaters also generate much of the plastic debris that is known to harm wildlife in the marine environment. Increasing the license fees for boats and trailers, or imposing a tax on the sale of boats and other marine equipment, could generate significant revenue.

A final category of funding is opportunistic. This group includes cigarette, alcohol and soft-drink taxes, as well as an unlimited number of sources that bear no necessary relationship to wildlife but are easy to identify and tax. An Oregon bill proposed in 1987 would have increased the deposit on returnable beverage containers and earmarked a portion of the increase for the state's nongame program. Similarly, states that have bottle-deposit laws might collect the unclaimed deposit funds and earmark the money for nongame wildlife.

The options are endless, and funding schemes will vary from one state tot he next. The efforts succeed when diverse interests form effective political coalitions to support a common proposal.

Conclusion

Wildlife viewing and photography are popular, appealing, family-oriented activities that should be automatically incorporated into any recreation and tourism strategy. Very few states have effectively seized the opportunity because tourism departments appear to have insufficient information about wildlife resources, and even less information concerning the level of interest the public has in seeing and photographing wild animals in natural habitats.

To the extent that they acknowledge each other's existence, tourism departments depend on state fish and wildlife agencies to provide information on wildlife recreation. Most fish and wildlife agencies are still preoccupied with hunting and fishing, and continue to allocate more than 90 percent of their resources to consumptive use and traditional management. There is little information exchange concerning wildlife viewing because, in most cases, nobody has bothered to assemble any information.

Implementing new public relations strategies, without substantive change in wildlife management activities, is not enough. Responding to the demand for more wildlife, more habitat, interpretive signs, trails, boardwalks, viewing blinds, parking lots, rest rooms, trash cans and bird lists requires a greater commitment than most states seem willing to make until the demand for these amenities is louder and more focused. When the demand is finally acknowledged, it will force difficult decisions about priorities and the allocation of resources, and fundamental changes in the way fish and wildlife programs are financed and managed. The states with foresight to invest substantially in programs to enhance the conservation and appreciation of their wildlife resources will be the winners. The direct beneficiaries will be the public, the tourism and recreation industries, and wildlife.

Recommendations

1. More information is needed concerning the expenditures on nonconsumptive wildlife recreation, and the preferences people have for viewing. The USFWS's 1990 survey should be expanded. In the meantime, public attitude and marketing surveys can be conducted to help guide decision making. The results of such surveys will be useful to tourism departments.
2. Develop a coordination scheme to facilitate effective interagency cooperation in the protection of wildlife habitat and to facilitate wildlife appreciation. The effort should include state and federal resource agencies and tourism departments.
3. Coherent plans for nongame wildlife conservation and recreation need to be developed to justify significant investment in new programs. The plans should incorporate an effective public relations strategy (a) to inform the public as to how the funds will be spent and (b) to generate continuing support.
4. Develop a network of wildlife-viewing areas in each state to increase the visibility of nonconsumptive wildlife recreation and attract more participants. Signs, maps and guidebooks make the sites easier to find.
5. In each state, systematically identify the wildlife habitats that are important for their recreational and/or ecological values. Prioritize the list of unprotected sites, and then a wide range of techniques—including acquisition, easements, zoning, etc.—can be applied to protect them.
6. Organize a broad coalition of interest groups to support the allocation of a sufficient amount of money to the conservation of all native species, and to establish and maintain nonconsumptive wildlife recreational activities. In the short run, rearranging priorities is appropriate. New, earmarked funding is needed in the long run.

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"Wyoming's Wildlife—Worth the Watching": Management in Transition

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Wyoming is unique in the United States in its abundance and diversity of wildlife. Nearly all of the species that were found in the central Rocky Mountain region in 1800 still exist there. For the past 200 years, people from throughout the country and world have travelled to Wyoming to hunt, fish and trap. The state, consequently, enjoys an international reputation as a destination for these consumptive wildlife users, so called because their activities serve to consume some of the available resource.

Wyoming is also unique in that its populations of free-ranging wildlife are managed under an integrated system of management that directs manpower and funding toward predetermined goals and objectives. This system has been very successful, as evidenced by the fact that hunting, fishing and trapping annually generate approximately 4.5 million recreation days in the state, resulting in expenditures of approximately $220 million per year. These figures underscore the importance of consumptive wildlife-related recreation, both aesthetically and economically, to the state of Wyoming. They do not, however, reflect the total value of Wyoming's wildlife resource.

The majority use of this resource, is nonconsumptive in nature. For purposes of this paper, nonconsumptive use is defined as "any use of wildlife which does not result in intentional removal of an animal from its environment by the participant." Examples of nonconsumptive use include wildlife observation, photography, nature study and appreciation.

State fish and wildlife management agencies have not traditionally provided much in terms of goods or services to nonconsumptive users of the wildlife resource. That's not too surprising when one considers their principle constituency historically has been hunters, fishermen and trappers, who have funded conservation programs directly through the purchase of licenses and indirectly through federal excise taxes on certain sporting equipment. In Wyoming alone, that contribution has amounted to $400 million over the last 100 years.

During the first three-quarters of this century, this funding base and constituency were sufficient to carry on aggressive and highly successful conservation efforts. It wasn't until the full implication of population demographics was understood that wildlife agencies across the country were forced to re-evaluate their traditional management roles.

The realization that changes in management emphasis and strategies were imminent came to Wyoming in 1985 during a most unlikely period in its history—a time when the state ranked fiftieth nationally in population, first in per-capita hunting participation, third in per-capita fishing participation, and whose wildlife agency's own fiscal projections indicated the license fee increase enacted five years prior would sustain funding requirements an unprecedented 11 years.

No single factor triggered the move; rather, it was a succession of particular events. Among them: (1) a series of Wyoming Game and Fish Department (WGFD) reports that indicated the future of wildlife-related recreation in Wyoming was likely to be influenced by a number of human population, economic, social value and government trends—most notably a de-emphasis of consumptive recreation in favor of nonconsumptive use caused principally by an aging population, increased input from special interest groups and an expanded role of women; (2) a concurrent WGFD examination of alternative funding methods, spurred on by the belief that sportsmen could not continue to be the sole financial supporters of conservation programs; (3) a major downturn in Wyoming's export-based economy, especially the industrial and agricultural sectors, and a subsequent state government, multi-agency commitment to expand and diversify the tourism industry in the state, including more reliance on wildlife to attract visitors; and (4) the availability of new, state-specific information in the form of graduate research at the University of Wyoming, which documented for the first time the real importance of nonconsumptive use of wildlife in Wyoming.

The numbers were staggering. From Banks (1985) it was learned that more than 1 million recreation days and $24 million in expenditures are attributable to primary or "active" participation in nonconsumptive wildlife use annually by Wyoming residents. When secondary or "incidental" participation is considered, Wyoming residents enjoy a total of approximately 50 million recreation days of nonconsumptive wildlife use annually.

Information compiled by the Wyoming Travel Commission (unpublished data) documented that approximately 6 million nonresidents come to Wyoming annually to vacation and stay an average of 6.0 days. The 1980 National Survey of Hunting, Fishing and Wildlife-associated Recreation (U.S. Fish and Wildlife Service 1982) reported 54.5–84.4 percent of these nonresident vacationers are active nonconsumptive wildlife users.

Finally, statistics gathered by the Wyoming Highway Department (unpublished data) revealed that approximately 3 million additional nonresident passenger vehicles enter Wyoming annually en route to another state, resulting in no expenditure of recreation days in the state. These vehicles are principally confined to the state's three interstate highways systems including I–25, I–80 and I–90, with I–80 having by far the largest traffic flow.

Given this information, the following conclusions were drawn (Wyoming Game and Fish Department 1986):

1. Approximately 190,000 Wyoming residents and 3,270,000–5,088,000 nonresidents actively participate in nonconsumptive wildlife use annually in Wyoming.
2. Residents average approximately 7.0 recreation days in active nonconsumptive use annually and nonresidents average approximately 6.0 days annually.
3. Per-day expenditures are approximately $23.32 for resident and $33.33 for nonresident nonconsumptive wildlife users.
4. Total expenditures by active nonconsumptive users are at least $678 million, including $24 million from residents and $654 million from nonresidents. That's nearly three times the annual expenditure by consumptive users in Wyoming, and quantifies the existing value of Wyoming' wildlife resource to the state's economy—when expressed in terms of expenditures—at nearly $1 billion annually.

In addition to compelling statistics, there were several other common themes that ran throughout this analysis that ultimately provided the momentum to bring about change. First, Wyoming will be faced with tremendous increases in the demand for wildlife-related recreation. Second, the public will demand more diversity in wildlife-related recreation, and more demand for nonconsumptive wildlife use is a certainty. Third, habitat loss will continue to increase. Fourth, controversy over wildlife-related recreation will intensify.

The upshot of all this being that the WGFD can expect wildlife-related recreation to be much more important in the next two decades than it has been in the preceding two. Americans in general and Wyomingites in particular will be demanding more from the wildlife resource.

In the final analysis, the decision was made to incorporate nonconsumptive use into the WGFD's planned management system—a process that includes all the activities leading to the development and implementation of goals, program objectives, operational strategies and evaluation of progress. After a year of preparation, the nonconsumptive use of wildlife plan became operational in January 1987.

There are several aspects of this program in terms of design and administrative philosophy that set it apart from others. It is, first and foremost, a "nonconsumptive use of wildlife" program, one that encompasses both game and nongame species. It therefore has removed most, if not all, potential conflicts inherent when "sportsmen's dollars" are used to fund "nongame" efforts. Among Wyoming's most visible and popular watchable species are those huntable big and trophy game species for which the state is so renowned. For example, elk are premier big game animals, but are "used" at least as much by nonconsumers, such as the people who ride sleighs to view and photograph elk on the Greys River Habitat Management Unit near Alpine, Wyoming, as by consumers (hunters). Likewise, Wyomings extensive pronghorn population provides challenges for more than 100,000 hunters every year. It also is the source of unlimited viewing opportunities for millions of interstate highway travellers. All total, there are approximately 603 species (including subspecies) of wildlife that fall under the regulation of the WGFD, but only 102 of which are officially recognized as game species. All others are considered nongame. Nonconsumptive use transcends game/nongame status to include all species of wildlife in Wyoming.

The program also acknowledges that wildlife is a valuable economic commodity for the state and a growth industry—and what better to direct those activities than the state wildlife management agency. In order to compete successfully at the marketplace with other resources and leisure pursuits, however, the program endorses a marketing strategy. Primary emphasis of the program is focused on the economic return to the entire state, while secondary emphasis is directed toward economic return to the WGFD.

The cornerstone of the program is in the underlying premise that the future effectiveness of the WGFD—indeed, the future of the wildlife resource in Wyoming—depends on broad-based public support. That support is expressed in both political and fiscal strength. With most huntable populations at or near objective levels, the chances for significant growth in the consumptive sector are unlikely in Wyoming. Nonconsumptive use, on the other hand, has almost unlimited potential for attracting and maintaining a large percentage of the populus. There will be no reduction in emphasis of traditional constituencies and their interests, rather expansion of nontraditional constituencies by tailoring programs that encourage broader public participation. The fiscal strategy accompanying this program is that "money will follow opportunity," instead of the more often practiced and accepted "pay your own way first."

The objectives of Wyoming's nonconsumptive use of wildlife program are to bring about a 5-percent annual increase in both participants and user days over 1986 levels for the period 1987—1991. More specifically, they call for active nonconsumptive user participation to increase to a minimum of 238,000 resident and 4.1 million nonresident participants annually by 1991, and active nonconsumptive user days to increase to 8.75 days annually for residents and 7.5 days annually for nonresidents by 1991. No change in existing wildlife population objectives will be required to meet these new nonconsumptive-use objectives.

Achievement of these objectives will increase the total annual recreation days provided by active nonconsumptive use of wildlife in Wyoming to approximately 2.08 million for residents and 30.7 million for nonresidents. Maintaining the existing per-day expenditure rates, these recreation days will result in annual expenditures within the state of approximately $48.5 million and $1.02 billion, respectively, by 1991.

To achieve these objectives, the nonconsumptive use of wildlife program utilizes a multi disciplinary approach consisting of information, education, assistance and acquisition elements. Informational efforts are designed to inform residents and nonresidents about nonconsumptive use of wildlife opportunities to be found in the state. During the first year of the program, these have included news releases, talk shows, slide presentations, meeting attendance, magazine and tabloid features, internally produced radio programs and television news segments, and program products. Long-term projects will include but not be limited to general and site-specific brochures, books, short-range radio broadcasts, statewide signing integrated into the state's network of rest areas and roadside stops, displays at travel information centers and other state-owned facilities, and print and electronic media and outdoor billboard advertising.

Educational efforts are undertaken to educate these same nonconsumptive users about the needs of wildlife in Wyoming and how they can get involved. These efforts tend to be more complex, specialized and costly. Again, during the first year of the program, they have included pamphlets and posters, youth-oriented publications, visitor center remodeling, and video productions. Ongoing and long-term projects include but are not limited to: constructing an education center in association with WGFD's black-footed ferret captive breeding facility; remodeling existing WGFD installations, especially fish hatcheries, to better accommodate public use and interpretation; constructing additional, strategically located visitor centers; developing hiking trails and self-guided auto tours; and creating "do it yourself" wildlife observation and backyard study kits.

Assistance, at the present time, is limited to being technical in nature and directed largely at communities or other local entities of government planning projects which compliment the state's plan for expanding nonconsumptive use of wildlife opportunities. This perhaps has been the most surprising and rewarding of the work accomplished during the program's first year. All total, 19 local entities of government have actively sought advice and expertise in making wildlife, specifically nonconsumptive use, more a part of their economy and tourism/business promotion activities. Several cities have submitted site-specific proposals. Cooperation has ranged from assistance in state and federal permitting to habitat protection and development.

Finally, land acquisition is allowable where high nonconsumptive wildlife use values exist. This can be accomplished by fee title acquisition, property exchange, easement or other forms of property right guarantees. Funding is provided through an ongoing Wyoming Game and Fish Commission (hereafter referred to as Commission) approved acquisition program that identifies and/or reviews then prioritizes properties for acquisition using a structured process known as the Wildlife Land Use Management Plan (WLUMP), which matches biological values with property rights. While no land was acquired specifically for nonconsumptive use during the first year of the program, these values were evaluated and reflected in each parcel's respective ranking prior to acquisition. Future potential acquisitions will be analyzed in the same manner, using the established procedures of WLUMP. Designation of existing WGFD-owned property to include "nonconsumptive use only" areas is also a possibility.

The success of Wyoming's program is largely dependent on an aggressive and innovative marketing strategy that packages and promotes nonconsumptive use of wildlife under a consistent "look" and theme that will become easily identified and readily accepted by the public. It represents a significant departure from traditional government thinking, but applies the same logic routinely used by Corporate America to "sell" consumers new products. The only difference is that the product in this case is a concept.

In the examination of similar efforts by other states, one phrase that regularly surfaced was "watchable wildlife" and, almost without exception, it was used to describe *nongame* programs. While expressing the desired action, designers and copyrighters contracted to give birth to Wyoming's new initiative, believed that tag lacked appeal and would not allow for market positioning. Instead, they recommended and the WGFD accepted, the monicker "Wyoming's Wildlife—Worth the Watching." It bonds the state to the resource and imparts the message that nonconsumptive use of wildlife (i.e., watching) has a value (i.e., worth). The program logo (Figure 1) was then designed to convey that message. It does so in an attractive, positive, reassuring and lively manner. Even the blue and green colors were carefully selected to be representative of aquatic and terrestrial resources, respectively.

In an effort to give the WGFD absolute control over its use and preclude it from becoming a program identifier elsewhere, the "Worth the Watching" logo was

WYOMING'S WILDLIFE
Worth the Watching®

Figure 1. Logo for Wyoming's nonconsumptive use of wildlife program.

registered with the U.S. Department of Commerce, Patent and Trademark Office. After only a year, it appears that move was and will continue to be essential to maintaining the integrity of the program.

The marketing and promotion strategies of this program are designed to allow it to stand alone, yet be compatible with other state tourism-enhancement programs. It will piggyback on those efforts whenever possible. The focus is designed to be statewide and regional in nature, and will go national only with the help of other state tourism-advertising campaigns. One key element of the program is to target the motoring public who travel in and through the state. Another is to appeal to children, women and those individuals over age 35.

No discussion of new state initiatives would be complete without looking at funding methods and requirements. Since the thrust of this program reaches well into the next century, the first priority during development was to identify funding sources that would be stable or growing and long-lasting. Since Wyoming has no personal income tax, the tax checkoff measure adopted by a number of other states was not an option. However, because the WGFD is an autonomous state agency—that is to say, the Legislature does not appropriate its monies—the Commission created what is now commonly referred to as the internal Wildlife Trust Fund, which currently has an inviolate corpus of $5.3 million, the interest of which can only be used for habitat acquisition or improvements and nongame/nonconsumptive use of wildlife projects. The Wildlife Trust Fund is structured in such a way as to facilitate donations from any and all potential contributors. In 1986, when the fund was established, $2 million of WGFD revenue was used as "seed money." The money came from four sources: (1) Sale of conservation stamps; (2) sale of publications; (3) gifts and donations; and (4) interest from investments. In 1987, the Commission placed an additional $3 million into the Wildlife Trust Fund. Future fiscal projections anticipate placing about $2 million per year in the fund, utilizing the same revenue sources. During 1988, interest earnings will exceed $350,000.

Efforts to date have not been overly expensive. Funding for the program officially began with the start of the current (1988) fiscal year. Through the budget review and approval process, the Commission directly allocated $125,000 to initiate the program. Together with reorganization of existing maintenance and operations dollars, first-year program costs are going to be approximately $175,000. In the fiscal year 1989 budget deliberations just completed last month, the Commission approved a minimum of $304,000 for new nonconsumptive-use wildlife projects. Since several of the first year's projects are multiyear funding efforts, second-year expenditures will more realistically be in the realm of $400,000. This represents about 2 percent of the total agency budget. As the Wildlife Trust Fund corpus continues to grow, the interest available to finance these kinds of projects will also increase each year.

Another possible, though initially unexpected, source of funding for the nonconsumptive-use wildlife program is corporate sponsorship. Because interest in wildlife in this country is at an all-time high, companies appear willing to cooperate. During the first year of Wyoming's program, two out-of-state firms have submitted proposals to work jointly on specific projects. Although expected, no contractual agreements have yet been signed. If consummated, one of these would actually involve a firm providing money to complete a project, while the other would result in national exposure for the program through the use of the "Worth the Watching" logo in concert with the firm's corporate logo in its advertising efforts and on its products.

Income from the sale of program products is another source of revenue that has unknown potential. These products display the program logo and double as advertising agents and revenue generators. They range in price from a few cents to more than $100. They include everything from lapel pins to posters, publications, clothing, trinkets and other collectibles. During the last three months of 1987, when this effort was first initiated and only a limited number of these products was available, more than $8,000 in income was received. Based on a potential product list that presently numbers 27 items to be developed over the next year and a half, gross annual sales exceeding $100,000 appear reasonable within a five-year period.

Within the next decade, the WGFD expects to implement a major fund-raising function. The development master plan has already been completed. The benefits of this effort, and the previously described sale of program products, are that they provide or will provide a direct means for nontraditional supporters to contribute directly to the state's nonconsumptive use of wildlife program.

In summary, nonconsumptive use is the fastest growing facet of wildlife-associated recreation nationwide. It is likely to grow even more rapidly given current trends. Traditional constituencies and traditional funding sources are currently inadequate to develop programs for nonconsumptive users. Need exists to expand and aggressively pursue new and innovative approaches to attract political and fiscal support on behalf of the wildlife resource. Such a program is operational in Wyoming.

The implementation of the nonconsumptive use of wildlife program entitled ''Wyoming's Wildlife—Worth the Watching'' represents a substantial change in direction for the WGFD. It is intended to improve and expand nonconsumptive-use opportunities for residents and nonresident tourists and subsequently generate significant revenue for the state through increased expenditures by participants. Ultimately, an expanded constituency is expected. After just one year, the results of this undertaking and the potential it represents excite even the most conservative thinkers.

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Special Session 7. *Management of Wetlands, Including Bottomland Forests and Other Riparian Areas*

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Policy, Planning and Science: Integrating Disciplines for Management of Wetlands and Wildlife

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Introduction

Of the 2.3 billion acres (928 million ha) of land in the United States, slightly over half is devoted to farming and ranching. These agriculture industries also account for 80 percent of our water use (Cook 1985). Thus, the agricultural sector, federal water projects and the policies that have affected both have impacted wetlands to the point that less than 46 percent of the original 215 million wetland acres (87 million ha) in the lower 48 states remains today (Barton 1986).

Policy

Rationale used to justify agriculture and federal water project policies involves arguments for stimulating economic development and providing social benefits. These motivating forces in policy formation continue to override environmental concerns. This occurs despite increasing public skepticism that government programs no longer justify their costs to society, in relation to increasing crop production (Cook 1985, Nikiforuk 1986), developing water projects and irrigated agriculture (LeVeen and King 1985, Letey et al. 1986), and subsidizing livestock grazing in riparian areas of public land (Barton 1985).

Current federal policies do not consistently deal with wetland use, and this situation is often cited as the major reason for wetland destruction (Barton 1986). However, recent economic analyses suggest that a strong, long-term economic incentive to drain wetlands exists regardless of the availability of farm programs (McColloch et al. 1987). This in turn, suggests that agricultural attitudes and practices towards wetlands (which are viewed as nonprofitable real estate) will only change if: (1) regulatory programs prohibiting wetland modification are vigorously enforced (on the basis of society values of flood storage, sediment retention, water quality improvement and wildlife value [Sather and Smith 1984]); (2) dual management of wetlands for agricultural and conservation purposes can be promoted (e.g., wetlands as storage for natural runoff and irrigation water [Giron 1981, Guthery and Stormer 1984], or managed for seasonal grazing or hay production [Neckles et al. 1985, Clay and Nelson 1986, Fulton et al. 1986]; and (3) conservation organizations integrate their wetland programs with field-level agricultural extension. It is likely that policies to conserve wetlands will require several strategies (Nelson 1986), and because public participation in natural resource policy development and decisions is being required by law, professional organizations and universities now have several options to increase their involvement in resource policy (Lyons and Franklin 1987).

Planning

In theory, national and regional wetland policy should guide local managers in working with the public to determine which wetland issues need to be addressed. Local planners should then develop literature reviews, inventory data and realistic resource objectives within regional constraints, and build this information into a comprehensive plan. They should then prepare alternatives for supervisors or steering committees to select preferred options to reach desired resource objectives.

In reality, many key decisions as to the nature of programs, target areas and numerical objectives are made at high levels and passed down to local planners, who then feel compelled to implement programs and attain objectives no matter what the cost to the economy, environment or integrity (Barton 1985, 1986, O'Toole 1986). Many of the problems of poor planning could be alleviated if scientists were more involved with planners in determining critical assumptions, assisting in careful review of background data and devising evaluation programs.

Science

Land-use planners, resource managers and policy makers often have to assess the effects of various management decisions on wetland systems. The difficulties of predicting results of impacts on the entire wetland ecosystem (e.g., energy pathways) are well-known (Sather and Smith 1984). At this point in time, it is virtually impossible to predict these results with any degree of accuracy. This is because, although models may be available for integrating the vast arrays of data for a particular ecosystem, baseline data are either insufficient or not available.

As components of the ecosystem are separated out, for example, plant communities, predictions become more accurate. Pearlstine et al. (1985) developed a quantitative model to predict the effects of altered hydrologic regime on bottomland forest communities. They found the model accurately predicted the importance values (sum of relative density, dominance and frequency) of individual tree species in relation to observed field conditions. These positive results were likely because the model incorporated a good life history data base for the tree species involved and because trees are relatively long-lived plants.

When entire wetland plant communities and/or wetlands dominated by herbaceous (or relatively short-lived) plant species are subjected to management, predictions become less clear. Verhoeven et al. (1982:159) stated that, "With additional autecological information on the plant taxa constituting the community, a real understanding of the mechanisms that determine the community structure can be achieved." Unfortunately, this type of information is generally only available for a few species within a community. For example, Keddy and Reznicek (1985) presented a model of shoreline vegetation as it was affected by water levels in the Great Lakes. They noted, however, that the model had not been "refined enough [we assume this means lack of data] to predict occurrence of communities or species associations." The model was useful for interpreting vegetative types and conceptual frameworks that may be suitable for some management decisions.

Even combining life history information into a few discrete categories (e.g., flood-tolerant versus flood-intolerant) may not provide enough predictive power for dynamics models of herbaceous wetland vegetation. Verhoeven et al. (1982) noted that generalizing plant strategies into a few groups does not improve our understanding about the relationships between plant populations or population relationships to environmental conditions. For example, Smith and Kadlec (1985), using a qualitative model of plant species composition (van der Valk 1981), had limited success predicting vegetation response following a marsh fire. Lack of predictive ability of the model was partially attributed to the generalization of life history characteristics into discrete categories (e.g., shade-tolerant versus shade-intolerant). By allowing life history variables to vary on a continuous scale (Smith and Kadlec 1985), and emphasizing the diversity of plant strategies (Verhoeven et al. 1982), management predictions will more closely approach reality.

Finally, only as the community becomes simpler (i.e., dominated by one or two species), or in instances where we are dealing with one plant species, does management prediction become more certain. This is obvious, because we are dealing with fewer variables for a situation in which plant life history characteristics are well known (as is often the case for aquatic weeds). As an example, hydrilla (*Hydrilla verticillata*), an exotic submerged plant, often dominates an aquatic plant community (Haller 1978). Because the life history characteristics of this species are relatively well-known (e.g., Haller 1978), management practices can be predicted and economic impacts also can often be estimated (Colle et al. 1987).

Conclusions

Future wetland policy and planning efforts will undoubtedly reflect changes in technology, natural resource use and human population. Thus, wetland management planning will incorporate more economic theory and sociology (McCollock 1986, Nelson 1986), involve systematic computer-assisted processes, be concerned with increased problems related to environmental contaminants, and include intensive, small-unit management for species or groups of species. Implementation of existing legislation (e.g., "Swampbuster" of Food Security Act of 1985) and new proposed programs (e.g., North American Waterfowl Management Plan) will require devoted on-the-land effort by conservation organizations and unprecedented cooperation among groups with philosophical differences toward wildlife and wetland management.

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The Impact of Federal Programs and Subsidies on Wetlands

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Introduction

During the past three years, the U.S. Department of the Interior has been conducting an analysis of the impact that federal programs and subsidies have had and are likely to have in the future on the conversion, degradation and conservation of wetlands in the United States. The study was mandated by Congress, and will culminate in a report to Congress. The study area was exhaustive, covering every major wetland region in the 48 contiguous states, Alaska and Puerto Rico. This paper summarizes the research findings to data, covering only the Lower Mississippi Alluvial Plain (the Delta) and the Prairie Pothole Region (the Prairies).

The Function of Wetlands

Wetlands produce numerous benefits for society. They are the nursery for much of life, providing habitat for many species of fish and wildlife. They play an important role in reducing flooding problems by temporarily storing large quantities of water and by slowing the velocity of flood-waters. They help to maintain water quality by filtering out pollutants and sediments. They serve to control erosion by trapping soil washed from nearby farmlands. They are a source of recreation, timber and other natural products for commercial use. They are a vital element in the ecosystem, and they are disappearing rapidly.

The Nature and Extent of the Losses

Approximately 215 million acres of wetlands existed in the conterminous United States at the time of the nation's settlement. By the mid-1970s, only 99 million acres remained—46 percent of the original wetland acreage. Between the mid-1950s and the mid-1970s about 9 million acres of wetland were lost. Annual wetland losses average 458,000 acres.

By far, the most important economic sector absorbing wetlands is agriculture. Agricultural development accounted for 87 percent of recent wetland conversions, urban development for 8 percent, and other development for only 5 percent of the losses (Tiner 1984).

The Federal Role

Although a number of federal programs are designed to protect wetlands, federal policy is not consistent with respect to wetland use. Indeed, federal policies affect wetlands in opposing ways. Some encourage wetland conversion by reducing the cost, increasing the revenue and/or reducing the risk of wetland development. Simultaneously, other federal programs control or manage wetlands use through acquisition and easement, regulation, and policy guidance.

Regulatory programs are frequently cited for their limitations. Among these are: restricted jurisdiction and limited statutory authority; divergent interpretations of the statues; limited staffing for regulation and enforcement; and failure by regulatory authorities to assess developmental impacts properly. Such criticisms are often accompanied by calls for increased federal wetland aquisitions and easements. However, with the overwhelming majority of the remaining wetlands in private hands, it is unrealistic to expect acquisition and easement programs alone to solve the problem of conserving environmentally important wetlands. The cost is simply too high, given other priorities and competing budgetary interests.

The Purpose of the Study

Although more vigorous regulation and increased acquisition would conserve more wetlands, both the Administration and Congress have shown a preference in recent years for attempting to redesign federal programs that produce unwanted effects on wetlands, before engaging in additional land acquisition or regulation to counter the programs in question. Thus, in 1985, as a precursor to developing greater consistency in federal policies with respect to wetlands, Congress directed the Secretary of the Interior to conduct a study of the impact that federal programs and subsidies have on wetlands in the United States.

The report to Congress will be in two volumes. Volume I, which is expected to go to Congress in the spring, focuses on two of the most important wetland regions in the country: the bottomland hardwoods of the Lower Mississippi Alluvial Plain and the Prairie Pothole Region of the Upper Midwest. Volume II (expected to be completed later this year) covers all other major wetland regions in the United States—southeastern Alaska, California's Central Valley, Florida's Everglades, coastal Louisiana, Maryland's Eastern Shore, coastal Michigan, northern Michigan, the Pocosins in North Carolina, New Jersey, Puerto Rican mangroves, the Texas coast, and three western riparian areas (Idaho, Nevada and New Mexico).

The study has been comprehensive in its consideration of federal programs, examining the effects of agricultural programs, water-management programs (flood control, drainage and irrigation), highway programs, land-management programs (minerals development, grazing and forestry), conservation programs and provisions of the tax code. The study did not address regulatory programs, that work having already been conducted by the Office of Technology Assessment (OTA 1984). Since the agriculture sector absorbs 87 percent of converted wetlands, the analysis concentrated on those programs that make conversion technically and financially feasible by lowering the costs, increasing the revenue and/or reducing the risk of conversion and development of wetlands for agriculture.

Federal Programs Affecting Wetlands in the Delta and the Prairies

Federal programs may affect wetlands in two ways: (1) directly through project construction or (2) indirectly by altering the financial incentives to convert wetlands (increasing revenues, reducing costs, reducing risks).

In the Prairies and the Delta, agricultural conversion accounts for almost all wetland development. By increasing the profitability and reducing the risk of engaging in agriculture, federal programs alter the incentives that farmers have to bring additional land under cultivation. Owners of wetlands may respond by draining and converting their property. The major federal programs that have had an effect on wetlands in the Delta and the Prairies are:

- flood-control and drainage programs of the U.S. Army Corps of Engineers (Corps) and the Soil Conservation Service (SCS) in the Delta;
- flood-control, drainage and irrigation programs of the Corps and the Bureau of Reclamation in the Prairies;
- agricultural programs and subsidies (price and income support, below-market interest rate credit, crop insurance, disaster aid and technical assistance);
- tax incentives that encourage conversion of wetlands;
- highways in the Prairies; and
- conservation programs (acquisition, easement and oversight).

The Methodology for Estimating the Impact of Federal Programs

The Conceptual Framework

The basic underlying assumption for the study is that a decision to convert wetlands into farmland is an investment decision by the landowner in an attempt to maximize his long-term economic return and/or reduce his economic risk from the activities conducted on the land. For example, in its natural state, land in the Delta can be managed for its timber value and, in some instances, can be leased for recreational hunting. Cleared, leveled and drained, the land can be cultivated. The decision to incur the conversion costs depends on the expected earnings and the potential risk from the alternative uses of the land. As already noted, federal programs and policies can influence this decision by increasing the expected net income from alternative uses of the land, lowering the risk premium, reducing the cost of conversion and changing land values.

At a given level of risk, a landowner seeking to increase his income from the land would compare the net income expected over the years from conversion with the net income expected from timber production and hunting leases. The greater the net gain from the conversion, the more likely it will be that landowners will make conversion investments.

Statistical Models

In the Delta. The Department used two distinct approaches to estimate the impact of federal programs on the conversion of forested wetlands in the Delta: (1) an econometric model and (2) a cash-flow simulation model.

An econometric model is a mathematical way to determine and express the extent to which each of a variety of possible causes affects the variable of interests, e.g., how flood control affects conversion of wetlands. In this case, a model was developed to test the statistical relationship between changes in the acreage of forested wetlands in the Delta during the 50-year period 1935–1984 and the various conditions, policies and programs that, in concept, may have affected decisions to convert wetlands (Stavins 1986). The model was designed to reflect the basic underlying assumption that landowners attempt to maximize the expected return from their land and that the decision to clear the land is influenced by those variables that affect the rate of return from alternative uses of the land.

No previous research of these dimensions has been conducted on the factors affecting depletion of the bottomland hardwoods. The study was made possible by the existence of rich data sets, published by the U.S. Forest Service, the U.S. Department of Commerce, and State Crop and Livestock Reporting Services. These data provided estimates of changes in forested acreage, at the county level, in 36 Delta counties, at five-year intervals, over the 50-year period.

The econometric model was designed to examine the impact that only one of the federal programs of interest had on conversion of the hardwoods—Federal flood-control and drainage projects. The model could have been structured to permit an examination of the impact of individual agriculture programs, conservation programs and tax code provisions as well. However, a preferable approach was available to estimate the effects these federal programs had on wetlands in the Delta. A farm-level, cash-flow model was developed that simulates the rate of return and risk associated with converting bottomland hardwoods to farmland under specified public policies (Kramer and Shabman 1986). The model has the flexibility to test the impact that changes in the design of these public policies have on the profitability of conversion. Simulations were conducted for four different situations, reflecting differing ownership patterns, crop mixes and soil characteristics in the Delta. Interpretation of the simulation results was supplemented and enhanced by an analysis of data describing the ownership of bottomland forests and Delta cropland.[1] Different owners face different constraints and have different motivations for developing bottomland forests. Therefore, in a given policy and economic climate the likelihood that land will be converted depends on the characteristics of the landowners.

In the Prairies. The Department conducted two separate studies to examine the effect that federal agriculture programs and tax provisions have had on the incentives and farmers' decisions to convert prairie potholes to agriculture. A farm-level simulation model was used to estimate the effect of various programs on the net present values of six representative farm types (McColloch and Wissman 1986). The simulation model for the Prairies was similar in structure and concept to the one used for the analysis of the Delta. A review of past research augmented by selected case studies and focus group interviews was also conducted (Leitch and Nelson 1986). In addition, the Department examined the extent to which runoff ditches for federally aided roadways have been used by farmers as outlet ditches for draining prairie potholes (Nomsen et al. 1986), and the impact which the construction of federal dams, reservoirs, channels and irrigation systems have exerted on wetlands in the Prairies. Time series data on wetland losses are not available for the Prairies; hence, a statistical analysis, like that done for the Delta, could not be conducted.

One technique used throughout the analysis to determine the impact that a federal program had on wetland conversion was to assume that landowners who converted wetlands to agriculture would be selectively ineligible for program benefits. For example, when analyzing the effect of agriculture price supports, it was assumed that they were withheld only from selected farm operators and not eliminated altogether.

[1]The ownership characteristics included type of owner (corporation, family, sole proprietor, etc.) size of the holding, occupation, net farm income and age.

Research Findings

The Delta

Impact of federal flood-control and drainage projects. Federal flood-control and drainage projects built in the Delta between 1935 and 1984 accounted for approximately 25 percent of total wetland depletion. These projects (known as the Tributary Projects) played a more important role in wetland depletion than any other factor, including the mainline levee system, increases in farm product prices and dry weather. The mainline levee system (built largely before 1935) together with the natural topography also accounted for nearly 25 percent of wetland depletion in the Delta during the period 1935–1984.

Role of agricultural economic conditions. Historically, clearing of forested wetlands and conversion to agriculture have been highly profitable in the Delta. Basic economic conditions are no longer as favorable to bottomland development as they have been over the past two decades. Agricultural production costs have risen sharply over the past decade, and community prices have not kept pace. Under current, depressed market conditions, opportunities for profitable conversion and development of wetlands in the Delta are limited, even with agricultural subsidies in place.

Effect of agricultural income and price-support programs. Federal agricultural income and price-support subsidies significantly increase the profitability and reduce the risk of conversion and agricultural development in the Delta.

Effect of favorable tax treatment. Special tax code provisions that favored conversion of wetlands to agricultural land also increased the profitability and reduced the risk associated with conversion and agricultural development in the Delta, but not by as much as agriculture programs.

Combined effect of tax reform and Swampbuster. The combined effect on ineligibility for agriculture programs and elimination of those tax deductions that favored conversion has a very significant impact on the incentive to convert and develop forested wetlands in the Delta—the estimated rate of return to the investment is reduced dramatically and the risk increased.

Vulnerability of wetlands. Although under current economic conditions bottomland development has only marginal economic feasibility, the future for these wetlands is quite uncertain and, in the long run, the wetlands in the Delta remain vulnerable to agricultural development.

The Prairies

Impact of federal agricultural programs. Federal agriculture programs have significantly increased the profitability of drainage in the Prairies. The program with the greatest impact on the incentive to convert wetlands in the Prairies was price and income supports. Other influential programs were cost-sharing for drainage and the general encouragement for expansion of the agricultural sector provided by below-market rate credit.

Role of general economic conditions. Drainage of prairie potholes has been generally profitable, even in the absence of government incentives. Federal agriculture programs made it more so and, at the margin, induced some additional drainage. Economics is the most important factor influencing prairie pothole conversion, especially when all the costs and benefits to the individual (such as nuisance and avoidance costs) are included in the analysis.

Effect of tax incentives. Income tax provisions, such as expensing drainage costs, while important to some larger farm operations, are not generally a strong incentive to drain prairie potholes. This is probably due to historically low income tax liabilities of Prairie farmers and the small cost of drainage in the Prairies relative to the overall costs of farming.

Impact of federally aided roadways. Drainage of prairie potholes has been facilitated by outlet ditches provided through construction of roads and highways. Drainage into road ditches violates federal highway aid provisions. The Federal Highway Administration has had regulations prohibiting encroachment since 1960, but responsibility for enforcing these regulations has been delegated to the states. Since enforcement is infrequent and the penalties are not punitive, these road ditches continue to offer an incentive to drain adjacent farmlands.

Impact of water-management programs. Water-management programs have affected a sizable number of wetlands in the Prairies. The effects have been both direct and indirect, but the major impacts have come during construction of five large dams and reservoirs along the mainstem of the Missouri River by the Corps of Engineers during the 1950s and 1960s. The mainstem Missouri River projects resulted in the loss of nearly all the riparian wetlands and oxbow lakes in North and South Dakota (approximately 388,000 acres). Authorizing legislation did not commonly call for mitigation when these dams were built, consequently almost none of these losses was mitigated.

It is expected that in the future the threats to Prairie wetlands from federal water projects will be much reduced, because the prospects for construction of new, major water projects in the Prairies are limited, and authorizing legislation is more likely to require mitigation of wetland impacts.

PL-566 stream channelization also induced considerable wetland drainage. The existence of a drainage outlet provided by a PL-566 project was a major factor influencing decisions by landowners to drain.

Vulnerability of the wetlands. A combination of changes in land ownership and the cyclical nature of agricultural prices makes it highly likely that most unprotected wetlands will eventually be vulnerable to conversion.

Prospective effectiveness of Swampbuster. Swapbuster will be effective in protecting wetlands in the Prairies if its provisions are vigorously enforced. During recent Congressional hearings, questions were raised by members about the enthusiasm with which the regulations were being enforced, and members voiced strong support for the Swampbuster provisions.

Historically, strategic avoidance tactics have often been adopted in response to eligibility criteria for federal subsidies and benefits. In the case of Swampbuster, such tactics could take the form of increased acreage of nonprogram crops, illegal drainage or creative real estate transfers.

Recommendations

At the time of this writing, the Administration has not yet submitted its report to Congress, and recommendations are still being formulated. However, when the study began, it was thought that a principal recommendation that would emerge from it would likely be for legislation designed along the lines of the Coastal Barrier Resources Act (CBRA). CBRA made any new development projects in designated areas on coastal barriers ineligible for most federally financed assistance programs. Since the study was initiated, however, Congress has enacted three significant pieces of legislation that affect wetlands:

1. the Food Security Act of 1985, with its conservation provisions (Swampbuster and the Conservation Reserve Program);
2. the Water Resources Development Act of 1986, with its provisions for increased cost-sharing and emphasis on the benefit principle for financing government programs, i.e., that each beneficiary should bear the cost, including any environmental costs, of generating his benefits; and
3. the Tax Reform Act of 1986, which eliminated provisions of the tax code that encouraged conversion of wetlands to farmland.

These new laws have the potential for solving many of the economic and environmental problems that were identified during the study. As a result, it is unlikely that the Administration will recommend comprehensive legislation similar to CBRA. Instead, the recommendations are likely to build on the foundation established by these landmark statutes and call for more state, local, and private participation in the effort to conserve the nation's wetlands.

Author's note: The views expressed in this paper are those of the author and do not necessarily reflect those of the U.S. Department of the Interior.

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Management of Wetland Complexes for Waterfowl Production: Planning for the Prairie Habitat Joint Venture

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Introduction

Breeding duck populations in North America have been generally declining since the mid-1950s. In 1985, mallard (*Anas platyrynchos*) and total duck breeding populations reached historical lows of 4.99 million and 26.5 million birds, respectively (Reynolds 1987). This long-term, continentwide decline in ducks led to an international initiative to identify and address the factors responsible. Consequently, the North American Waterfowl Management Plant (NAWMP) was drafted and signed by the governments of the United States and Canada in 1986 (Anonymous 1986).

The prairies and parklands of Alberta, Saskatchewan and Manitoba are recognized as one of the most important waterfowl production areas in North America (Pospahala et al. 1974). Although the area historically held about 50 percent of the continental mallard population, more recent estimates show this to have fallen to 44 percent (Turner et al. 1987). In recognition of this region's importance, an ad hoc Prairie Habitat Joint Venture Steering Committee (PHJV) was established to facilitate planning, negotiate interagency agreements and implement habitat programs within the NAWMP framework.

The PHJV Committee, comprised of representatives from provincial, federal, and several nongovernment wildlife and agricultural groups, initially developed a prospectus identifying general strategies and guidelines to return waterfowl populations in this region to 1970–1979 average levels (Anonymous 1987). Faced with complex interactions between various aspects of the waterfowl breeding cycle and an ever-changing agricultural landscape, the Committee developed and adopted a computerized system (CPT) of planning habitat programs which would estimate associated costs, staffing and waterfowl production. Our objective in this paper is to describe the planning process used, the types of programs being considered and the relative strengths of the system in planning large-scale habitat programs for the PHJV.

Approach to Planning

Although prairie/parkland wetland drainage and degradation is ongoing (Turner et al. 1987), the lack of suitable nesting cover is considered most immediately limiting to waterfowl, based on recently completed studies of nesting success (Greenwood et al. 1987). Whereas drainage rates in the Canadian prairie/parkland region are currently less than 1 percent annually, mallard nesting success averaged 12 percent from 1982–1985. Cowardin et al. (1985) suggested populations experiencing nesting success below 15 percent might have difficulty maintaining themselves. Thus, we surmised that populations of upland-nesting species have declined because nesting cover has been reduced to remnant patches that are easily searched by predators, causing depressed nest success and lower recruitment rates.

PHJV planning efforts are concentrating on the mallard because it is better understood than any other upland nesting duck species. Mallards are also the most heavily harvested and most abundant duck in North America (Johnson et al. 1987). We use this species as the best model available for how other upland-nesting duck species might respond to the habitat programs proposed by the PHJV.

Planning has been most detailed for various programs that provide large blocks of undisturbed, dense nesting cover (DNC) that are protected in some way from excessive nest predation. Other programs have been proposed that encourage farming techniques that improve soil and water conservation while providing benefits for breeding waterfowl. All programs strive to protect the present wetland base while improving recruitment rates through upland habitat programs. Although harvest management is not discussed, we assume harvest will be regulated as outlined in the NAWMP.

A variety of "direct" and "indirect" programs will be necessary to produce the shifts in land use required to meet and sustain PHJV duck breeding population objectives. Direct habitat management programs, implemented only in high waterfowl capability areas, will be aimed at achieving a rapid waterfowl response. Indirect programs will focus on changing public opinion and policies, and are intended to produce broad-scale land-use shifts that will benefit waterfowl in the long-term.

The CPT was developed to generate biologically sound waterfowl population projections, and to define costs relative to waterfowl production resulting from each program proposed. An obvious advantage to using this computer-assisted planning process is that various program combinations can be rapidly and reliably compared prior to making choices.

The ultimate goal in planning for PHJV habitat programs is to maximize programs providing the greatest long-term return on the resources invested. Highly cost-effective programs are usually constrained by factors other than monetary resources, i.e., public acceptance, acres available, etc., before the spring population goals are met for the region. In these cases, sequentially less cost-effective programs must be applied if population goals are to be attained.

Targeting Programs

Several factors should be considered when targeting programs of habitat improvement. Generally, the most expensive programs per unit area should be focused in areas supporting high pair densities in most years. An example of this kind of program is fenced DNC, which can cost $18,000 (U.S.) to establish each 40-acre plot. As costs per unit area decline, the importance of a consistently high resident pair population diminishes. Opportunities for cooperation with agricultural interests to promote better land use exist with these kinds of programs, e.g., the Conservation Reserve Program in the U.S. (Food Security Act 1985).

The PHJV has adopted such an approach and targeted most programs in the Canadian parklands where water conditions are stable relative to the prairies. Both Pospahala et al. (1974) and Reynolds (1987) found significant relationships between May ponds and proportion of mallards in the prairie/parkland region. It is no surprise that consistently good mallard pair populations are associated with areas of high spring pond densities in most years.

Methods Used to Select Areas

Several data sources were used to select areas of high pond density, each with their own biases. Landsat V Thematic Mapper data were made available by Ducks Unlimited, Inc. (Koeln et al. 1987). These data provided resolution to two acres and summarized wetlands into three classes—shallow marsh, deep marsh and open water. Both counts and acres of each wetland category allowed selection of townships with the highest wetland density and quality for waterfowl production.

Canada Land Inventory (CLI) waterfowl capability maps provided another more generalized source of information. In Alberta, waterfowl classifications were overlaid on CLI agricultural capability maps so that areas with high waterfowl but low agricultural capability could be targeted for suitable habitat programs (Figure 1).

An additional source of information at the township level was provided in Manitoba by the provincial Forest Inventory. This mapping, based on 1981 aerial photography, provided a detailed description of upland cover-types in addition to area estimates of wetlands larger than five acres.

When counts were available by township, they were ranked according to total acreage of temporary (wet meadow and shallow marsh), permanent (deep marsh and open water) wetland habitat, and intensity of agriculture. Then townships were selected sequentially, starting with the township having the highest acreage of semi-permanent wetlands and lowest acreage of cultivated uplands, until most of the high capability waterfowl habitat was included. For example, in Manitoba roughly 75 percent of the wetland area in Strata 39 and 40 was found in 50 percent of the townships. These comprised the townships targeted for all kinds of habitat programs.

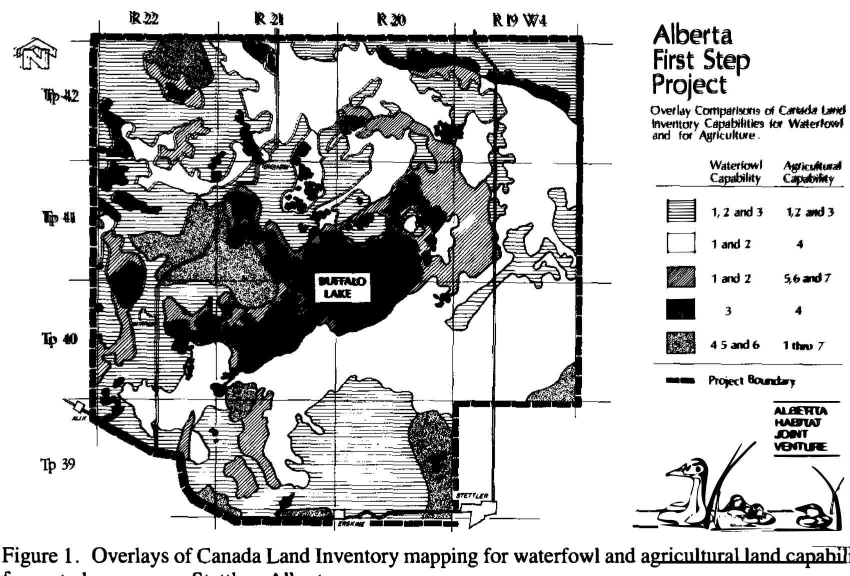

Figure 1. Overlays of Canada Land Inventory mapping for waterfowl and agricultural land capability for a study area near Stettler, Alberta.

Large areas of southern Saskatchewan and Alberta can be very productive of waterfowl during years of wet spring conditions. Agricultural and wildlife interests will cooperatively target improved land-use programs in these areas. With relatively inexpensive programs of soil and water conservation in place, improved recruitment of northern pintail (*Anas acuta*) and mallard should result in wet years because of expected reduction in acres under spring tillage.

Organization of Planning System

The CPT is organized into two basic components—the Land Management Programs, and the Mallard Production Model (Figure 2). Information is entered via a

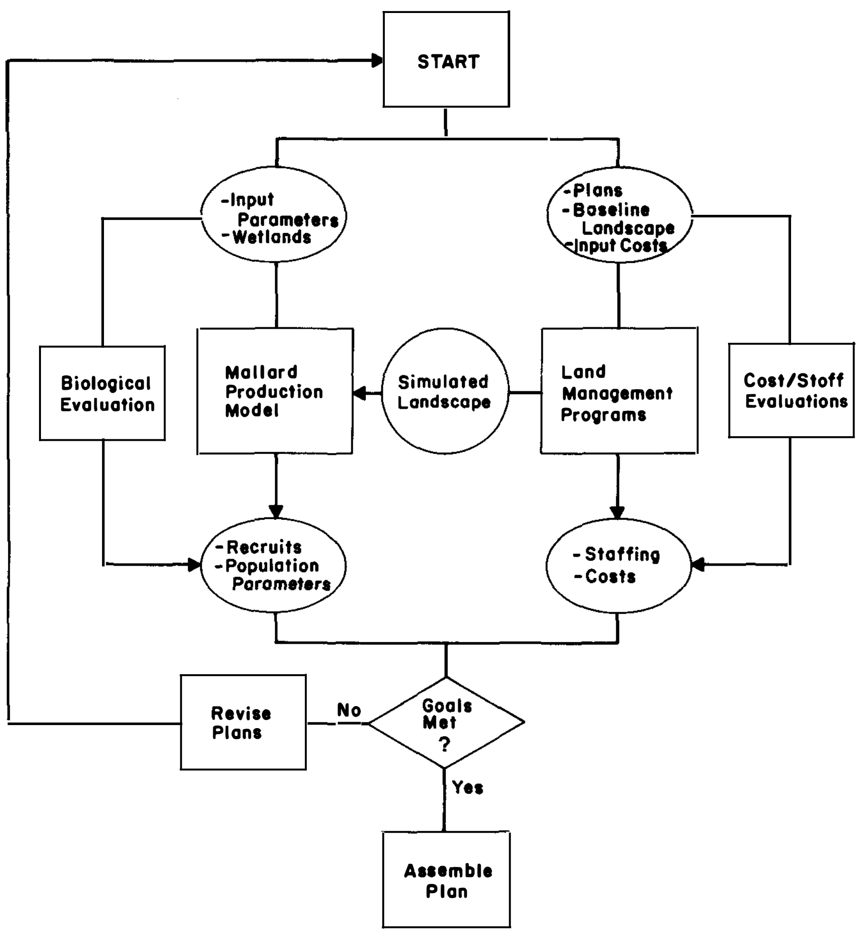

Figure 2. Schematic flow of information between the Land Management Programs and the Mallard Production Model in the CPT.

menu-driven system written in Natural Version 1.2, SM Level 7 (product of Software AG). A system of Land Management Programs allows users to enter management plans for a wide variety of potential programs. Costs and staffing requirements are summarized based on the acres proposed each year.

Acres of each cover type are then routed to a Mallard Production Model (MPM) that generates estimates of resultant waterfowl production from each program. This stochastic model was described in detail by Johnson et al. (1987) and subjected to sensitivity testing in that and other papers referenced therein. Cowardin et al. (1983) presented initial applications of the model demonstrating its use in planning waterfowl management programs. Although few data are available for validation, Johnson et al. (1987) provided evidence that outputs closely parallel field measurements.

Outputs from the MPM are routed through a series of routines to summarize mallard production resulting from the newly proposed habitat programs. Costs are compared with production for each program until the most efficient expenditure of resources is found and goals are met. The entire CPT runs on an IBM 4341 mainframe computer in a VM/CMS environment given about 3.5 megabytes of memory.

Land Management Programs

Inputs are made into these programs at two levels of organization. First-level inputs apply across several targeted zones and include the daily cost of staffing, the inflation rate in five-year intervals and various habitat treatments and plans proposed. These inputs might apply to an entire province, whereas an example of second-level inputs, described below, might be surveyed strata occurring within the province.

The second level of input, applying to specific areas within the area of first-level input, includes annual estimates of the area for each plan proposed, costs of land for each type of agreement (i.e., leases, purchases, etc.), areas of cover comprising the current landscape and wetland numbers expected over the next 10 years.

Several additional biological parameters are input at this level for the breeding hens. They include annual survival rates, average initial spring weights, parameters estimating carrying capacity in relation to the number of ponds, probability of mortality associated with nesting, a daily mortality rate for the breeding season and expected nesting success for each cover type. Finally, seasonal brood mortality and duckling mortality rates are entered for each area.

Developing management plans. Management plans are simple combinations of the user-defined treatments. Only one treatment is applied in each year of a management plan, so all operations scheduled within a year are combined to define the treatment. For example, if plowing, seeding, herbiciding and fencing occur in the first year of establishing fenced cover, they comprise one treatment, and all costs and staffing are incorporated for the year. The same treatment can be used in several management plans because each treatment simply represents the set of resources required to accomplish a given task.

Once different treatments have been assembled into various management plans, each plan is applied against a cover type via one of several types of landowner agreements (Table 1). Costs and negotiating time are entered for each agreement type by the user. Types of agreements vary to include purchase, lease, free easement, agriculture demonstration, government-owned land and right of access. Costs and negotiating time vary for each of these agreements, depending on the type of land

Table 1. Cover types against which improvements are made and landowner agreements available for planning habitat programs in the CPT.

Cover types	Landowner agreements
Cropland	Free Easement
Emergents	Purchase
Fallow land	Lease
Hayland	Wildlife lands
Idled areas	Right-of-way
Pasture	Demonstration
Right-of-ways	
Brushland	
Woodland	

in question. For instance, leasing cropland will be more costly than leasing the same amount of pasture. Management plans can be applied against any type of cover and agreement, leaving the user great flexibility with little additional data entry.

Defining program size. Once treatments have been incorporated into management plans and all necessary landowner agreement data have been entered, either acres or hectares can be applied to management plans for incorporation into a habitat program. The Land Management Programs will automatically calculate costs and staffing over as many as 35 years, incorporating inflation into cost estimates.

Most importantly, the system summarizes annual changes in the landscape as the habitat program is implemented during the course of the NAWMP. These changes are routed to the MPM, along with all the biological parameter inputs, for annual estimates of spring mallard populations and population parameters, such as hen and nest success, summer survival rates and recruitment rates.

Mallard Production Model

We use the MPM to estimate the number of mallard recruits fledged from the proposed landscape each year. To accomplish this, we run a sample of 600 adult and 400 yearling hens through the model in five replicates for each year, to estimate the average number of recruits fledged annually over the 15-year PHJV plan. Individual estimates are outputed for each area within a province, i.e., at the second level of input.

Nesting cover. The model takes into account "competing" habitat types by allowing each of the hens to choose from among the various upland habitats available within the area of interest. Choice is based on the relative abundance of each type, the relative attractiveness (i.e., based on cover density) of each type and, optionally, how successful females using each type are likely to be, which influences homing rates.

Both relative attractiveness and success can vary through the nesting season, depending on the cover type. For example, hayland becomes more attractive through time until the crop is cut. On that date, nest mortality approaches 100 percent and the field becomes very unattractive to nesting mallards. Thereafter, the field gradually becomes more attractive again, and nests initiated in it become increasingly more successful.

Wetland conditions. Wetland conditions influence the magnitude of breeding effort by nesting hens. During wet years breeding effort is strong and, consequently, more renesting occurs, and both summer hen mortality and hen success probably rises. The model takes simulated spring pond numbers into account by matching patterns of pond drying to the relative annual abundance of ponds entered for each area.

For the PHJV, pond numbers in each area were derived from May Breeding Ground Surveys, by randomly choosing three wet, three dry and four average years from the span 1971–1986. The sequence of wet or dry years was initially randomized, always beginning with the 1986 pond count. Thereafter, this same sequence was maintained for other areas within and across provinces so that standard comparisons could be made when comparing relative cost efficiencies. Conditions during the final five years were restricted to being average, to gauge the impact of PHJV habitat improvements during average years as outlined in the NAWMP.

Pair Carrying Capacity. Pair numbers are always initiated for the same year pond numbers are initiated—1986 for the PHJV planning. This estimate is also based on May Breeding Ground Surveys for the area of interest. As simulated populations build in response to the implementation of habitat programs, the system limits pair populations to the highest densities observed in the area between 1971 and 1986, after adjusting for wetland numbers. As pond numbers diminish, pair carrying capacity declines even though pair densities (i.e., pairs per pond) rise. Pairs not accommodated within the areas with improved habitat are assumed to disperse to peripheral areas and contribute about 0.65 young per breeding adult.

The number of pairs returning to breed the following spring depends on the proportion of adult hens surviving winter, the number of female recruits fledged, and how well they survive the winter period. We assume all hens alive home to the general area where habitat improvements have been made. Pond numbers are the final determinant of how many breeding hens will settle the following year in the area. Some may not settle if conditions are dry or if returning populations are large.

Estimating incremental production. Once the number of recruits fledged on the basis of 1,000 pairs has been estimated for each cover type, an adjustment is made to reflect the number of pairs actually using the area for which an estimate of recruitment is required. The MPM generates annual recruitment estimates for both a managed and unmanaged landscape for each area.

For the initial year of PHJV planning, actual recruits were estimated by multiplying 1986 mallard pairs, in thousands, by the number of recruits fledged from the original 1,000 pairs. In subsequent years, returning breeding hen populations, within the limitations of carrying capacity, were used to generate these estimates.

Incremental recruits are calculated by subtracting estimates of fledged recruits from an unmanages landscape from those produced after management in the area. Initially, fewer recruits are fledged from relatively unattractive cover types when attractive cover types are added nearby, providing that hatch rates are comparable. This trend reflects movements of the initial population of hens into the better areas provided by habitat programs. If pair populations build with improved recruitment rates, gains may be observed even in relatively unattractive cover types because nest densities, and thus recruits produced given constant success, reflect more hens in an area.

Application of CPT—Alberta

Planning for a 528-square mile (1360 km^2) site near Stettler in the eastern parklands of Alberta provides examples of information provided easily by the CPT. This knob and kettle area, named the Alberta First Step Project (see Figure 1), is comprised of just over 20,000 acres (8,097 ha) of wetlands. The upland area is largely cropped in small grains, hayed or pastured. About 15 percent of the cropland is conventionally fallowed each year, leaving little stubble on the surface. Between 15 and 20 percent of the upland area is currently in its native ''unimproved' state.

Programs to improve soil and water conservation were proposed for about 37 percent of the fallowed cropland each year. Three hundred and fifty nest baskets were also proposed at a rate of about 0.5–1.0 per acre of permanent water. Lastly, this proposal called for one 100 acre (16 ha) managed cover block per 25 square miles (27 km^2). Each block was proposed to be protected from nest predators by barrier fencing and removal from within the exclosure. For brevity, we have presented in Table 2, management plan outputs for only the fenced cover. Costs for developing the blocks and subsequent management include staffing costs associated with the levels shown.

Indications are that mallards would respond positively to these kinds of programs. Overall, pair densities would be expected to rise from about 10 currently to 30 pairs per square mile (25–74/km^2) over 15 years, given current survival rates. Overall, nesting success is projected to increase from about 15 to 21 percent, with correspondent hen success increases from 29 to 36 percent. Costs associated with this kind of improvement can be compared with other proposed habitat programs, providing useful information for decision making.

Our experience with this type of planning in the PHJV has shown the importance of considering cash-flow patterns. If dollars are initially set aside in interest-bearing investments (e.g., annuities) when programs requiring high future management costs are being implemented on the land, proper management of all acres developed will be ensured. More acres can be developed in this way because the return on investment after inflation can be applied to management costs. However, this approach requires

Table 2. Yearly costs, assuming 4-percent annual inflation, and staffing estimated to establish and manage 2,000 acres (810 ha) of predator-fenced managed nesting cover in Stettler, Alberta.

Year	Costs	Staffing
1	$ 392,000	0.1 SY
2	419,000	0.2
3	148,000	0.7
4	155,000	0.7
5	28,000	0.2
Total 1–15	$1,479,000	3.7

large outlays early in implementation, because both development and future management costs are being incurred.

Conclusions

There are many advantages associated with using the CPT to plan implementation strategies for the PHJV. Assumptions made in the planning process are numerous and can be clearly documented on input screens as data are entered into the system. Subsequent evaluations and research designed to test these will lead to improved data inputs so that the modelling process can be regularly updated and plans refined.

Many potentially useful methods exist to improve waterfowl habitat. However, these vary considerably in cost to implement and maintain, as well as in output of incremental duck recruits provided. Use of the CPT allows planners to compare these methods and maximize the use of those that are most cost-effective. It also allows those planning such programs to alter habitat implementation strategies through time and in relation to various climatic sequences, to predict how these factors can affect specific resource needs and production.

Technical committees in each of the three Prairie Provinces are using the CPT system to plan programs for each of their jurisdictions. This will ensure a consistent approach by all participants in the PHJV and facilitate the consolidation of an overall plan for presentation to funding agencies. This is not to say that all plans will be identical. The CPT is flexible, allowing input of many types and variations of habitat plans to take into account geopolitical differences between areas.

To date, the only available complete plan generated by the CPT is for Manitoba; plans from Saskatchewan and Alberta are soon to follow. We are encouraged to see that the potential exists in Manitoba of generating the NAWMP goal for provincial waterfowl populations, both within an acceptable budget and over the next 15 years. These predictions, achieved using the integrated CPT system and based on present knowledge, will be key to receiving the necessary broad public support and funding for such a large, complex, and long-term undertaking.

Some might view the CPT as an inflexible tool that sets out rigid prescriptions that must be followed over the next 15 years. This is not the case. The CPT provides a starting place for implementing programs based on the best information available. Evaluation and research conducted concurrently with implementation, and directed at measuring results against predictions and key assumptions made during the planning process, will provide refinements in the system. Plans can be revised as required, according to results from these studies.

The CPT has been useful in clarifying several concepts for planners. It is apparent from Manitoba's plan that, although programs directed at altering farming practices will be important in producing additional ducks cost-effectively over the long-term, considerable emphasis must also be placed on developing supplemental, intensively managed nesting habitat if we are to progress rapidly toward the waterfowl objectives.

Also of great significance is the importance of maintaining the present quality of habitat both within and outside areas targeted for direct programs. Existing habitat must be secured from further degradation if duck population objectives are to be achieved. This underlines the importance of the indirect programs aimed at altering government policies that presently permit or encourage the destruction of wetland and upland habitats.

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A Cooperative Program for Restoring Drained Wetlands in Minnesota

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Introduction

The many functions of wetlands are valued by mankind in different ways (Doyle 1974, Brun et al. 1981, U.S. Department of Transportation 1983). The positive values attributed to wetlands by society usually are not shared by the landowner. Landowners typically are neither adequately compensated for retaining wetlands nor held financially responsible for converting them to other uses for immediate, often short-term personal economic gain. Of the 215 million acres of wetlands existing in what is now the lower 48 states in the U.S. at the time of settlement, fewer than 99 million acres remained by the mid-1970s—a loss of 54 percent (Tiner 1984). Wetlands in the U.S. continue to be drained at an annual rate of 458,000 acres (Tiner 1984).

In the Prairie Pothole Region (Figure 1), where approximately 50 percent of the North American waterfowl are produced (Smith et al. 1964), wetland drainage and the loss of upland nesting habitat are especially alarming. Annual drainage rates in the U.S. portion of this region averaged 33,000 acres in the 1960s (Haddock and DeBates 1969). Most wetland losses (87 percent) are the result of agricultural development (Frayer et al. 1983). Throughout the region, grassland nesting habitat has been increasingly converted to annually cultivated cropland. Duck nest densities on private land have been reported to be 12 times less on cultivated croplands than on untilled uplands (Higgins 1977). These habitat losses have dramatically reduced waterfowl production potential on private lands throughout the Prairie Pothole Region.

The objective of the pilot program described in this paper was to restore waterfowl production habitat through a joint venture involving interested private landowners, the U.S. Fish and Wildlife Service (FWS), and Ducks Unlimited, Inc. (DU).

Background

In 1978, the FWS Mid-Continent Waterfowl Management Project (MCWMP) was established with a field crew located in Fergus Falls, Minnesota. The goal of MCWMP was to increase breeding duck populations in a three-county pilot area, using innovative management techniques applicable throughout the mid-continent region of

Figure 1. The Prairie Pothole Region of North America.

North America. A number of waterfowl management issues were explored and courses of action initiated to improve duck production in Douglas, Grant and Otter Trail counties (Figure 2). MCWMP objectives included preserving existing wetlands, enhancing breeding waterfowl habitat and improving waterfowl nesting success.

DU was founded in 1937 with a singular purpose to develop, improve, preserve and restore important waterfowl habitat in North America. Since 1938, funds raised by DU in the U.S. have been channeled through DU-Canada to construct waterfowl habitat-improvement projects in Canada. Recent concerns over the continued extensive loss of wetland and upland nesting habitats important to breeding waterfowl in the Prairie Pothole Region of the U.S. resulted in a decision by DU to begin expending funds to create, enhance and restore waterfowl production habitat in the U.S. DU's Habitat USA Program officially started in 1984, when its Great Plains Regional Office was opened in Bismarck, North Dakota, with the directive to construct projects to increase waterfowl production on lands owned or managed by public wildlife management agencies. A Memorandum of Understanding between DU and the FWS agreeing to improve waterfowl habitat cooperatively was signed in March 1984.

Among several management strategies developed to increase waterfowl production, FWS designed and implemented a plan to restore drained waterfowl habitat on private farmland. Paramount to any wildlife work on private land is the landowner's willingness to cooperate. In many instances, this requires a conscious decision to take land out of crop production. The role of the FWS was to capitalize on the interest

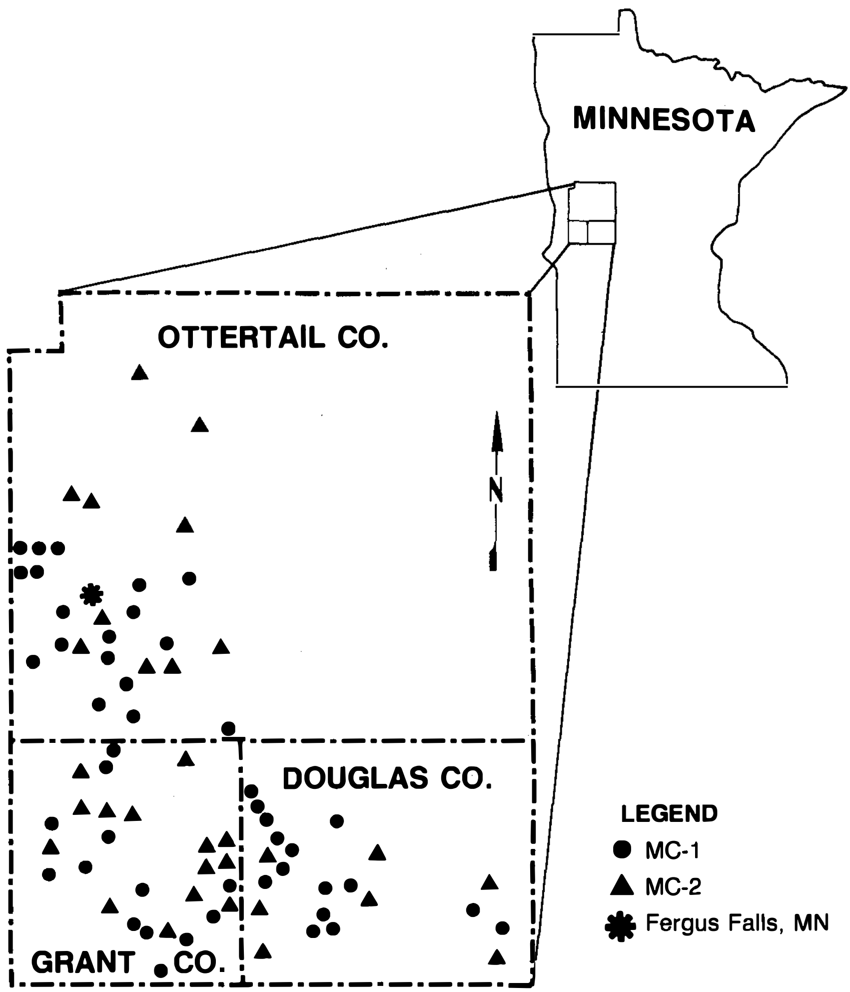

Figure 2 Wetland and upland waterfowl habitat restored on 78 parcels of private land in the Minnesota counties of Douglas, Grant and Ottertail, leased to the U.S. Fish and Wildlife Service.

that most landowners have in wildlife. Financial incentives were developed and presented to landowners that gained their support and participation. In 1985, the incentive offered by the FWS was a paid lease contract whereby, for mutually agreed compensation, the FWS was given wildlife management authority, including the right to restore drained wetlands and establish herbaceous nesting cover on previously drained wetlands and cropped uplands. These waterfowl habitat improvements funded by DU on private lands leased by the FWS were designated the MC-1 Project.

In this pilot effort, FWS developed administrative procedures and provided the economic incentive for landowners to participate. Initial project site reviews and selections, surveying, and watershed evaluations were also performed. DU provided biological assistance, engineering, contracting, and construction management services, and all funding for upland and wetland habitat developments.

Some of the successful features of the MC-1 Project were replicated by the U.S. Department of Agriculture (USDA) in the Conservation Reserve (CRP) subtitle of the 1985 Food Security Act. Private landowners in the pilot counties readily accepted the land-retirement incentives offered by CRP, including a paid lease from USDA. A second pilot project, called MC-2, was developed by the FWS and DU to integrate wetland restoration with other management options offered by USDA on enrolled CRP lands. In 1986, the FWS designed a "free lease" to secure limited wildlife management rights on private land. The written lease confirmed a verbal agreement between the FWS and the landowner. Landowner acceptance of the lease allowed third-party (DU) funding of wildlife habitat developments on private land. The lease did not include additional payments to the landowner. The landowner's compensation was the completion of a wildlife habitat-enhancement project on his land, and the annual CRP payment by USDA. There was no intent to record the lease as a deed covenant; therefore, legal terms were minimized, and the lease was viewed as a "friendly document" by farmers.

The FWS developed a management plan for the leased land, conducted site surveys, secured DU funding for the habitat developments, supervised and monitored construction contracts, and provided follow-up management services to the landowner. DU provided biological technical assistance, contracting, construction management and funding for wetland habitat developments. The MC-2 project restored wetlands on farms where the uplands were already enrolled in CRP, retired from crop production and seeded to grass cover.

Results of the First Pilot Project (MC-1)

The wetland restoration lease drawn up by FWS in 1984 for the MC-1 project was designed to reimburse landowners for use of their land for wildlife management. The FWS developed a land-valuation schedule to determine rent payments and then negotiated with landowners for the right to restore wetlands and seed upland cover. The lease format was developed with a 10-year contract period familiar to most farmers. Cash rent was paid by FWS to the landowner annually at the end of each crop year, similar to private cash rent agreements. This lease was field tested in the pilot project area in late 1984 and 1985. Land-rental rates were determined by the prevailing cash rent market—a market considerably stronger than it is today. The FWS objective was to fund rental agreements for the restoration of 2,000 acres of drained wetlands. Assumptions made for planning purposes were that 6,000 acres of land would be secured at an upland-to-wetland ratio of 2:1 and that rental rates would be approximately $50.00 per acre. In actuality, the upland to wetland ratio on leased land was 3:1 and negotiated rent averaged $64.50 per acre.

In MC-1, the FWS and DU restored 228 wetlands totaling 1,038 surface acres on 47 leases throughout the three-county area (Table 1). An estimated 1,600 acre-feet of water is stored in these wetlands, which average 4.4 acres in size (0.5–35 acres). The restored wetlands are Palustrine Emergent Wetlands that are seasonally or semipermanently flooded (Cowardin et al. 1979).

The most common wetland-restoration technique was to construct small, clay core dams across the open ditches originally excavated to drain individual basins. Other

Table 1. A summary of waterfowl production habitat restored and construction costs expended on MC-1 and MC-2 cooperative projects.

	MC-1	MC-2
Number of leased project sites	47	31
Number of wetlands restored	228	78
Wetlands acres restored	1038	254
Upland acres restored	2157	[a]
Project cost	$236,816.59	$25,629.46
Project cost/acre habitat restored	$74.12	$100.90

[a]Not applicable—on CRP lands.

techniques involved raising the outflow elevation or breaking and removing sections of existing tile drains. Two wetlands were restored by raising the culverts in existing roadbeds.

Water-control structures were installed on 66 of the restored basins. These structures consisted of half-round, variable level, stop-log risers or fixed-level, full-round risers either attached to an existing tile drain or incorporated into a constructed clay core dam. One fixed-level, steel sheet-piling weir was constructed in a channel draining a 35-acre semi-permanent marsh. All construction occurred in 1985, except for the sheet-piling weir which was completed in 1986.

Herbaceous nesting cover was established on 2,157 upland acres on private lands leased by the FWS (Table 1). Smooth bromegrass was seeded on 1,832 acres and a switchgrass/slender wheatgrass mixture on 325 acres. These uplands will remain in a non-use status for at least 10 years and will provide excellent waterfowl nesting habitat around the restored marshes. In addition, 475 upland acres will be farmed using a crop rotation including no-till fall-seeded grain. This rotation ensures that, in some years, there will be undisturbed spring nest cover in the form of winter wheat stubble. An additional 366 acres were seeded to alfalfa and are to be managed on a delayed-harvest basis. The landowner may harvest alfalfa following the completion of duck nesting and before the end of the alfalfa growing season (mid-July to late August). This protects current year nests, yet allows regrowth for residual nesting cover the following spring. The no-till and delayed harvest alfalfa options were included to determine the incentives necessary to induce landowners to enroll their property in the program and produce ducks, while continuing to make economic use of their land. While most lessees chose the non-use grass option, seven selected the no-till cropping, and eight chose delayed alfalfa harvest.

DU provided the money necessary to complete wildlife habitat development on the 47 upland and wetland restoration leases. A total of $236,816.59 of DU funds were spent to develop 3,195 acres of habitat—a per-acre expense of $74.12.

To comply with the Site Specific Agreement between the FWS and DU for the MC-1 Project, the FWS will conduct all routine maintenance and operations on the leased acres. Responsibilities include: maintenance of water control facilities; management of upland nest cover; performance of waterfowl production surveys; and, where possible, manipulation of water levels in the restored wetlands to sustain healthy populations of aquatic plants and invertebrates beneficial to duck production. The FWS/DU agreement is in effect for 10 years, commencing May 13, 1985.

Recognition for cooperating landowners who allowed DU and the FWS to restore waterfowl production habitat was an important part of this pilot project. A sign recognizing their contribution was made available to each landowner (Figure 3). In addition, each landowner and his family were invited to an appreciation dinner sponsored by a local sportsmen's club. These benefits, plus frequent contact between FWS personnel and the landowners, serve to strengthen the relationship and provide reinforcement to the landowner that his decision to restore wildlife habitat was the proper one.

Figure 3. Recognition of participants in the habitat restoration effort was an important feature of the pilot project. This is an example of signs that have been posted on each project site.

Results of the Second Pilot Project (MC-2)

The second pilot effort, MC-2, was a modest demonstration of the wetland restoration potential on CRP land. The CRP program was popular with farmers, and many lands enrolled contained drained wetlands. The MC-2 project utilized the opportunistic device of superimposing a "free lease" negotiated between the FWS and farmers for wetland restoration rights on CRP lands. CRP proved to be an ideal avenue to use for wetland restoration because of several factors: (1) USDA provided annual payments for use of the land; (2) low commodity prices resulted in large numbers of landowners finding it in their best interest to retire land from crop production; (3) CRP uplands were required to be planted to an acceptable cover crop, thereby guaranteeing nearby secure nesting cover for breeding waterfowl attracted to the restored wetlands; and (4) water was considered a legal and acceptable cover crop (i.e., restoring drained wetlands saved landowners and taxpayers the cost of seeding drained basins to acceptable grasses and/or legumes). Because USDA field offices were overwhelmed with the workload of processing CRP contracts, many opportunities to restore wetlands would have been missed without the FWS extension efforts to inform landowners about alternative land-use options available (i.e, wetland restoration).

Construction was performed in 1987, and methods were similar to those of the MC-1 Project. Drained wetlands were restored by blocking drainage ditches or drain lines. Local contractors were again utilized by DU to complete the work. The project restored 78 wetlands totaling 254 surface acres at a cost of $25,629.46. The cost per acre of wetland habitat restored was $100.90 (Table 1).

Wildlife Response

The response by plant and animal life to wetland restoration was immediate. Aquatic plants and invertebrates colonized newly restored wetlands during the first growing season after reflooding. Systematic analysis documented the diversity and abundance of aquatic life during the second and third growing season (Sewell 1988). Data also indicated that seeds from aquatic plants persist for decades after a wetland is drained (Erlandson 1987). Seeds that withstood years of dessication, cultivation and herbicide application while the drained wetland was farmed, germinated and flourished when water was restored. Two years after restoration, it was often difficult to tell that a wetland had ever been drained, even those converted to agriculture for more than 70 years.

Wild ducks were attracted in relatively large numbers to restored wetlands during spring and autumn migrations to rest and feed. Duck breeding pairs were recorded on MC-1 Project wetlands during spring surveys in 1986 and 1987, the second and third years following restoration. Pairs were found in much greater densities on the restored wetlands than on natural undrained wetlands. The smaller, restored wetlands with seasonal water regimes were more attractive to duck breeding pairs than were larger wetlands (Table 2).

Conclusions and Recommendations

We found that many landowners were willing to restore wetlands and develop surrounding nesting cover. Landowners were anxious to retire marginal lands. The

Table 2. Indicated pairs of breeding ducks per acre of wetland. Survey data from 1986–87

Wetland size class	Duck pairs per wetland acre MC-1 restored wetlands	MC-1 undrained wetlands
0.1 to 20.0 acres	0.995	0.670
More than 20.0 acres	0.405	0.170

FWS was willing to spend money for the short-term acquisition of limited-use rights on private land. A proposal to DU resulted in their financial support for wildlife habitat improvements. The amount of high quality waterfowl production habitat restored is a measure of the success of this pilot program.

There are many more opportunities for wetland restorations on CRP lands throughout the U.S. In the Prairie Pothole Region, 2,325,980 acres of erodible land had been enrolled in CRP by January 1988. Estimating that restorable drained wetlands cover 5 percent of the CRP acreage would mean there are 116,300 acres of wetland habitat potentially available for restoration. Other regions of the U.S. and Canada may also be ready for wetland-development efforts on private lands where decisions have been made to retire land from agricultural production. The major requirement to restore wetlands is the decision by the landowner to retire land for conservation purposes. Once that decision is made on land containing drained wetlands, then it becomes a matter of identifying the participants and funding sources necessary to restore the habitat.

This joint venture involving the FWS, DU and private landowners, with assistance from many others, demonstrates how an effective network of people, working together on wetland-restoration projects, can achieve results beyond the capabilities of the individual participants. Most of the breeding ducks in the U.S. portion of the Prairie Pothole Region use private lands that are not managed by federal or state wildlife agencies. Therefore, we recommend that networks of people interested in wildlife be established specifically to create and actively pursue wetland restoration and other wildlife management opportunities on private land.

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From Community Ecology to Vegetation Management: Providing a Scientific Basis for Management

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Introduction

What relevance has theoretical community ecology to vegetation managers? The answer to this question has at least two parts. One, community ecology provides a framework for understanding how communities are put together; i.e., what determines their composition, structure and location. Two, community ecology provides insights into what type of data and research are needed to perceive, predict or produce vegetative change. The second part of the answer has direct applications to vegetation management. If mechanisms that cause vegetation change are understood, then they can be exploited to manipulate vegetation, and the results of these manipulations can be predicted more reliably.

I will first consider briefly both parts of contemporary reductionist answers, and then illustrate with examples from wetland ecology how reductionist models of communities can be translated into better management. Management in this paper is restricted to what Milton Weller (1978) has called "natural" management; i.e., the manipulation of natural forces that control the composition and dynamics of vegetation. This approach involves manipulating either water levels, fire frequency or grazing intensity to alter the composition or structure of vegetation.

What is a Plant Community?

Although there is not yet unanimity among plant ecologists about the nature of plant communities, there does seem to be consensus developing. Since the 1950s, the reductionist community concept put forward during the first third of the twentieth century by Gleason (1917, 1926, 1939) in North America and others in Europe has become the dominant community paradigm among plant ecologists, and it is gaining favor among animal ecologists (McIntosh 1985, 1987). Gleason's views can be summarized in his own words (Gleason 1917): "1. All phenomenon of vegetation, i.e., of numbers of individuals, depend upon the phenomenon of the individual plant. 2. The plant population of any area is determined by environmental selection of immigrants from the surrounding population. 3. Because of similarity of environmental selection and of available sources of immigration, areas of uniform vegetation are developed, known as plant associations. 4. Effective change in the environment or in the surrounding population may lead to significant changes in the vegetation of an area. If these changes involve the establishment of a new association, the phenomenon is known as succession."

Gleason's "individualistic" concept of plant communities had its first major impact in the 1950s on how plant ecologists sampled and classified vegetation. It challenged the old typological approaches, and resulted in the development of alternative approaches, collectively known as ordinations (Whittaker 1962, 1967, McIntosh, 1967, 1985). It is generally not until the 1970 and 1980s that plant ecologists interested in other aspects of community ecology began to recast various concepts or problems in Gleasonian terms, including two perennial problems, the nature of the community and succession. Many other ecologists contributed ideas, insights and data that influenced this reformulation, particularly the American community ecologists F. E. Egler (1954), H. M. Raup (Stout 1981) and R. H. Whittaker (1975), and the British population ecologists A. S. Watt (1964) and J. L. Harper (1977).

A large number of papers and books in the last decade or so dealing with disturbance, palaeoecological change and the population biology of plant species have influenced the development of contemporary formulations of reductionist concepts of plant communities whose origins can be traced back to Gleason. Of these, the most important and influential, arguably, are: Grubb (1977) on the importance of dispersal, seed germination and seedling survival for understanding community development and persistence; P. S. White (1979) on the ubiquity of disturbance; Noble and Slatyer (1980) on predicting successional changes from life-history characteristics of species; Tilman (1980) on relative efficiency of nutrient uptake as the basis for predicting the outcome of competition among species; Davis (1981) migrational patterns of tree species in eastern North America during the quarternary; the book, *Ecological Communities: Conceptual Issues and the Evidence*, edited by Strong et al. (1984); the book edited by Diamond and Case (1986) on *Community Ecology*, particularly the chapter by Chesson and Chase on nonequilibrium community theory; the book edited by J. White (1985) on *The Population Structure of Vegetation*; Johnstone (1986) on plant invasions and the definition of succession; and the book *Landscape Ecology* by Forman and Godron (1986).

It is beyond the scope of this paper to analyze the specific contributions made by the each of these papers or books, but I will summarize what is, from my perspective, their overall message: that plant communities are impermanent assemblages of species that are not in equilibrium with their environment; that they are constantly recovering from disturbance(s) (i.e., that communities have a history); that the characteristics of a community are those of its constituent species; that communities can undergo several different kinds of changes; and that understanding and predicting all kinds of changes requires a knowledge of the life-history characteristics of species whose invasion, growth and elimination cause them.

Vegetation Change

Several types of community change are recognized—succession, maturation and fluctuation (van der Valk, 1985, 1987). Succession is defined as the "observed change with time in species number and type in an assemblage" (Johnstone 1986) or, in more operational terms, any change in the species in an area from year to year (van der Valk 1985). It is caused by species invading an area and/or established species being eliminated. Change due to the growth of plants are classified as either maturations or fluctuations (van der Valk, 1985, 1987). Maturation is the accumulation of biomass on a site from year to year. It is caused by the growth of plants from one year to the next. Fluctuation is a change in the relative contribution of species to the total biomass of an area from year to year (van der Valk 1985). It is due to differences in rates of vegetative propagation of species from year to year due to differences in environmental conditions from year to year. I will restrict myself here to a consideration of contemporary concepts of succession and its implications for management.

Since succession is caused by either the invasion or extirpation of a species, it is these two population-level phenomena that must be studied to understand and predict changes in the composition of vegetation in an area, i.e., its future compositional states. Neither phenomenon has received a great deal of attention in the literature (Johnstone 1986). What makes it possible for a plant to invade an area is the presence of a "safe site," an area whose environmental conditions are suitable for its establishment, usually as a result of seed germination (Harper 1977). Four types of safe sites have been recognized by Johnstone (1986)—default, stable, temporary, and future. These are defined in terms of barrier type (vegetation and environment) and barrier selectivity (selective and universal).

An invasion window is a time-dependent safe site that is defined in terms of type of barrier and its selectivity. A default invasion window (universal, environmental barrier) means that no safe site exists. Habitat creation is needed to change a default window to some other type. Stable windows exists whenever an environmental barrier to invasion is removed, e.g., geographical isolation, fire, flooding, etc. Whenever a universal, vegetative barrier to invasion is removed, a temporary invasion window is opened. This window remains open only for a short time after the vegetation on a site has been eliminated by fire, overgrazing, wind throw, etc. Future windows involve the removal of a selective, vegetative barrier. A species can reach or become established in a vegetated area, but remains suppressed until an opening occurs in the vegetation due to disturbance or the death of a plant. This classification scheme provides a framework for examining the kind of invasion window a particular species requires for its establishment, and when is this likely to occur. In a management context, it provides a framework for determining what barrier must be removed to get a desirable species established.

The extirpation of species from a site has received even less theoretical consideration that has the invasion of species. Classifications of species on the basis of their potential longevity are primitive (annuals, biennials, perennials without vegetative propagation, perennials with vegetative propagation). The potential longevity of species under specific conditions is rarely known. This may not be of any great significance, since disturbance seems to cut short the life span of most species (White 1979).

Understanding and predicting successional change requires a knowledge of both the life-history characteristics of species (seed dispersal, seed longevity, seed-germination requirements, age at which sexual reproduction begins, vegetative propagation, potential life span, etc.) and of the type of frequency of disturbance events that create potential invasion windows and/or eliminate species. Noble and Slatyer (1980) used this type of information to predict the composition of postfire forest vegetation, and van der Valk (1981) used a similar system to predict the composition of wetland vegetation after a change in water level.

Management Applications

A reductionist community model assumes that characteristics of constituent species determine community characteristics (composition, structure, biomass, etc.). Consequently, research emphasis is placed on comparative studies of the life-histories of species. Life-history studies of different types of freshwater species have revealed many important characteristics of those species that determine how they behave in the field. These include the fact that many have long-lived seed and thus are abundant in seed banks, and that seeds of most emergents and annuals germinate only when there is no standing water (van der Valk 1981). For these groups of species, recruitment is possible only during a drawdown when a stable invasion window occurs. Comparative information on the life-histories of species (dispersal syndromes, seed-germination traits, growth rates, etc.), particularly their safe requirements, can be used to analyze and predict succession.

Because in some wetlands species are recruited primarily from seed banks, predicting the composition of drawdown vegetation solely from seed bank data is feasible. For managers, this is important because drawdowns are used routinely to reestablish emergents and annuals in these wetlands (Weller 1978). If, for some reason, the seed bank of such a wetland does not contain desirable species, *a priori* predictions of the composition of drawdown vegetation can prevent management mistakes. The discrepancy, if any, between predicted and actual seedling densities also is an indicator of how well factors controlling recruitment from the seed bank during drawdown are understood.

Comparative seed-germination studies of wetland species (e.g., Galinato and van der Valk 1986) have indicated that species of the same life form can differ significantly in their germination traits. These differences can be exploited potentially in the field by manipulating environmental conditions to alter the composition and structure of wetland vegetation.

As two examples of the management benefits to be gained from a reductionist approach to succession, I will outline how this approach permits *a priori* predictions of the densities of emergent species at various elevations in a prairie lacustrine wetland during a drawdown, and how exploiting seed-germination traits can be used to prevent the establishment of undesirable species in moist soil units.

Predicting Future States of Vegetation

A reductionist model of wetland succession of freshwater prairie wetlands (van der Valk 1981) has been used to predict the composition of drawdown vegetation in a series of experimental marshes (Table 1). In these marshes, the emergent vegetation was eliminated by flooding them 1 meter above normal for two years, and then the marshes were drawn down for one or two years (Murkin et al. 1985). Prior to raising the water levels, the seed banks of these marshes at various elevations were investigated (Pederson 1983). This was done by placing seed bank samples (collected at random) in trays in a cold frame during the growing season, keeping the samples moist and counting the number of seedlings that emerged. Predictions of the composition of the drawdown vegetation were made solely from these seed bank data. This is feasible because recruitment during drawdowns is almost exclusively from their seed banks (Welling 1986). Seedling densities during the first year of the

Table 1. Mean predicted and actual shoot densities (per m^{-2}) of dominant emergents during the first year of a drawdown at different elevations in experimental cells of the Marsh Ecology Research Project, Delta, Manitoba, Canada.

Elevation (m)	*Scripus lacustris*		*Typha glauca*		*Scolochloa festucacea*		*Phragmites australis*	
	Predicted	Actual	Predicted	Actual	Predicted	Actual	Predicted	Actual
248.0	0	0	72	0	17	7	25	0
247.9	0	0	49	0	7	1	26	0
247.8	60	80	150	0	10	140	12	1
247.7	150	160	110	4	27	340	10	1
247.6	530	15	310	1	51	170	14	1
247.5	2,100	200	360	16	69	230	25	2
247.4	800	1,600	610	12	20	23	8	2
247.3	360	310	140	130	0	0	3	1
247.2	290	50	18	7	0	0	1	0
247.1	130	2	32	0	0	0	4	0
Mean	440	240	190	17	20	91	13	1

drawdown were obtained from 80 permanent quadrants at known elevations located at random in the experimental marshes (Welling 1986).

The predicted and the actual mean densities of four dominant emergent species (*Scirpus lacustris*, *Typha glauca*, *Scolochloa festucacea* and *Phragmites australis*) at different elevations in eight experimental marshes are presented in Table 1. For *Scripus lacustris*, *Typha glauca*, and *Phragmites australis*, predicted mean seedling densities were lower than those found in the field by 44, 91, and 93 percent, respectively. Mean *Scolochloa festucacea* seeding density, on the other hand, was higher in the field than predicted by 400 percent. Rank order correlations between predicted and actual seedling densities at different elevations were 0.93 for *Scolochloa festucacea*, 0.76 for *Scirpus lacustris*, 0.44 for *Typha glauca* and only 0.03 for *Phragmites australis*. Environmental conditions along the elevation gradient seem to have influenced the recruitment of each species differently. Their seed germination traits are different. This was confirmed by Galinato and van der Valk (1986) in a series of laboratory studies.

Seed bank data allows managers to make quite detailed predictions about the composition of drawdown vegetation. Having such data takes most of the uncertainty out of this type of management manipulation. Nevertheless, there remain discrepancies between predicted and actual densities of seedling during the drawdown. These suggest that factors controlling the recruitment in the field were different from those under which the seed banks were examined, particularly for *Phragmites australis* and *Typha glauca*. This will always be a problem with predictions from seed bank data. It is impossible to know precisely what field conditions will be during a drawdown, so that they can be simulated exactly in the seed bank study.

Seed Germination Traits and Community Composition

The impact of soil moisture levels on the recruitment of species in moist soil units in the Mingo National Wildlife Refuge, Missouri, has been studied by Naim (1987). These units are managed to produced seeds for overwintering waterfowl, by drawing them down in summer and reflooding them in the fall (Fredrickson and Taylor 1982).

In the field, soil moisture changes, after the initiation of a drawdown, were monitored for a month, as were the emergence of seedlings for four dominant species (Table 2).

Seeds of each species began to germinate when soil water matrix potentials had dropped to a particular level: *Polygonum* seeds began to germinate while there was still some standing water (O kPa); *Eleocharis* at about −3 kPa; *Echinochloa* at about −13 kPa; and *Xanthium* at about −25 kPa. Experimental studies of the impact of soil water matrix potential on seed germination parallel the field results: *Polygonum* seeds germinate in the wettest soils (>−10 kPa); *Eleocharis* seeds between −10 and −20 kPa; *Echinochloa* seeds germinated over a wide range of soil matrix potentials, but best around −25 kPa; and *Xanthium* seeds best between −40 and −60 kPa (Naim 1987). These results indicate that a slow drawdown is preferable to a fast one, because it keeps soil moisture higher longer. This favors the recruitment of such desirable species as *Polygonum* and *Echinochloa*, but prevents the recruitment of such undesirable species as *Xanthium*.

Many other examples of manipulating natural forces (water level, fire and grazing) to manage vegetation are available whose consequences can best be understood and predicted in a reductionist perspective (e.g., Basset 1980, Bakker and Ruyter 1981, Neckles et al. 1985, Thompson and Shay 1985). Since reductionist models require comparative information about species, they often cannot be developed yet, because the information needed is not available. To predict under what circumstances species can invade, persist or be eliminated, the key features of the life-history of species in a given situation must be identified, and research done to obtain the required information about each relevant species. Reductionist models based on comparative life-history data will provide the best possible foundation for vegetation management.

Conclusions

In reductionist community models, the characteristics of a community are a function of its constituent species. The composition of of community at any time and its change with time are consequences of the difference between rates of establishment and extirpation of species. The more information that is available about life-history features (dispersal, seed-germination traits, age at which sexual reproduction begins, etc.) of species in an assemblage and in the surrounding area, the better future states (composition, structure, biomass, etc.) of that assemblage can be predicted. To

Table 2. Emergence (%) of seedlings of four species in June 1985 during a drawdown in a moist soil unit at the Mingo National Wildlife Refuge, Missouri. Soil moisture is expressed as soil water matrix potential (kPa)—the more negative the value, the drier the soil (data from Naim 1987).

Week	Soil moisture	*Polygonum hydropiperoides*	*Eleocharis obtusa*	*Echinochola crusgalli*	*Xanthium pensylvanicum*
0	0	5	0	0	0
1	−10	73	20	0	0
2	−31	100	72	30	8
3	−60	100	93	60	62
4	−76	100	100	100	100

predict when changes of state will occur, however, the environmental changes or disturbances that are needed to open potential invasion windows must also be known. In a management context, this information is needed to determine what environmental factor(s) must be manipulated (i.e., what barriers must be removed) to produce a desirable change in the composition or other states of an assemblage. Reductionist models stress the basic ecological realities—recruitment and elimination of individuals— that are ultimately the cause of all vegetation change. A reductionist perspective provides a more realistic foundation for understanding, evaluating and planning management schemes. Since managers can predict the future state of vegetation, often in detail, it eliminates much of uncertainty associated with managing vegetation.

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Evaluation of Greentree Reservoir Management Options in Arkansas

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Introduction

Greentree reservoirs (GTRs) were first established in the late 1930s, in the bottomland hardwood forests near Stuttgart, Arkansas (Rudolph and Hunter 1964). Since that time, GTRs have become an important form of waterfowl management in the eastern and central United States. They are especially common in the southcentral U.S.; of the 179 GTRs located in a recent survey, 134 were in Arkansas, Louisiana, Mississippi, Missouri and Tennessee (Wigley 1987). Arkansas, with at least 85 GTRs, still has many more than any other state.

The basic theory behind the establishment of GTRs is simple—areas of living hardwood forest are shallowly flooded during the fall and winter, and often into the spring, to provide food and resting/roosting habitat for wintering waterfowl (Mitchell and Newling 1986). Mallards (*Anas platyrhynchos*) and wood ducks (*Aix sponsa*) are the two waterfowl species most commonly occurring in GTRs. Other species occasionally using GTRs include black ducks (*Anas rubripes*), ring-necked ducks (*Aythya collaris*), hooded mergansers (*Lophodytes cucallatus*), green-winged teal (*Anas crecca*), northern pintails (*Anas acuta*), gadwall (*Anas strepera*) and American widgeon (*Anas americana*).

While GTRs have been shown to be successful in increasing local wintering waterfowl populations over the short-term (Thompson et al. 1968, Newling 1981), there is also evidence that water management practices on these reservoirs can have detrimental long-term effects on vegetation, and ultimately on wintering waterfowl and other wildlife. Several studies, for example, have found that, for some desirable mast-producing tree species, growth declined and/or mortality increased after several years of GTR management (Newling 1981, Francis 1984, Malecki et al. 1983, Schlaegel 1984).

There has been much speculation on how these long-term impacts to vegetation can be avoided. One suggestion is to delay flooding GTRs until the trees become dormant in the fall, and/or to drain GTRs before the trees break dormancy in the spring (Newling 1981). Another possibility is to alternate years of flooding with occasional ''drydown'' years, in which the GTR is not flooded at all or is allowed to flood only to the degree that it would naturally (Francis 1984, Newling 1981). This type of speculation on the part of scientists and GTR managers indicates that research is needed on the effects of different GTR flooding schedules.

As part of a study of a new GTR at Felsenthal National Wildlife Refuge in southern Arkansas, the long-term impacts to vegetation of a variety of potential flooding schedules are currently being evaluated using a bottomland hardwood forest succession simulation model. The use of such a predictive model could be of significant value to managers of GTRs, who are faced with management decisions now, the results of which may not become apparent for 10 years or more. In this paper, the Felsenthal GTR study is described briefly, and some preliminary results of the computer simulation are presented.

The Felsenthal Greentree Reservoir

Felsenthal National Wildlife Refuge is located in southern Arkansas, at the confluence of the Ouachita and Saline Rivers (Figure 1). It was established in 1975, partially to offset the impacts of the U.S. Army Corps of Engineers' Ouachita-Black Rivers Navigation Project. Most of this 65,000 acre refuge is located in the Felsenthal Basin, an extensive natural depression that is crisscrossed by an intricate system of creeks, sloughs, bayous, rivers and oxbow lakes.

The Ouachita-Black Rivers Navigation Project has affected the forests within the refuge, through the construction of two lock and dams. The first one, known as Lock No. 6, was built in 1925, about 3.5 river miles downstream of the refuge's southern boundary. This lock and dam created a permanent navigation pool with a top elevation of 61.6 feet above MSL, which inundated nearly 5,000 acres of forest within the current refuge boundaries. In 1985, the Felsenthal Lock and Dam, which is located on the southern border of the refuge, became operational. This lock and dam raised the permanent pool created by Lock No. 6 an additional 3.4 feet (to 65 feet above MSL), thereby permanently inundating another 11,000 acres of forest within the refuge boundaries.

The Felsenthal Lock and Dam was constructed so that a fluctuating pool with a top elevation of 70 feet above MSL can be created. This fluctuating pool, when full, floods approximately 22,000 acres, and is managed as a greentree reservoir. Since completion of the lock and dam in 1985, the GTR has been flooded annually beginning on November 1. The water level in the GTR is raised one inch per day until it reaches 70 feet. It is held at 70 feet for one week, and then lowered one inch per day until the water level reaches 65 feet, which is scheduled to occur on March 1. Every three years, the schedule for draining the GTR will be modified to allow more area for fish spawning. The water will be lowered gradually to 67 feet, held for seven weeks, and lowered to 65 feet by May 15.

The GTR at Felsenthal differs in one key respect from many of the GTRs in the Southeast—it was created by damming a large river system, rather than diverting water into an area surrounded by low levees. This has resulted in a system through which the water is constantly flowing. It also makes control over the water levels

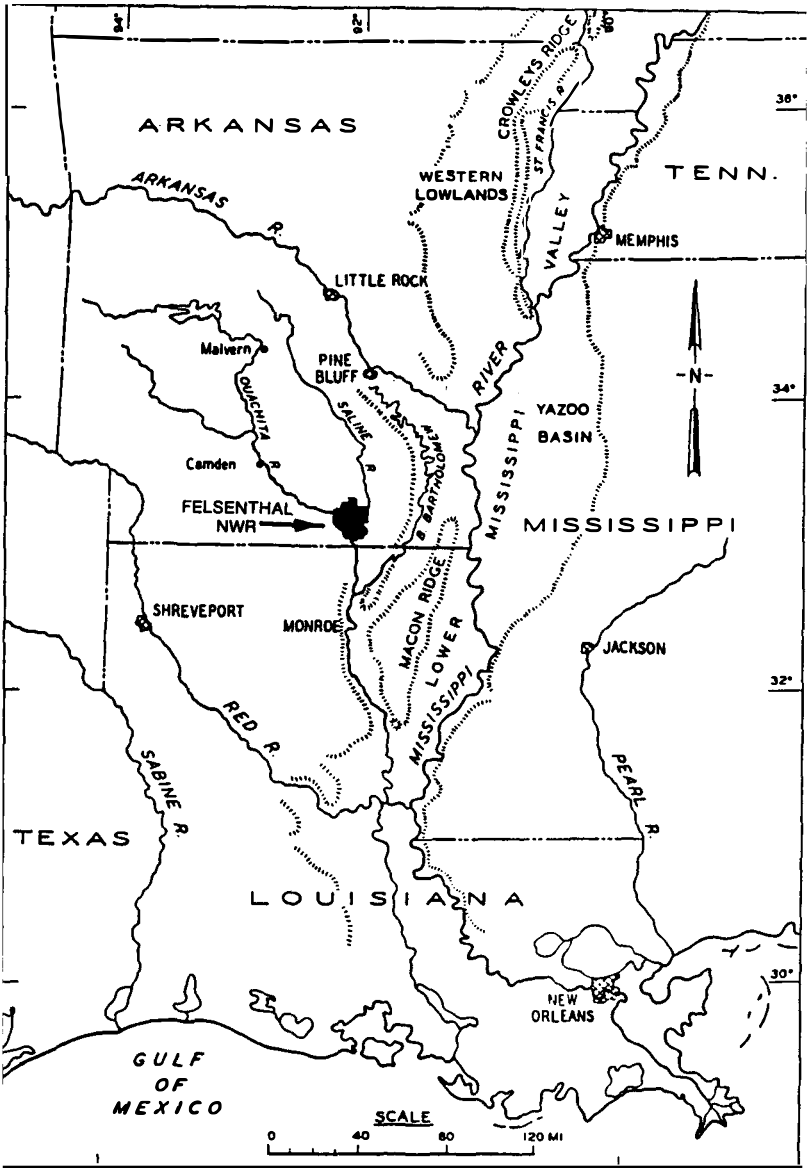

Figure 1. Location of Felsenthal National Wildlife Refuge (redrawn from Saucier and Fleetwood 1970).

in the GTR more difficult and, in many cases, natural river conditions may override attempts to maintain or lower water levels at designated times.

Within the GTR, three forest types predominate. The lowest elevations in the GTR are occupied by the cypress/tupelo (*Taxodium distichum*/*Nyssa aquatica*) forest type. It occurs in sloughs and areas along the border of the permanent pool that have almost constantly saturated soils, and covers about 1,000 acres. Approximately 14,000 acres of the GTR are backwater basins and poorly drained flats occupied by the overcup oak/water hickory (*Quercus lyrata/Carya aquatica*) type. On better drained sites within the GTR, the sweetgum/Nuttall oak/willow oak (*Liquidambar styraciflua/Q. nuttallii/Q. phellos*) type predominates. This type covers about 7,000 acres.

The goal of forest management within the GTR is to maintain and even increase the proportion of Nuttall and willow oak. These two species produce mast that is more desirable to waterfowl than that of overcup oak and water hickory (U.S. Fish and Wildlife Service 1979).

The Greentree Reservoir Study

The Felsenthal Greentree Reservoir Study began in 1985, prior to the initial flooding of the GTR. The first phase of the study is scheduled for completion by early summer 1988, and has three major components: (1) a quantitative analysis of short-term impacts to vegetation based on data from 94 permanent plots; (2) concurrent qualitative analysis, using infrared aerial photographs, of short-term impacts to vegetation; and (3) application of a forest succession simulation model (FORFLO) to predict long-term changes in forest composition that would occur under a range of GTR flooding schedules.

Part of the objectives of the first two components of the study were to document baseline conditions within the GTR. A long-term monitoring program is proposed, in which the permanent plots will be remeasured and new aerial photographs taken every 3 years for the next 30 years. Teaford (in preparation) describes the baseline conditions within the GTR and the proposed monitoring program.

Application of the FORFLO Model

The Model

The development of FORFLO can be traced back to an upland deciduous forest simulation model called JABOWA (Botkin et al. 1972a, 1972b), which was used in conjunction with research carried out in the Hubbard Brook Ecosystem Study (Bormann et al. 1970). JABOWA was adapted for use in southern Appalachian upland forests by Shugart and West (1977), who used their version of the model (FORET) to investigate the impacts of chestnut blight (1977) and air pollution (West et al. 1980) on forests in the region.

FORFLO was developed at the National Wetlands Research Center by modifying FORET to allow for the consideration of flooding and groundwater table levels on tree growth, reproduction and mortality. Two types of hydrologic data are required as input to the model—average water stage and standard deviations for each of 24 half-month periods (from January 1–15 to December 16–31), and average water table level during the growing season. Other types of data that are required include: site characteristics such as soil type, elevation and temperature degree-days; tree species composition; and a set of parameters that define the growth and reproductive characteristics of each species used in the model. The data requirements and modifications, and the results of the first application of FORFLO are described by Pearlstine et al. (1985) and Brody and Pendleton (1987).

FORFLO works by simulating the germination, growth and death of individual trees on a 1/12 hectare (0.21-acre) plot. In past applications of the model, several plots have been selected for the simulations, with the goal of representing the range of forest types and stand conditions within the forest under study. This paper presents the results of a set of simulations for only one plot within the Felsenthal GTR. However, for the overall evaluation of GTR management options, at least five more plots will be evaluated in the manner of the one selected for this paper.

Selection of Site for Simulations

The plot selected for the purposes of this paper is referred to as Hogan Tract 2C. It is located near the center of the refuge, in an area classified as the overcup oak/water hickory type. The elevation of the plot is 66.5 feet, so it is in an area that was already subjected to frequent flooding prior to completion of the lock and dam. Selected characteristics of this 40-year-old stand are presented in Table 1.

This plot was selected because, although it is in the overcup oak/water hickory type, the plot has a substantial component of Nuttall oak. It would be in the interests of the managers of the GTR to at least maintain this Nuttall oak component because of its value to waterfowl and other wildlife.

Baseline Simulations

Before the effects of various GTR management scenarios can be adequately evaluated, it is critical that the future characteristics of the plot without GTR management be predicted. Since the Felsenthal Lock and Dam has only recently become operational, two sets of baseline simulations were performed—one with the lock and dam and one without it. For each of these simulations, as well as those of the GTR management scenarios, 50 replicate model simulations of 50 years each were run, and the results averaged. This results in an approximation of the most likely outcome (Pearlstine et al. 1985).

The baseline hydrologic conditions without the lock and dam were obtained by using data from the Crossett gauge. This gauge is located on the Ouachita River about 0.5-mile southeast of Hogan Tract 2C, and is maintained by the U.S. Army Corps of Engineers. River stage data from the 23-year period of 1962–1984 were averaged for the 24 half-month periods, and standard deviations were calculated. Only two years of gauge data were available for the hydrologic conditions after

Table 1. Selected characteristics of Hogan Tract 2C.

	Overstory tree data			
	Trees/Acre	Basal area (ft^2/acre)	Importance value (200)	Mean dbh (inches)
Tree species				
Nuttall oak	36	28.8	46	11.6
Overcup oak	146	51.4	118	7.9
Water hickory	49	13.8	36	7.2

Predominant shrub/sapling species: overcup oak, swamp privet (*Forestiera acuminata*)
Herbaceous cover: approximately 10 percent
Soil type: Una silty clay loam

construction of the lock and dam, so the averages and standard deviations by half-month period were developed based on discussions with Corps of Engineers Hydraulics personnel from the Vicksburg District Office. Based on these two mean hydrographs, the average annual flood duration on Hogan Tract 2C was 39 percent without the lock and dam, and will be 53 percent with the lock and dam.

As shown in Figure 2, the predicted trends in total basal area (both overstory and understory trees) are very similar over time for both scenarios, except that, with the lock and dam, basal area is generally lower. The pattern of an initial increase followed by an early maturity and gradual decline is not unexpected in Felsenthal, where the trees have been observed to mature and decline earlier than in other bottomland areas (U.S. Fish and Wildlife Service 1979). The fact that the lock and dam scenario results in lower total basal areas may be indicative of slightly reduced growth and vigor.

The same three species that currently dominate the overstory—Nuttall oak, overcup oak and water hickory—are predicted to still be dominant in 50 years. However, as shown in Figure 3, the model predicts that Nuttall oak will become an increasingly major component of the stand under both scenarios. This seems to be a reasonable expectation, given that the Nuttall oaks on Hogan Tract 2C are already considerably larger than the overcup oaks and water hickories. Nuttall oak also tends to exhibit a slightly higher optimal growth rate than the other two species (Fowells 1965).

The impact of increased flooding on tree species composition is predicted to be more dramatic in the understory. Based on importance values of trees less than 10

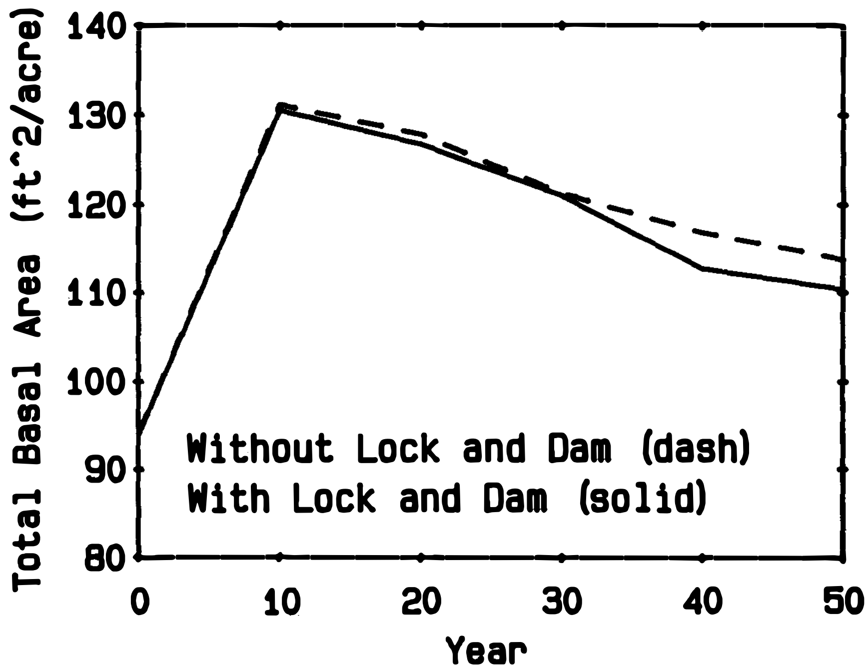

Figure 2. Predicted total basal area for baseline simulations.

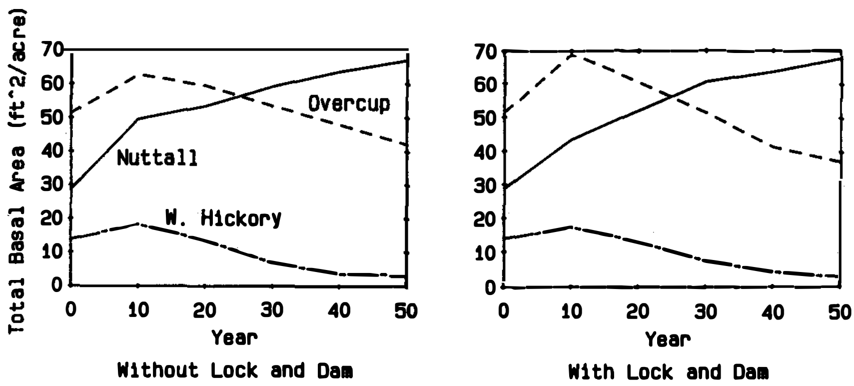

Figure 3. Predicted basal areas for Nuttall oak, overcup oak and water hickory for baseline simulations.

inches in diameter, it is apparent that, with the lock and dam in place, wetter-site species, such as baldcypress, water tupelo and water locust (*Gleditsia aquatica*), will be favored (Table 2).

The results of these two baseline simulations indicate that the Felsenthal Lock and Dam alone will have a subtle, but significant impact on the trees within the plot. The predicted impact on the current overstory will be minor, but the 14-percent increase in annual flood duration is apparently enough to alter significantly the composition of the next generation of overstory trees.

Greentree Reservoir Management Simulations

To date, the effects of four potential GTR management scenarios have been examined. The first scenario is the current GTR management plan, as described earlier. The second and third management scenarios are similar to the current plan, except that flooding begins earlier in the second scenario, on October 1, and is delayed in the third scenario until December 1. The fourth scenario is also similar to the first, except that one year in three the GTR is not flooded deliberately; flooding in the third year is similar to conditions for the with lock and dam baseline scenario. In the order that they are described above, the estimated average annual flood durations are 59 percent, 66 percent, 57 percent and 56 percent.

Table 2. Predicted importance values (300) of selected understory tree species in Year 50 for baseline simulations.

Species	Importance value without lock and dam	Importance value with lock and dam
Baldcypress	35	47
Nuttall oak	14	3
Overcup oak	31	19
Persimmon	49	16
Water hickory	51	28
Water locust	62	117
Water tupelo	17	59

The trends in total basal area for the four GTR management scenarios were similar to those predicted for the baseline scenarios. Flooding beginning in October results in slightly reduced total basal areas, compared with the other three scenarios, but follows the same pattern as shown in Figure 2. In Year 50, total basal area for the October flooding scenario is predicted to be 105 square feet per acre, which is 5 square feet per acre lower than that predicted for the baseline lock and dam scenario.

The model does not predict any substantial reductions in growth or increased mortality in the current overstory. Even Nuttall oak, which is somewhat less flood tolerant than the other two dominant overstory species (Hook 1984), is expected to be able to grow well enough to continue to dominate the stand for the next 50 years.

The impacts on understory trees are predicted to be similar to those shown for the baseline scenarios. As the flood durations increase, the trend towards the dominance of wetter-site species becomes clearer (Table 3). By Year 50, cypress and water tupelo are predicted to account for just over 50 percent of the total importance value of all understory species with the flooding in October scenario.

Discussion

Based on the FORFLO simulations, it appears that the construction of the Felsenthal Lock and Dam and the operation of the greentree reservoir will significantly impact the nature of the refuge's forest. On Hogan Tract 2C, most of the impact to the forest will be associated with the construction of the lock and dam, but there will be additional adverse impacts associated with the management of the GTR. Both with and without GTR management, the changes on Hogan Tract 2C will be slow; in the first 50 years, most of the changes will occur in the understory.

The next generation of overstory trees, under all but one of the GTR management scenarios, will be somewhat of a transition type between an overcup oak/water hickory forest type and a baldcypress/water tupelo type. The October flooding scenario, with an annual flood duration of nearly 66 percent (and a 38-percent duration during the growing season), may result in a forest that is more clearly the cypress/tupelo type. More than half of the total importance value of the understory trees will be accounted for by baldcypress and water tupelo with the October flooding scenario.

Elsewhere in the Lower Mississippi River Valley, the long annual flood durations that are predicted to occur at Felsenthal with the lock and dam and GTR flooding might be expected to have more of an impact on the current overstory trees. Francis

Table 3. Predicted importance values (300) of selected understory tree species in Year 50 for GTR management simulations.

Species	IV300 Nov. scenario	IV300 Oct. scenario	IV300 Dec. scenario	IV300 Dry. scenario
Baldcypress	55	63	51	50
Nuttall oak	3	2	3	7
Overcup oak	22	11	26	17
Persimmon	9	3	1	5
Water hickory	40	21	39	49
Water locust	103	99	121	108
Water tupelo	59	99	53	55

(1984), for instance, studied a GTR in Mississippi that was often flooded from early October to mid-June, and found decreased growth and increased mortality of Nuttall oak after 17 years. Two reasons that the trees on Felsenthal might be less affected are: (1) that the soils are somewhat lighter and better drained than on most GTRs; and (2) the water in the GTR is constantly flowing. The soil type on Hogan Tract 2C is classified as a silty clay loam, while most of the GTRs previously described in the literature are on heavy clay soils. The water table level on Hogan Tract 2C remained below 3.5 feet for much of the summer of 1987, giving the Nuttall oaks plenty of well-aerated root space and perhaps partially counteracting the effects of extended flood durations.

There seems to be no clear advantage in changing the current GTR management scenario to one of the others considered in this paper. Delaying the flooding until December and not flooding the GTR one year in three both result in a higher oak component in the overstory. The improvement, however, is relatively small, compared with the loss of wintering waterfowl habitat that these scenarios would cause.

It may be possible to influence the future composition of the plot by some form of harvesting program. Increasing the amount of light reaching the understory will probably result in improved survival and growth of the relatively shade-intolerant Nuttall oak seedlings, as long as flooding conditions are not too severe.

If the future component of Nuttall oak is to be maximized, it may prove necessary to have a flexible GTR management program that combines harvesting and manipulation of water levels. For instance, it is possible that the best way to increase the future component of Nuttall oak may be to keep water levels as low as possible for two or more years after a good crop of Nuttall seedlings become established (e.g., Johnson 1975) and, within no more than five years, thin the overstory to allow more light to reach the seedlings. FORFLO is not currently designed to simulate the effects of such scenarios, but we hope to modify the model so such possibilities can be considered.

We feel it is necessary to remind the reader that these results must be considered preliminary. Although FORFLO results have been tested formally in other applications, we have not yet done a formal validation for Felsenthal. We have located a 30-year-old (1957) forest inventory plot that we intend to remeasure once the water levels recede this spring, and we plan to input the 30-year-old data and compare FORFLO predictions with current plot conditions. Since this plot is very nearly the same elevation as Hogan Tract 2C, it should give a good indication of how well the model is working.

Also, the results presented in this paper are the averages of 50 possible outcomes, and are an approximation of what is most likely to occur. An unusual combination of wet and/or dry years, a major storm, fire, or outbreak of some insect or disease could result in a substantially different outcome. Overall, though, we are pleased with the apparent ability of FORFLO to predict the impacts of relatively small, incremental changes in hydrology. FORFLO should prove to be valuable as an additional source of planning information for wildlife and natural resource managers responsible for GTRs and the maintenance of wintering waterfowl habitat.

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Application of the Habitat Evaluation System to Modeling Bottomland Hardwood Forest Communities in West Tennessee

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Introduction

The bottomland hardwood forests of the Lower Mississippi River Valley are among the most productive ecosystems in North America (McKeever 1959, Harris and Gosselink 1986). The decline of these forests has been widely reported (MacDonald et al. 1979). Despite recent conservation programs, losses of this valuable resource have continued. The significance of and threat to bottomland communities point to the need for a widely applicable, practical, habitat evaluation technique based on the best available information on structure and function of these communities.

The Tennessee Department of Conservation's Division of Ecological Services is conducting a statewide natural areas inventory. An essential element in that inventory is the ability to characterize and locate the best remaining examples of natural communities. To address project planning-assessment needs specific to fish and wildlife habitat, the Lower Mississippi Valley Division of the U.S. Army Corps of Engineers developed the Habitat Evaluation System (HES) (U.S. Army Corps of Engineers 1980). HES was then modified by the Division of Ecological Services for use as an assessment tool in its natural areas inventory (Smith et al. 1983, Bridges et al. 1985, Durham et al. 1985). In 1985, the Corps and the Tennessee Department of Conservation began a cooperative effort to refine and evaluate HES for application in bottomland hardwood forests in West Tennessee. Objectives of this effort were: (1) to reconstruct the bottomland models which serve as the basis of the 1980 version of HES using an up-to-date review of the literature and expert opinion; (2) to determine behavior of the reconstructed literature-based model using actual and hypothetical data sets; (3) to examine the literature-based HES model's ability to predict wildlife communities (primarily the avian community); and (4) to refine the model further based on habitat and wildlife data collected from 60 sites in west Tennessee, supplemented with professional judgment.

Background on the Habitat Evaluation System

HES was developed to be primarily a method for evaluating the environmental impacts of water resource development projects using a community- and habitat-based approach. The original version was completed in 1976, and the procedures were revised and updated in 1980. HES has been used for environmental impact and wildlife mitigation analyses in a variety of Corps' water resource planning studies in the Lower Mississippi River Valley.

The 1980 version of HES is a straightforward habitat evaluation method. It uses measures of key habitat variables obtained from circular plots, combined with sets of functional curves and variable weights for specific cover types to compute Habitat Quality Index (HQI) scores. These scores, which may range in value from 0.0 to 1.0, are then multiplied by habitat acreage data to calculate Habitat Unit Values (HUVs) for the cover type being evaluated. HUVs may be computed for existing and future condition scenarios. By comparing data on futures with-project and without-project, potential impacts of water resource development alternatives can be evaluated.

As a result of accumulated experience with the 1980 version of HES, it became clear that the foundation of the procedures needed better documentation. Refinements were also needed to take advantage of new developments in habitat modeling, to improve precision, and to insure that the method was founded on a base of current ecological theory and practice. The bottomland hardwood cover type was selected for study.

Assumptions and Content of the Revised Literature-based Model

Revision of the model began with an extensive literature review and involved both theoreticians and practitioners as reviewers. The revision process is documented by Durham et al. (in press). The following is a brief overview of the assumptions and content of the model discussed in that document.

Assumptions

1. Habitat quality can be expressed for the entire wildlife community irrespective of interactions between species such as predator-prey relationships or competition.
2. High animal species richness and high population levels of individual species indicate high quality habitat.
3. There is a positive association between structural diversity of the habitat and faunal diversity and abundance.
4. The presence of late successional stage forest indicates high quality wildlife habitat.
5. Larger tracts of forest are more valuable as wildlife habitat than are smaller tracts.
6. Tracts of bottomland forest with connections to other bottomland hardwood or to upland forest tracts are more valuable wildlife habitat than are isolated tracts.
7. Tracts containing a high degree of interspersion of wet and dry areas are more valuable to the wildlife community than are homogeneous sites.
8. Forest tracts containing natural, nondegraded streams have higher habitat value than do those containing more degraded streams.

Description of the Variables

Two types of variables were developed: small-scale or plot (variables 1–9); and large-scale or tract (variables 10–14). For each variable, there is a bar graph or curve that expresses the relationship (HQI) between the variable and wildlife habitat potential. HQI from all variables are combined using simple mathematical processes to compute an HQI value for individual forest tracts.

Plot-specific model variables are: (1) tree species association, which assigns a HES plot to 1 of 10 associations based on the importance values (relative density + relative dominance) of the canopy layer trees; (2) flood-tolerance index (FTI)—a numerical expression of the hydrologic regime of a bottomland area (Theriot and Sanders 1986), estimated from species composition of the vegetation; (3) percentage ground cover; (4) texture of the ground layer—defined as the number of elements present including bare ground, leaf litter, fallen timber, and short and tall herbaceous vegetation; (5) percentage shrub cover; (6) texture of the shrub layer—defined as elements of deciduous and evergreen shrubs and vines; (7) percentage canopy cover; (8) diameter of the canopy layer trees; and (9) diameter, number and condition of standing dead trees.

Tract variables are: (10) temporary water, which measures the presence or absence of temporary pools of water; (11) tract size, the number of hectares of contiguous forest; (12) watershed quality index—an assessment of the amount of disturbance in the watershed resulting from urban, industrial and agricultural activities; (13) tract interconnectedness, or the number and quality of connections of the tract under evaluation to other tracts; and (14) interspersion—the proportion of wet and dry areas and their plant associations.

Data Collection

Sixty forested sites were selected at random from the seven major river systems in Tennessee's coastal plain. Middle and late successional stages were represented across a range of hydrologic conditions. Sites were a minimum of 100 acres (40 ha) with relatively homogeneous vegetation throughout. A 0.6-mile (1 km) transect and six 0.25-acre (0.10 ha) vegetation/bird sampling plots were established on each site at random. Using this design, vegetation characteristics were measured at each plot. Vegetation measurements were made on 351 plots on 59 sites in seven river systems throughout West Tennessee. Bird populations were censused at the plots and along the transect. Data on reptiles and amphibians were collected from 20 sites.

In addition to the variables currently in the model, data were collected on such potentially important features as intensity, type and time of site disturbance, and other characteristics believed to be important in model testing and development (e.g., grazing). Variables 11–14 were evaluated from maps and aerial photos.

Birds were counted in both breeding and winter seasons. Bird species richness and density were estimated using the fixed-width line transect method (Järvinen and Väisänen 1975) and the variable circular plot method (Reynolds et al. 1980, Hamel 1984). The line transect method was used during all seasons. The variable circular plot method was used during the breeding season only. Replication over two years occurred on 35 sites in the breeding season and on 40 sites in the winter season. The remainder of the sites were surveyed during both seasons in one year only. A single survey consisted of two separate visits to the site.

Reptiles and amphibians were collected on 20 of the 60 sites. Sites included all river systems and successional stages. Collections were made by chance observations, pitfall traps, and dipnets or seines (Campbell and Christman 1977).

Data Analysis and Results

Vegetation sampling revealed a mean basal area on the plots of 56 square feet per acre (12.7 m^2/ha); the mean canopy height was 82 feet (25 m); and 10 percent of the plots had mean canopy height less than 59 feet (18 m). Mean canopy flood-tolerance index was 4.3, with a range from 2.6–5.6 (a score of 2 indicates very wet conditions and a score of 6 indicates very dry). Modal herbaceous cover was 15 percent, and 50 percent of the plots had herbaceous cover between 15 and 60 percent. Modal shrub cover was 5 percent, and 50 percent of the plots had shrub cover between 5 and 17 percent. The dominant tree species, in terms of basal area, were baldcypress (*Taxodium distichum*), water tupelo (*Nyssa aquatica*), sweetgum (*Liquidambar styraciflua*), red ash (*Fraxinus pennsylvanica*), hackberry (*Celtis laevigata*), red maple (*Acer rubrum*), slippery elm (*Ulmus rubra*), cherrybark oak (*Quercus pagodaefolia*), overcup oak (*Q. lyrata*) and box elder (*Acer negundo*).

Disturbance such as logging, channelization, or conversion to agricultural or other intense human land use took place on 10 of the sites during the two-year course of fieldwork for this study.

Bird transect counts revealed 143 species, of which numbers of registrations for 96 species were sufficient for use in analysis. For these species, 8,566 identifications were made of 68,211 individuals, with 59 percent of the identifications and 30 percent of the birds observed in the breeding season.

Data on birds were converted to five measures to be used to evaluate the model's performance—winter density, winter species richness, breeding density, breeding species richness and total species richness. Bird species were also grouped into several ecological categories or guilds, e.g., cavity nesters, forest-interior dwellers, etc. The most abundant breeding bird species, in decreasing density order, were blue-gray gnatcatcher (*Polioptila caerulea*), northern cardinal (*Cardinalis cardinalis*), Carolina chickadee (*Parus carolinensis*), prothonotary warbler (*Protonotaria citrea*), Acadian flycatcher (*Empidonax virescens*), tufted titmouse (*Parus bicolor*), indigo bunting (*Passerina cyanea*), downy woodpecker (*Picoides pubescens*), ruby-throated hummingbird (*Archilochus colubris*) and great crested flycatcher (*Myiarchus crinitus*). The most abundant winter species, in identical order, were Carolina chickadee, white-throated sparrow (*Zonotrichia albicollis*), red-bellied woodpecker (*Melanerpes carolinus*), northern cardinal, downy woodpecker, golden-crowned kinglet (*Regulus satrapa*), tufted titmouse, red-headed woodpecker (*Melanerpes erythrocephalus*), common grackle (*Quiscalus quiscula*) and yellow-rumped warbler (*Dendroica coronata*). Some species, such as the Mississippi Kite (*Ictinia mississippiensis*), occurred at densities too low to be detected by our sampling design and only on the largest tracts. Data on the 38 species of reptiles and amphibians encountered have not yet been fully analyzed.

For the tests of the HES model, we randomly assigned field sites to one of the two groups—a reference group and a test group. The 27 sites in the reference group were used to examine specific relationships between model variables, HQI scores predicted by the model, and the wildlife community as measured by the data on the bird communities from those same sites. The 32 sites in the test group were used as an independent test of the relationships developed in the reference group.

Univariate and multivariate analyses were done to determine correlations among and between vegetation and bird data. Numerous statistically significant results were obtained within vegetation measures, which indicated that alternative field measures existed for model variables at the plot level. For example, for canopy closure, we could use either percentage canopy closure, height of the tallest tree on the plot or total basal area on the plot, as each of these measures was highly correlated.

Correlation analysis of seasonal total density and number of bird species with 27 measures of vegetation structure revealed far more significant relationships than would be expected by chance alone. In the breeding season, 8 of 54 tests indicated significant associations at $p = 0.05$. For example, total breeding density is significantly associated with total basal area ($r = 0.42$, $p = 0.03$, $n = 26$). In the winter, 19 of 54 comparisons yielded significant results. For example, total winter density is also significantly associated with total basal area ($r = 0.52$, $p = 0.006$, $n = 26$).

Correlation analysis further suggested meaningful relationships between field measures at the tract level and avian community characteristics. For example, in 240 tests of relationships between various measures of tract size and composition of guilds, we found 44 statistically significant correlations; 24 of these correlations involved the guild of forest-interior species and indicated that species in this guild were indeed more numerous in large tracts (Table 1). This result extended to the level of the individual species, indicating that certain species were more frequently encountered on large tracts than on small ones sampled with equal effort. Our exploration of the relationships in these data continues.

Initial Performance of the Literature-based Model

Our initial objectives led to several expectations from the effort. First, we expected to summarize a larger literature base into the model. Second, we expected that model HQI scores would match our perceptions of site quality over a range of conditions from poor to good quality habitat. Third, we expected that the HQI scores from the model would be correlated with one or more measures of diversity of the vertebrate community. We also expected that not all correlations would be equal in strength because of the variety of habitat-utilization strategies found among the animals in a bottomland forest. Fourth, we expected that analysis of the field data on vegetation and animal communities would provide ample information with which to improve model performance. We also anticipated that further improvements would be necessary.

We conducted several evaluations of the literature-based model. In the first, a sensitivity analysis showed that model scores ranged across the full 0.0–1.0 scale and that a small number of unwanted interactions among variables occurred.

In the second, we made a cursory comparison of the results of the literature-based model with those from expert opinion. Spearman rank correlation analysis of a subsample of seven sites compared the rankings of the literature-based model with those of two groups of experts—one that had visited the sites, and another that rated the sites based solely on photographs. Higher correlation ($r = 0.72$, $p = 0.06$) was found between scores from the literature-based model and those of experts familiar

Table 1. Correlation analyses of measures of tract size with density of individuals in guilds of birds in 60 West Tennessee bottomland hardwood tracts.[a]

Guild	Season	Random group[c]	Measure of tract size[b]: Total	Total core	Roadless	Roadless core
Cavity nesters	Breeding	1	—	—	0.42*[d]	—
		2	—	—	—	—
	Winter	1	—	—	—	0.43*
		2	0.43**	0.38*	0.42*	0.40*
Open nesters	No significant correlations observed in 16 tests					
Edge species	Breeding	1	—	—	—	—
		2	−0.51**	−0.44**	—	—
	Winter	No significant correlations observed				
Forest interior species	Breeding	1	0.47*	0.44*	0.53**	0.51**
		2	0.38*	0.37*	0.40*	0.34*
	Winter	1	—	—	0.48**	0.60**
		2	—	—	0.39*	0.41*
Flocking species	Breeding	1	—	—	—	—
		2	−0.52**	−0.61**	−0.48**	−0.56**
	Winter	No significant correlations observed				
Solitary species	Breeding	1	—	—	0.42*	—
		2	—	—	—	—
	Winter	No significant correlations observed				

[a]Densities measured from transect counts (Järvinen and Väisänen 1975). Analysis for the number of species in each guild yielded similar results that are not presented here.
[b]Total tract is the area of a tract to a minimum vegetation width of 0.3 mile. Roadless tract is the area of a tract to either a minimum vegetation width of 0.3 mile or to a paved road, whichever area is smaller. Core areas of either tract size are the same areas as above less a band 100 meters wide around the edge.
[c]Sites assigned to one of two groups at random: Group 1, n = 26; Group 2, n = 32 in breeding season, n = 33 in winter.
[d]Probability of larger absolute value of r: * $p < 0.05$; ** $p < 0.01$.

with the sites. Rankings of photographs were not as highly correlated ($r = 0.63$, $p = 0.12$).

We explored the correlation between the HQI score predicted by the literature-based model and the observed value of the five different bird community parameters previously mentioned. There were significant correlations between the model score and winter number of species ($r = 0.32$, $P < 0.05$) and winter density of birds ($r = 0.35$, $P < 0.01$). The low R^2 value for each of these examinations indicated a modest explanatory value for the model.

In the final evaluation, we examined the relationship between the individual model variables, HQI scores for each variable and the values of the bird community, at the scale of the entire bird community and for selected guild groupings of birds. Comparison of individual model variables (e.g., number of snags, canopy cover) with bird community data, both at the overall scale and for individual guilds, revealed that correlations were higher between birds and individual model variables than between birds and HQI scores for each model variable.

Model Revision and Testing Needs

Not all of our expectations have been met as of this writing. We have been successful at improving the ecological base and documentation level of HES. This has resulted in a large data set and in a model that is capable of producing scores ranging from 0.0–1.0. We have also developed a large data set to use in further model refinement and testing.

In formulating the model, early judgments had to be made regarding shape of functional curves and bar graphs. This was done without full knowledge of field conditions in the study area. As a result, certain bar graphs for variables in the literature-based model do not fully reflect real-world conditions. For example, the variable, percentage shrub cover, has a maximum HQI score of 1.0 beginning with 34-percent coverage. Analysis of the vegetational data for West Tennessee revealed that shrub cover for 75 percent of the plots was 17 percent or less. Thus, the bar graph used in the analysis is unrealistic and should be modified in the next iteration of the model, so that plots with less than 34-percent coverage are rated higher than they were in our first round of analyses.

All wildlife values cannot be met in a single successional context because there are wildlife species that require a variety of successional conditions. Because the protection of natural areas that contain rare species and communities is the main objective of Heritage Programs, the revised HES model values larger tracts and older stands for area-sensitive wildlife species. Just as habitat characteristics of individual wildlife species are chosen for HSI modeling in Habitat Evaluation Procedures (HEP) (U.S. Fish and Wildlife Service 1980), so too in the revision of HES were the condition of tracts and their placement on the landscape chosen for community modeling.

Limiting our selection of sites to larger, more homogeneous and older-than-average forest tracts yielded a sample of sites that did not include small, young, disturbed sites typical of much of the bottomland forest ecosystems of the Mississippi Valley. Excluding smaller, more disturbed sites from consideration may not provide a fair test of the model for project planning purposes. It may be that the model is not yet sensitive to differences among sites that we included in the sample, but it is effective at distinguishing these from other sites.

We were able to sample only one form of wildlife response, that of the bird communities of our sites. We were able to gather a small data set on reptiles and amphibians, but it was not sufficient to test the model in a meaningful way. Further testing of this or other formulations of the bottomland hardwood model must include provision for measuring more of the wildlife community.

Perspectives

A number of other evaluation tools, such as the Wetland Evaluation Technique (WET) (Adamus et al. 1987) and HSI models developed for the Habitat Evaluation Procedures (U.S. Fish and Wildlife Service 1980), are under development or in use. We anticipate opportunities for sharing data with other researchers in the arena of community modeling, e.g., HES has the potential to supplement WET's scoring for bottomlands.

A habitat quality model designed to favor communities with high diversity (expressed as species richness) is appropriate for the regulations of many federal agencies, supportive of technical and philosophic concerns (U.S. Congress, Office of Technology Assessment 1987), and realistic for evaluating impacts that result in land-use changes (Schroeder 1987). Diversity can be expressed at three scales or levels—alpha, beta and gamma (Whittaker 1972)—with all three having significance for conservation. Because HES can be applied on areas of any size, the model considers all three. Alpha diversity is addressed by the plot-level variables that measure habitat structure. Tract size and interspersion of wet and dry areas (variables 11 and 14) address beta diversity by reflecting the variety of habitats available on a tract. Finally, some aspects of gamma diversity are measured by watershed quality and tract interconnections (variables 12 and 13).

An unavoidable consequence of evaluation and subsequent management for maximum diversity is an increase in average rarity (Cody 1986) that entails a loss of information on some members of the wildlife community. Furthermore, species whose habitat requirements include large homogeneous patches, such as many forest-interior bird species, may suffer under management schemes that attempt to maximize diversity. A HES evaluation could serve as the framework for an evaluation for individual wildlife species of interest that are not emphasized in a community-level approach. Within bottomland hardwoods, the data required for HES are similar or the same as those used for HSI models in HEP for many individual species.

Several assumptions and variables in the model relate to recent guidelines for the "integration of conservation planning into development planning" (Harris 1984). This requires assessment of each project or action in context with adjacent projects, actions or land-use practices. Landscape pattern is changing so rapidly that efficient evaluation of project- or location-specific land use changes is important. In addition to specific effects, cumulative impacts from multiple actions or projects, from individually insignificant but chronic causes and from synergistic actions must be evaluated. A community-level evaluation can help to determine the ramifications of cumulative actions, to suggest alternative plans and to recommend corrective actions.

HES is being used for impact analysis and evaluation of baseline conditions, but is not limited to those purposes. By definition, variables in habitat models should be linked to viable management actions (Schamberger and O'Neil 1986); variables such as those found in HES can be expressed as planning standards and used to write management goals and prescriptions (Salwasser et al. 1984).

As a result of our three-year study effort, we now have a large vegetation and avian data set with which to modify the literature-based HES model further to make it more fully measure wildlife habitat quality. We intend to rework the literature-based model using what we have learned and to conduct additional statistical evaluations and field applications in the future. We believe that future iterations of the model will be superior to their predecessors.

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Secondary Production in Riparian Wetlands

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Introduction

The patterns in secondary production of riparian ecosystems are not described in the scientific literature as well as such patterns are for other wetland ecosystems. For example, of 113 food webs described by Briand and Cohen (1987), none of the 14 wetland ecosystems is what is generally known in this country as an inland riparian habitat. Riparian ecosystems share fundamental ecological characteristics in common with other ecosystems. They also undergo large environmental fluctuations, have a three-dimensional space (as opposed to two-dimensional space), and are subject to energetic and evolutionary constraints. This allows one to make preliminary observations about patterns in ecosystem secondary production rates and trophic interactions. It is the intention here to make comparisons of secondary production within wetlands and among all ecosystems in order to describe the probable patterns of secondary production in riparian ecosystems.

Ecosystem Food Chains

Ecosystem food chains are generally not more than three or four trophic levels long. This is a small variation compared with that of ecosystem primary productivity, which varies three to four orders of magnitude. Variations in food availability among ecosystems have been used to explain variations in food chain length. This "energy" hypothesis is based, in part, on the inefficiency of energy transfer between trophic levels (about 10 percent) and the minimum metabolic needs of predators, which are less likely to be met in impoverished environments. Although the length and composition of food chains is definitely influenced by food quantity and quality, there is no obvious constraint on food chain length exerted by food resource quantity, except in extreme or "threshold" cases (Pimm 1982). For example, the low primary production of arctic lakes supports ecosystem food chain lengths equal to that of highly productive coral reef ecosystems.

The variation in food chain length among ecosystems is better represented by the "dynamical stability" hypothesis. The dynamical stability hypothesis suggests that food chain length is greater in stable ecosystems because of fewer constraints between predator and prey, and, that perturbations decrease the likelihood of longer food chains persisting in nature.

The feeding relationships of trophic species within food chains are remarkably uniform. The ratio of prey-to-predator species in 62 community food webs analyzed by Briand and Cohen (1984) was 1:0.88. This ratio is not dependent on the number of species; the ratio is the same for constant and fluctuating environments. "Nor is there any significant correlation . . . between species richness and prey:predator ratio, percentage of specialized predators (those feeding only on one kind of prey), or food chain length. Taken singly, none of these variables can discriminate among fluctuating, constant, aquatic, terrestrial, tropical, or nontropical systems'' (Briand 1983).

Connectance within food chains for the 40 ecosystem examples used by Briand (1983) was lower in fluctuating than in constant environments. This is an important discovery, because riparian ecosystems undergo considerable fluctuations as a consequence of both flooding and drying cycles and soil pH and Eh. Briand interpreted this pattern to result from ecosystem constraints on the feeding behavior of its trophic species. Compared with constant ecosystems, feeding in fluctuating ecosystems is limited by perturbations; this situation results in intense and well-timed predation events that increase the strength of interactions between species, i.e., the relationships between connectance and interaction strength help define food web structure. For example, the relationship between the predator-to-prey ratio and trophic species richness and between the number of competitor-to-competitor trophic links and species richness were lowest in fluctuating environments, compared with constant environments (Briand 1983).

Both environmental variability (high and low) and dimension (two-dimensional compared with three-dimensional space) appear to affect food chain length, although the former seems to have less influence than the latter. Three-dimensional environments ''have distinctly longer food chains than environments that are two dimensional or flat, such as a grassland or lake bottom'' (Briand and Cohen 1987).

Materials and Methods

I analyzed data on 19 ecosystems for primary production and secondary production (Whitaker and Likens 1973), and on 113 ecosystems for mean food chain length, trophic species number, trophic linkages, and environmental dimensionality and variability (Briand 1983, Briand and Cohen 1987). The following original definitions will be used:

trophic species—''. . . may be a single biological species or a size class or stage in the life cycle of a single biological species or a collection of functionally or taxonomically related biological species, according to the original report'' (Briand and Cohen 1984).

food web—''. . . the feeding relations in a community of organisms'' (Briand and Cohen 1987).

food chain—''. . . an energy path or sequence of links that starts at a species that eats no other species in the web and ends at a species that is eaten by no other species in the web. The length of a chain is the number of links it comprises. The mean chain length is the arithmetic average of the lengths of all chains in the web'' (Briand and Cohen 1987).

connectance—defined diagramatically through the use of a matrix of trophic species interaction, based on the original report, it is ''the fraction of nonzero off-diagonal elements in the community matrix. Such a matrix indicates not only trophic interactions, as does the food web matrix, but also direct competitive interactions'' (Briand 1983).

i—defined mathematically, it is the ''average strength of interaction among species'' (Briand 1983).

environmental variability—defined as high, intermediate or low, using the original data reports, to distinguish the amplitude of "variations in temperature, salinity, pH, water availability, or any other major parameter" (Briand 1983).

ecosystem dimension—describes, in a rough way, spatial variability. "An environment is classified as having dimension 2 if it is essentially flat, like a grassland, the tundra, a sea or lake bottom, a stream bed, or the rocky intertidal zone. An environment is classified as having dimension 3 if it is solid, like the pelagic water column or a forest canopy. Webs from habitats integrating both flat and solid environments are considered as having 'mixed' dimension" (Briand and Cohen 1987). I classified intermediate dimensions as having a value of 2.5.

Ecosystems were labelled as wetland ecosystems, or not, as described in the original reports. Wetland ecosystems were separated from all other ecosystems for comparative purposes and comparative statistics computed on the data mentioned above.

Results and Discussion

Secondary Production Rates

Ecosystem secondary production rates are generally directly related to the primary production rates (Figure 1). Compared with other ecosystems, the primary production of wetlands is relatively high, especially for riparian ecosystems. Such ecosystems, therefore, have relatively high secondary production. Compared with terrestrial ecosystems, aquatic ecosystems tend to have a higher percentage of consumption of primary production by secondary consumers, a higher efficiency of conversion and, possibly, higher standing biomass.

Animal production in riparian wetlands is therefore high, in part, because plant production and animal consumption there are relatively high. A crude estimate of the average annual production rate of all animals is 2.5g $C \cdot m^2$ for the continents

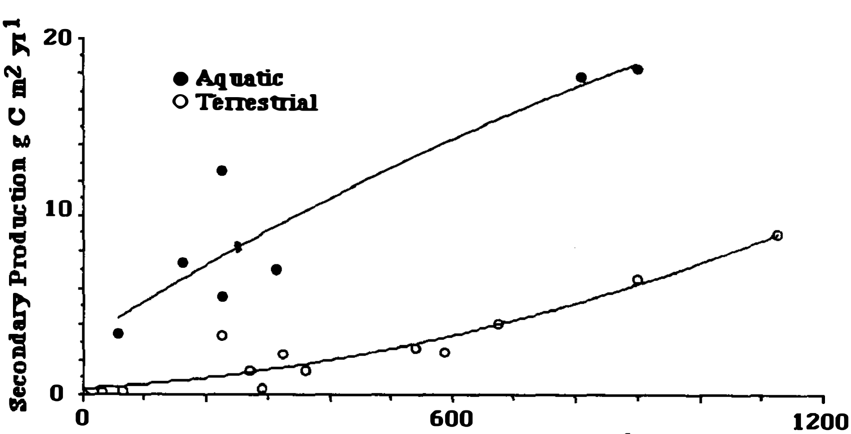


Figure 1. Secondary production and primary production rates in various ecosystem types.

as a whole, but about 9.0g $C \cdot m^2$ for marshes and swamps, or about 75 percent of the rate in upwelling zones and 50 percent of estuaries. Much of this marsh and swamp animal production is in the form of fish. For example, annual fisheries yields of 1 g $C \cdot m^2$ are common in tropical river floodplains. Though fish-feeding styles vary enormously, a considerable portion of their food may be traced back to wetland origins (e.g., Goulding 1980, Kapeksky 1981, Welcomme 1978, 1979). The flooded phase is important as a relatively rich food resource, and as a refuge from predators and from the physical challenges to life in the main channel. The total human population benefits from the long-term stability of the wetland ecosystem through fisheries development and above-average protein supplies (Turner 1988).

Food Webs

The relationship between the number of trophic species and the number of trophic links in wetland and nonwetland ecosystems is shown in Figure 2. In general, the number of food web links increases with the number of species, or vice versa. This may result from the greater number of opportunities for trophic links as species number increases, but a tautological trap potentially exists in trying to explain one axis as a function of the other; perhaps the number of trophic species is limited by predation. Regardless, wetlands have a fewer linkages per species than do other ecosystems, implying a simpler food chain. But caution is urged here also, since some of the differences between ecosystems may be apparent and not real, being attributable to the availability of data points; almost all wetland environments undergo large fluctuations in the physical regime and the food webs of fluctuating environments are different from the food webs of stable environments (Figure 3). Fluctuating environments, as most wetlands are categorized, tend to have simpler food chains or, fewer linkages per species, than stable ecosystems have.

The relationship between the number of trophic species and the number of trophic links in only fluctuating wetland and nonwetland ecosystems is shown in Figure 4.

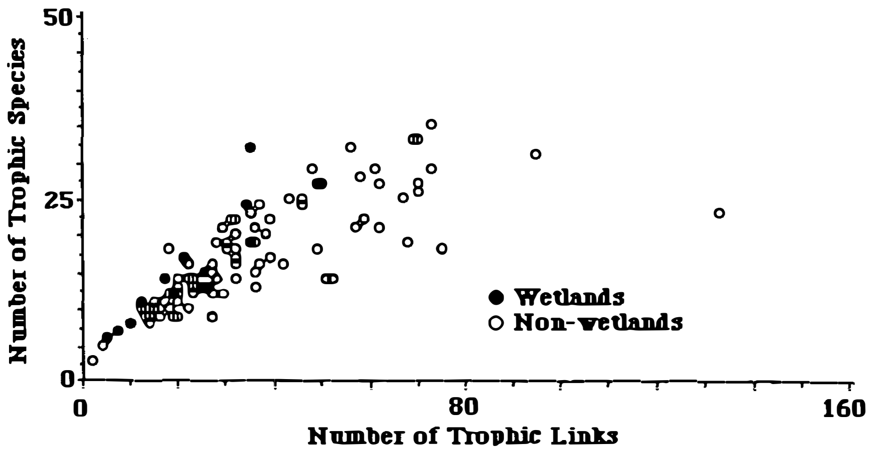


Figure 2. The relationship between the number of trophic species and the number of trophic links in wetland (black dots) and nonwetland ecosystems (open circles).

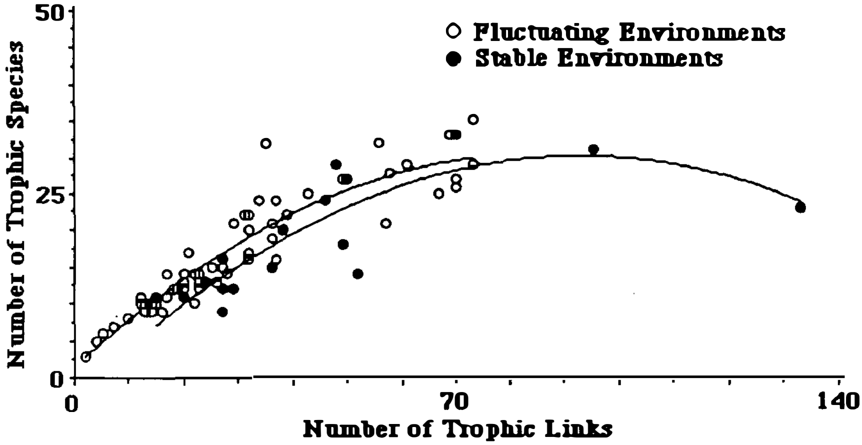


Figure 3. The relationship between the number of trophic species and the number of trophic links in fluctuating (open circles) and stable (black dots) environments. The original data are in Briand and Cohen (1987). The polynomial regression line is for fluctuating environments (upper line) and for all ecosystems together (lower line).

When fluctuating environments are considered by themselves, wetland ecosystems do indeed appear to have slightly fewer linkages per species compared with other fluctuating nonwetland ecosystems.

The relationship between the connectance within a food web and the number of trophic species in 40 wetland and nonwetland ecosystems described by Briand (1983) is shown in Figure 5. Connectance is roughly proportional to the trophic species

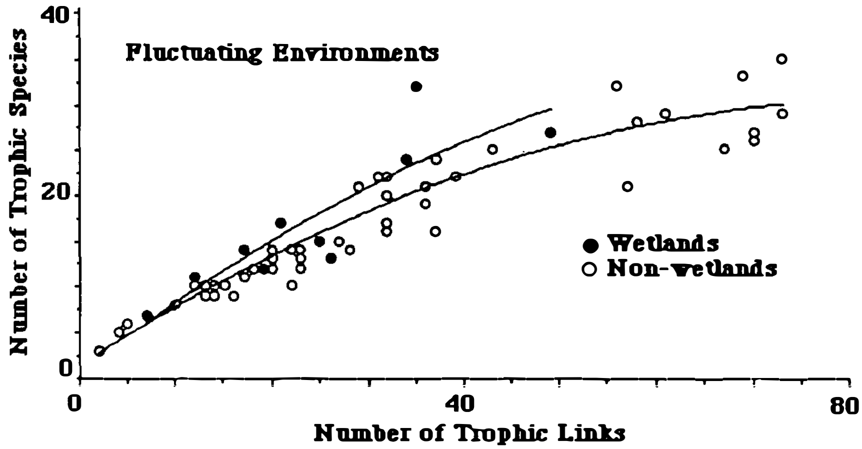


Figure 4. The relationship between the number of trophic species and the number of trophic links in fluctuating wetland (black dots) and nonwetland (open circles) ecosystems. The polynomial regression line is for wetland environments only (upper line) and for all ecosystems combined (lower line).

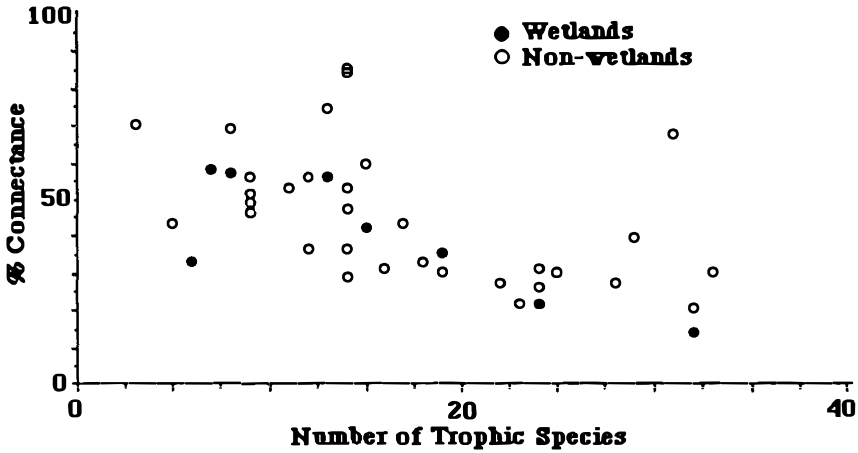


Figure 5. The relationship between the connectance within a food web and the number of trophic species in 40 ecosystems, described by Briand (1983). Wetland (black dots) and nonwetland (open circles) ecosystem food webs are shown.

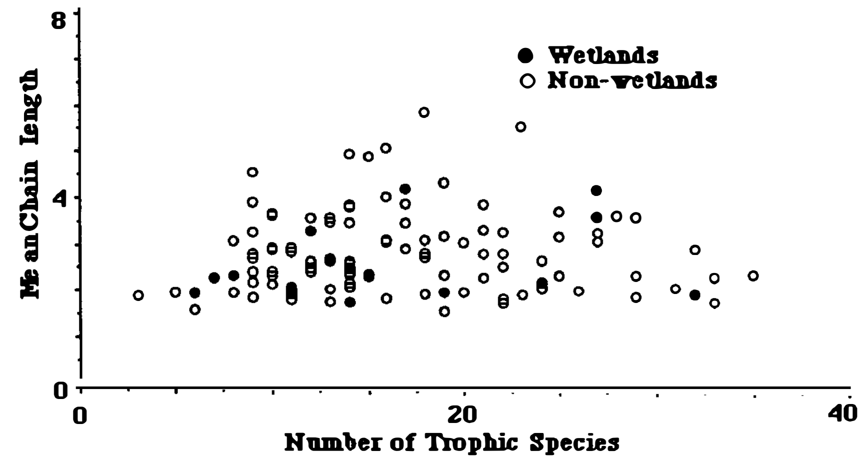
number, and there is no discernible difference between wetland and nonwetland ecosystems in this data set. However, Briand (1983) demonstrated significant differences among fluctuating and stable environments with regard to the ratio of the number of trophic species and (1) the number of predator to prey links and (2) the number of competitor links. In other words, compared with stable environments, fluctuating environments have fewer predator-to-prey linkages, when normalized for the number of trophic species. This result then implies that there is a greater possibility for longer food chains in fluctuating environments, i.e., wetlands.

Food Chain Length

Figure 6 shows the relationship between the mean food chain length and the number of trophic species in 113 ecosystems described by Briand and Cohen (1987). In general, there is an absence of any direct relationship between variables. There is virtually no relationship between trophic species number and mean food chain length. In other words, the number of trophic levels is not apparently constrained by community energetics, as Pimm (1982) and Briand and Cohen (1987) also concluded. In this regard, there is no apparent difference between wetland and nonwetland ecosystems or between stable and fluctuating environments.

The relationship between the mean food chain length and the ratio of the number of trophic species to the number of trophic links in both wetland and nonwetland environments is significant; there are no apparent differences between wetland and nonwetland ecosystems (Figure 7). A decline in the mean food chain length with increasing number of species per trophic link is evident, as might be expected with increasing prey choices for predators. Less complex food webs might have a longer food chain, but again, this is conjecture and not a tested hypothesis.

Table 1 has the mean number of trophic species to number of trophic links in wetlands and nonwetlands for three types of environmental variability. This ratio tends to be higher in wetlands, compared with nonwetlands, in both high and mod-



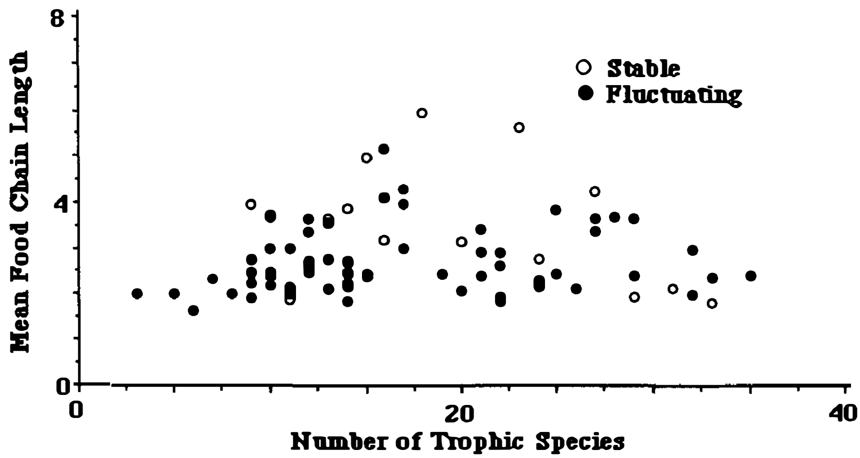


Figure 6. The relationship between the mean food chain length and the number of trophic species in 113 ecosystems described by Briand and Cohen (1987). The upper panel compares wetland (black dots) and nonwetland (open circles) ecosystems; the lower panel compares fluctuating (black dots) and stable (open circles) ecosystems. Note the absence of any direct relationship between variables.

erately variable environments. The statistical differences are not always significant, however, and results in this table do not take into account the nonrandom distribution of sampling points with regard to environmental variability. Most wetlands are in fluctuating environments, whereas nonwetlands are a mixture of fluctuating and stable environments.

Mean food chain length is related to environmental variability. Table 2 has the mean food chain length and the ratio of the number of trophic species to number of trophic links by ecosystem variability and by type of ecosystem dimension category. Mean food chain length tends to increase with increasing ecosystem dimension, while the number of species per link tends to decline with increasing ecosystem dimension.

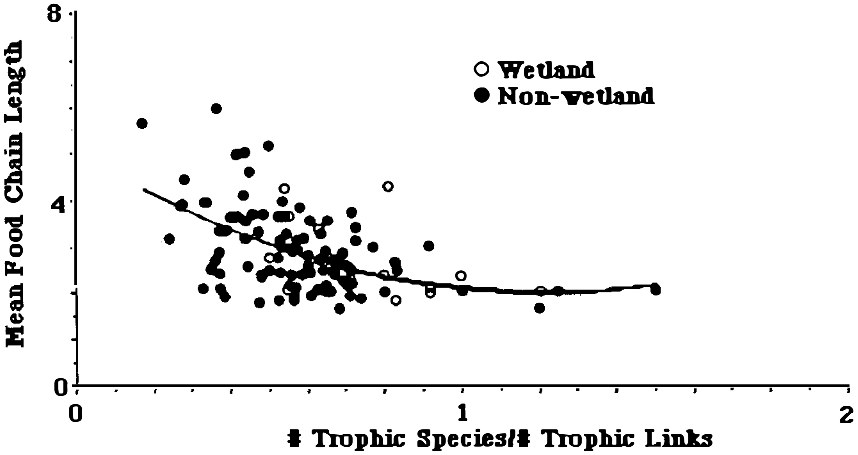


Figure 7. The relationship between the mean food chain length and the ratio of number trophic species to number of trophic links in wetland (open circles) and nonwetland (black dots) environments. A polynomial fit of each of the two data sets is shown (overlapping).

There is no consistent pattern with regard to changing variability and mean food chain length.

Because most wetlands are in a fluctuating environment, a more restricted analysis was conducted to discern differences between wetland and nonwetland ecosystems of otherwise similar environmental variability. Table 3 lists the mean food chain length and the ratio of the number of trophic species to number of trophic links for wetland and nonwetland ecosystems in fluctuating environments by type of ecosystem dimension category. Data are not available on 3 dimensional wetland environments (e.g., riparian ecosystems). However, based on patterns in other ecosystems, wetland ecosystem food chains should lengthen and the trophic species-to-link ratio decrease as ecosystem dimension expands. In other words, riparian ecosystem food webs are

Table 1. Mean number of trophic species to number of trophic links in wetlands and nonwetlands for three types of environmental variability.

Environmental variability	Mean	Standard deviation	n
Fluctuating			
All	0.656	0.206	64
Wetlands	0.745	0.172	10
Nonwetlands	0.639	0.209	54
Intermediate			
All	0.553	0.205	32
Wetlands	0.848	0.331	3
Nonwetlands	0.523	0.168	29
Stable			
All	0.46	0.139	17
Wetlands	0.54	—	1
Nonwetlands	0.455	0.142	16

Table 2. Mean food chain length and the ratio of the number of trophic species: number of trophic links by ecosystem stability and by type of ecosystem dimension category.

Environmental variability	Environmental dimension	Food chain length (mean +/− std. dev. (n))	Trophic species/trophic links (mean +/− std. dev. (n))
Fluctuating	2.0	2.368 +/− 0.44 (26)	0.684 +/− 0.243 (26)
	2.05	2.884 +/− 0.72 (25)	0.66 +/− 0.203 (25)
	3.0	3.033 +/− 0.86 (13)	0.584 +/− 0.102 (13)
	All	2.705 +/− 0.706 (64)	0.656 +/− 0.206 (64)
Intermediate	2.0	2.621 +/− 0.663 (11)	0.484 +/− 0.208 (11)
	2.5	2.768 +/− 0.571 (13)	0.646 +/− 0.202 (13)
	3.0	3.851 +/− 0.769 (8)	0.497 +/− 0.165 (8)
	All	2.988 +/− 0.814 (32)	0.553 +/− 0.205 (32)
Stable	2.0	2.35 +/− 0.297 (2)	0.497 +/− 0.075 (2)
	2.5	2.905 +/− 0.897 (8)	0.501 +/− 0.094 (8)
	3.0	4.186 +/− 1.423 (7)	0.403 +/− 0.186 (7)
	All	3.367 +/− 1.28 (17)	0.46 +/− 0.139 (17)
All	All	2.88 +/− 0.87 (133)	0.597 +/− 0.209 (133)

relatively longer, and the number of trophic species per trophic linkage is lower, compared with other ecosystems.

Conclusions

Riparian wetlands have high primary production that is available to consumers, a fluctuating environment and an aquatic/terrestrial food web or chain, resulting in concentrated secondary production. Based on this type of data analysis, riparian ecosystems have more trophic species per number of trophic links than do nonwetland ecosystems. Another way of saying this is that wetland ecosystems tend to have

Table 3. Mean food chain length and the ratio of the number of trophic species to number of trophic links for wetland and nonwetland ecosystems in fluctuating environments by type of ecosystem dimension category.

Environmental dimension	Food chain length (mean +/− std. dev. (n))	Trophic species/trophic links (mean +/− std. dev. (n))
Wetlands		
2.0	2.825 +/− 0.742 (2)	0.669 +/− 0.053 (2)
2.5	2.663 +/− 0.86 (8)	0.746 +/− 0.189 (8)
3.0	— (0)	— (0)
All	2.665 +/− 0.8 (10)	0.745 +/− 0.172 (10)
Nonwetlands		
2.0	2.33 +/− 0.408 (24)	0.685 +/− 0.253 (24)
2.5	2.988 +/− 0.65 (17)	0.616 +/− 0.196 (17)
3.0	3.033 +/− 0.861 (13)	0.584 +/− 0.102 (13)
All	2.706 +/− 0.695 (54)	0.639 +/− 0.209 (54)
All		
2.0	2.368 +/− 0.44 (26)	0.684 +/− 0.243 (26)
2.5	2.884 +/− 0.722 (25)	0.663 +/− 0.203 (25)
3.0	3.033 +/− 0.861 (13)	0.584 +/− 0.102 (13)
All	2.705 +/− 0.706 (64)	0.656 +/− 0.206 (64)

fewer links per trophic species. This is true for stable, intermediate and fluctuating wetland ecosystems. Further, no apparent large differences are anticipated between the ratio of the number of trophic species to number of trophic links and mean chain length for wetland and nonwetland ecosystems. But, the number of predator-prey and predator-to-predator links should be lower in wetland environments, compared with stable ecosystems. The vegetation canopy of riparian wetlands adds to maximum ecosystem dimension, which probably results in relatively longer food chains compared with other wetland ecosystem types.

Also compared with other ecosystems, trophic species of riparian wetlands have fewer connections with fewer species. Consequently, secondary production in riparian wetlands may be shown to accumulate in larger individuals. The ratio of prey-to-predator, however, is probably around 0.9, or similar to that of other ecosystems.

Helfman (1986) noted four themes about aquatic predator-prey relationships which, I believe, are generally applicable to ecosystems, including riparian ecosystems, and which contribute to learning about ecosystem structure and developing future research: (1) predation strongly affects the behavior of prey; (2) prey responses are not predictable and prey can adjust antipredator behavior; (3) predation is heaviest on the young and small individuals; (4) much important work remains to be done on the cause-and-effect relationships between predator and prey behavior. The last theme implies that natural history or autoecological studies will have a significant role in increasing our understanding of food chain and food web variability. The refuge value of wetlands to young fish and invertebrates is receiving increasing attention (Boesch and Turner 1984, Turner and Boesch 1987) as better field observations and experimental manipulations are conducted in riverine, lacustrine and coastal wetlands (e.g., Savino and Stein 1982, Strange et al. 1982, Werner et al. 1983, Durocher et al. 1984, Heck and Thomas 1984, Holland and Huston 1984). As Briand and Cohen (1987) remarked, "it is evident that environmental dimension may affect the probability per unit time of an encounter between predator and prey." Thus wetland vegetation may play a strong role in the determination of secondary production quality and quantity.

Although riparian wetlands have distinctively high secondary production rates and often unique kinds of consumers, this is not meant to imply that other ecosystems are of lesser importance. The patterns in secondary distribution in riparian wetlands represent examples resulting from the variety of constraints and exploitations to which all ecosystems must adapt, but in different ways.

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Ecosystem Approach to Management of Southwestern Riparian Communities

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Introduction

Southwestern riparian ecosystems are disproportionately rich in bird and other animal species (Carothers et al. 1974; Carothers and Johnson 1975, Szaro 1980). They are critically important to the survival of wildlife and fish populations of the region. Changes in vegetative structure that result from both natural and human-related disturbances are known to affect dramatically the richness and densities of riparian bird species (Anderson and Ohmart 1979, Szaro 1981, Szaro and Debano 1988). Typical disturbances include flooding, inundation, scouring, desiccation, grazing, recreation, dam construction and revegetation (Hendrickson and Minckley 1984, Minckley and Brown 1982).

One of the most prevalent forms of disturbance in riparian zones is heavy livestock use (Ames 1977, Brown et al. 1977, Davis 1977). Grazing is so ubiquitous in riparian ecosystems of the Southwest that only a few ungrazed sites are available for study as references or controls. Stream bottoms are natural concentration areas for livestock (Platts and Nelson 1985), and in arid or semiarid rangelands this attraction is intensified by limited water on the drier adjacent uplands. Ungrazed sites exist only where topography or exclosures on public or private lands limit livestock accessibility. Grazing has exerted a strong influence on riparian soils, vegetation and animal communities (Cannon and Knopf 1984, Jones 1981, Manning 1979, Ryder 1980).

Effects of disturbance on biological systems are often inferred from changes in species diversity, stability and biomass (Cole 1987). Habitat management decisions for wildlife are frequently made by considering a limited set of species, e.g., common game species or endangered species. Some groups, such as birds, respond quickly to changes in habitat structure because of their mobility. By contrast, small mammals, reptiles and amphibians are more limited in their ability to immigrate or emigrate to or from an impacted area. Similarly, fish species are limited to movements within their stream system. Unfortunately, few studies of riparian fauna have examined all vertebrate groups and their relationships with structural habitat components, disturbance (both natural and human-related) and vegetation. This could lead to erroneous assumptions about potential effects of overall resource management practices on wildlife, and result in undesired positive or negative effects on other vertebrate species.

Systematic patterns in both populations and communities may become apparent if one studies a system on a sufficiently large scale or over a sufficiently long time. However, such patterns are usually not evident if study is restricted in time and space (May 1984). Evaluating the effects of resource management on vertebrate communities depends on establishing the baseline structure and composition of these communities and their range of natural variability over time (Karr 1987). This potential for incorrect management decisions may be further compounded by basing them on studies that examine species and habitat relationships only for a single season or year.

Because all biotic communities are dynamic, the central issue is to distinguish between changes in species composition that result from changes in the physical and biotic environment from those changes that result from individual species' responses to weather fluctuations (Karr and Freemark 1985, Schlosser 1985). The goal of community ecology is threefold: (1) to determine the patterns of natural systems; (2) to explain them by discerning the causal processes; and (3) to synthesize these explanations as far as possible (Wiens 1984). Findings from community ecology, therefore, can contribute to the decision-making process for land managers. Often practical decisions are made in haste and in the absence of desired empirical information (May 1984). Ideally insightful use of biological knowledge should allow predictions rather than only after-the-fact judgments (Karr 1987). Different models and recommendations can be made in the same (or, in some cases, different) geographical areas, so that management regime assumes some of the aspects of a controlled experiment (May 1984). We, therefore, argue for the overall ecosystem approach to research and ultimately to manage riparian areas.

An ecosystem approach to management of riparian systems should consider goals and standards for the conditions of major indicators of plant and animal community health. It should also require continued monitoring of habitat indicators and of species' population levels over an extended time period (5 + years) to assess fully the effects of environmental perturbations and the adequacy of management strategies. Several studies in the southwestern United States that are beginning, in progress or nearing completion address the need for the long-term ecosystem approach. Conceivably, results from these and future studies will be used by land management agencies to manage riparian areas more effectively. In this paper, we discuss specific examples that support this concept and propose recommendations for future research and management of riparian areas in Arizona and New Mexico.

Study Areas

Over the past five years, we have studied riparian areas at upper, intermediate and low elevations in the Southwest. The high elevation area—the Rio de las Vacas—is in New Mexico. The mid-elevation, Mogollon Rim, and the low-elevation, Queen Creek, are both in Arizona.

Rio de las Vacas

The Rio de las Vacas is a third-order montane stream draining the San Pedro Parks Wilderness Area, Santa Fe National Forest, New Mexico. The area is about 17 kilometers southeast of Cuba in Sandoval County, at an elevation of 2,600 meters. Two cattle exclosures straddling the stream (both about 900 meters by 50 meters wide) were installed in the early 1970s (Szaro et al. 1985). Contiguous, downstream private lands that are grazed by livestock were used for comparison with the nongrazed areas.

Mogollon Rim Streams

This study area is on the Tonto National Forest immediately below the upthrust side of the Mogollon Rim, a major escarpment traversing Arizona. The area, about 15–25 kilometers north of Payson, Gila County, ranges in elevation from 1550–2100 meters. In 1985, research was initiated on six riparian-stream areas (from east to west)—Christopher, Horton, Ellison, Bonita, Dude and Pine creeks. For further details of the study areas, see Rinne and Medina (1988).

Queen Creek

This study area is along Queen Creek on the Tonto National Forest, about 16 kilometers west of Superior, Pinal County, Arizona, at an elevation of 625 meters. An earthfill dam was constructed in autumn of 1960 and has resulted in the dramatic development of an artificial riparian gallery forest of Goodding willow (*Salix gooddingii*) and saltcedar (*Tamarix pentandra*), occupying an area of approximately 18 hectares (Szaro and Debano 1985, 1988).

Methods

Fish

Fish populations (density and biomass) were estimated by a three-pass removal method in 50-meter blocked sections of stream, which served as sampling units (Rinne 1978). Upper and lower ends of study sections were blocked with nets and a DC backpack electrofishing unit was used while proceeding upstream to collect fish. Fishes were weighed (g) and measured (mm) and returned alive to the stream. In the Rio de las Vacas, fish populations were estimated in grazed and ungrazed reaches between 1982 and 1985 (Rinne 1988a). In streams along the Mogollon Rim, fish populations were estimated during low flow in late spring to early summer (May–June), 1985–1987 (Rinne and Medina 1988). Substrate fine particle (<0.25 millimeter) content was estimated with perforated plastic boxes (8 by 6 by 14 centimeter) filled with gravel (4.0–9.5 millimeter) and buried in the stream substrate for a 6-month period from October 1986 to April 1987. Fishes were not studied at the Queen Creek site.

Amphibians and Reptiles

Different methods of capture were necessary for sampling the herpetological communities at the Rio de las Vacas and Queen Creek; a study has not been initiated on the Mogollon Rim riparian areas. The most common reptile alone the Rio de las Vacas is the wandering garter snake (*Thamnophis elegans vagrans*), which was not easily captured by pitfall-traps. Consequently, snake populations were estimated using intensive searches by three to four observers for five consecutive days. Equal time was spent in each of three areas (upper exclosure, lower exclosure and grazed stream segments) along the Rio De Las Vacas. Time-of-day bias was minimized by alternating starting areas. Sampling began in June 1985 and was replicated in July, August and September of that year and in the same months in 1986. All snakes were marked and released. At Queen Creek, we established 40 pitfall trapping stations (20 each in the riparian and adjacent desert) with each station consisting of one 7-

meter drift fence with a 19-liter plastic bucket buried flush with the ground surface at each end. Traps were checked three times a week during April and May 1982 (Szaro and Belfit 1986).

Birds

Birds were counted by the variable-circular plot method (Reynolds et al. 1980). At Rio de las Vacas, birds were counted at 24 points (8 each in an upper exclosure, lower exclosure and along the grazed stream segment), six times a month from June to September 1985 and 1986 (Szaro unpublished data). At Queen Creek, birds were counted at 60 points (20 each in the riparian stand, desert wash and desert upland), 10 times during the height of the breeding season, April to May 1981 and 1982 (Szaro and Jakle 1985).

Small Mammals

Along the Rio de las Vacas, small mammals were captured using Sherman live-traps (8 by 9 by 23 centimeters), baited with rolled oats in a 40-trap grid pattern of 2 by 20 traps located parallel to the stream channel. Pairs of traps were located with one trap at the stream bank and the second 10 meters from the bank. Trap pairs were separated from the next pair downstream by at least 5 meters. Live-traps were set for five nights each month from June to September 1985 and 1986; 40 each in the upper exclosure, lower exclosure and in the grazed stream segments, for a total of 120 traps. Along Queen Creek, small mammals were captured in the same pitfalls used for the amphibian and reptile study (Szaro and Belfit 1987).

Results and Discussion

Since 1982, our studies have examined vertebrate communities at high, intermediate and low elevation riparian sites in Arizona and New Mexico. In preliminary studies at the high elevation Rio de las Vacas, we found a broad spectrum of vegetative and vertebrate responses to exclosure of a 2-kilometer section of the stream from cattle grazing. Bank stability along the Rio de las Vacas increased within exclosures, compared with downstream grazed areas (Rinne 1988b). Woody vegetation was markedly greater in the exclosures (Table 1), as was streambank and overhanging woody vegetation exclosures (Rinne 1988b).

Fish populations in reaches of stream in the grazed area, compared with those within exclosures, were not markedly different. Yet, estimates did vary in time and space (Table 1). The overall pattern of response by fishes to grazing is confounded by the superimposition of the extensive stocking and sport angling for trout in this stream on the variation in species-specific responses (Rinne 1988a). Because of this, interpretations of responses to grazing by the two salmonid species in this system are rendered problematic at best.

There were differences in how terrestrial vertebrates responded to the exclusion of cattle grazing. First, in both 1985 and 1986, wandering garter snake captures were markedly lower along grazed reaches of the Vacas than they were within exclosures (Table 1). However, differences in snake captures between years were not consistent within exclosures. That is, from 1985 to 1986, captures decreased in the lower exclosure and increased in the upper exclosure.

For birds, total individuals observed and species richness were markedly greater in ungrazed exclosures in both 1985 and 1986 than along the grazed stream reach (Table 1). Species common in grazed areas were those whose foraging mode concentrated either on the ground or in the air. These species included Brewer's blackbird (*Euphagus carolinus*), northern flicker (*Colaptes auratus*), mountain bluebird (*Sialia currucoides*), pine siskin (*Carduelis pinus*), robin (*Turdus migratorius*), spotted sandpiper (*Actitis macularia*), violet-green swallow (*Tachycineta bicolor*), western bluebird (*Sialia mexicana*), western wood pewee (*Contopus sordidulus*) and yellow-rumped warbler (*Dendroica coronata*). In contrast, although all of the above species were observed and some were as common or even more abundant in the exclosures, other species were important components of bird community structure. These included green-tailed towhee (*Pipilo chlorurus*), orange-crowned warbler (*Vermivora ruficapilla*), dark-eyed junco (*Junco hyemalis*), broad-tailed hummingbird (*Selasphorus platycercus*) and house wren (*Troglodytes aedon*).

Small mammal captures were markedly greater within ungrazed exclosures than along the grazed stream segment in 1985, but were similar in grazed and ungrazed reaches in 1986 (Table 1). Nevertheless, we captured fewer species on the grazed area than within either exclosure. Voles (*Microtus montanus*) and deer mice (*Peromyscus maniculatus*) were common in both grazed and exclosed areas, but chipmunks (*Eutamias minimus*) and golden mantled groundsquirrels (*Spermophilus lateralis*) were common only in exclosures.

Table 1. Vegetation, fish, garter snake, bird and small mammal population estimates along the Rio de las Vacas, New Mexico.

	Treatment					
	Grazed		Lower enclosure		Upper enclosure	
	1985[a]	1986	1985	1986	1985	1986
Fish						
Number of captures[b]	96	49	86	31	96	77
Fish biomass[c]	1,584	1,125	2,485	2,334	1,926	1,806
Number of species	5	5	5	5	5	5
Snakes						
Number of captures	20	10	164	120	115	179
Birds						
Number of observations	615	386	814	788	876	862
Number of species	36	34	44	44	44	47
Small animals						
Number of captures	52	25	189	31	138	30
Number of species	6	4	8	5	9	7
Vegetation						
Tree density[d]	0.3 ± 0.14		7.5 ± 1.23		9.5 ± 1.16	
Shrub density[d]	0.2 ± 0.13		6.2 ± 1.39		7.2 ± 2.06	
Herbaceous cover[e]	65.6 ± 3.30		52.2 ± 2.56		56.8 ± 1.61	

[a]Fish data are from 1984 and 1985.
[b]Number per 50 meters.
[c]Grams per 50 meters.
[d]Number per 250 square meters.
[e]Percentage.

The ability of interacting species to maintain dynamically stable populations or even to persist varies with the different abilities of species to compensate for the effects of increased exploitation or competition (Cole 1987). Changes in community structure in response to environmental stress, whether natural or human-related, can be useful in predicting the specific outcome of certain management regimes (Karr 1987), but they must be partitioned according to cause. However, because differences in response to grazing exclusion on the Rio de las Vacas undoubtedly were further confounded by critical climatic events, examination of the dynamics of this high elevation, montane, riparian ecosystem over a single year could lead to some incorrect assumptions and conclusions. The probability for error would be greatest if conclusions were based on the study of grazing impacts on small mammals only in 1986 when populations densities were extremely low. Error in management decisions could also result from using total fish response to grazing removal, without considering the impacts of stocking and sport fishing on salmonids (Rinne 1985, 1988a).

The varying patterns of vertebrate response we found are not unique to high elevation riparian systems in the arid Southwest. Low elevation areas, as along Queen Creek, apparently showed the same nonsynchronized patterns. At Queen Creek, 10 bird species were recorded only in this riparian island and 8 additional species had their highest densities in this recently created environment (Szaro and Jakle 1985). Using only bird response information, researchers and land managers could make erroneous conclusions about the overall value of mitigating riparian losses solely by changes in vegetative structure. Despite dramatic increases in bird populations in response to increased structural diversity of the vegetation upstream from the dam (Szaro and Jakle 1985), amphibian, reptile and small mammal populations did not respond in a similar manner (Szaro and Belfit 1986, 1987) (Table 2). Populations and species richness of these three vertebrate groups were actually lower than in the surrounding desert habitats. Moreover, use of the site by desert species has been restricted by the riparian stand. Some riparian vertebrate species typical of areas similar in structural diversity to Queen Creek were not found. This may be due to biogeographic considerations or the limited mobility of these species. Data from Queen Creek indicate that restoration of disturbed riparian faunas might require reintroduction of species, in addition to changes in vegetative complexity, to replicate full vertebrate community structure and richness at this and other riparian areas (Szaro and Belfit 1986, 1987).

Results of studies on the Rio de las Vacas and Queen Creek suggest that short-term, case history, descriptive studies of only selected species, although valuable, are lacking in generalizability. They do, in part, however, point to the necessity of conducting research that has pretreatment or "frame of reference" (Rinne 1988a) information, encompasses watersheds (ecosystems) and is of long-term (>5 years) duration. Treatments or manipulations (e.g., different grazing or timber-harvesting intensities) should be instituted, dictated largely by the pretreatment information on habitat and biota. Further, study should look not only for "cause and effect" relationships, but for the processes by which these occur.

In interwatershed comparisons, it is desirable for study areas to be as contiguous geographically as possible. The Mogollon Rim watersheds lie within a 50-kilometer area and are first-order streams issuing from beneath this major geological formation. Typically, such headwater riparian areas tend toward ecological simplicity, are more manageable from a research standpoint, should be more available for study from a

Table 2. Terrestrial vertebrate population estimates behind Whitlow Dam, along Queen Creek, central Arizona, 1981 (birds only) and 1982.

	Riparian		Desert	
	Interior	Edge	Wash	Upland
Amphibians and reptiles				
Number of captures	15	23	179	125
Number of species	4	6	12	10
Birds				
1981				
Density[a]	336	429	217	108
Number of species	22	25	30	24
1982				
Density[a]	437	445	326	145
Number of species	22	25	30	24
Small mammals				
Number of captures	2	12	49	19
Number of species	2	4	3	2
Vegetation				
Tree density[b]	1025 ± 128	911 ± 130	164 ± 22	109 ± 21
Shrub density[b]	279 ± 54	1221 ± 232	1555 ± 354	7283 ± 133
Herbaceous cover[c]	5 ± 1	4 ± 1	23 ± 4	11 ± 3

[a]Pairs per 40 hectares.
[b]Number per hectare.
[c]Percentage.

land manager's viewpoint, and should reduce or remove other uncontrollable factors that may induce unexplainable variation in data (Rinne 1985).

Currently, at mid-elevation riparian sites below the Mogollon Rim, we are beginning to study several stream systems over a number of years to determine vertebrate community dynamics under different grazing strategies. Because of different grazing histories on the six watersheds, a database that characterizes their present state is prerequisite. Such pretreatment information (2–3 years) is necessary to lay the foundation for ensuing viable and valid research design. Data collection from these six streams is ongoing, but preliminary analyses indicate that stream size and substrate fine content explain up to 80 percent of the variation in trout density and biomass in these first-order riparian areas (Rinne and Medina 1988). *A priori*, based on fishes, it appears that the Pine Creek watershed, which has not been grazed for 25 years, may serve as a "control" and may be best compared to Horton and/or Christopher creeks. Notwithstanding and in keeping with our thesis, data on the terrestrial vertebrates are needed before final decisions can be made concerning the most reliable and productive research approach or design needed to reach sound management.

Recommendations and Concerns

The basic requirements of scientific research are testable hypotheses, control of variables in time and space, replication of treatments, and an unbiased research area. The case history study on the Rio de las Vacas typifies the difficulty of achieving these basic requirements on national forest lands, even on a single stream. A researcher's lack of ability (authority) to control the varying degree of multiple uses on national forest land precludes determining the differential impacts of these uses. Management of habitats and vertebrate species by different federal and state agencies on the same lands further complicates the situation.

To date, replication in most grazing studies has been done linearly in treatments (pastures) on the same riparian system (Rinne 1988a). Although such a design removes interstream variability, it is certainly deficient in context of the functioning of aquatic ecosystems (Likens 1985). Despite the fact that terrestrial components within treatments or pastures are relatively confined and definable, the aquatic components are very dynamic. Water moves through these pastures and its quality is subject not only to upstream influences within the stream proper but those on the watershed as well.

To date, variations in results of research on grazing effects have resulted, in part, from faulty research design (Platts 1982) and, in part, from the arena available for study. Both Rio de las Vacas and Mogollon Rim study areas were made known to us by forest biologists. Basic to effective land management are clearly defined goals and the use of sound information on the effects of management on habitats and biota. Land managers need answers to specific questions, but have been offered contradicting results of poorly designed studies. Both researchers and land managers must remedy the lack of reliable answers and the lack of suitable study areas. Absence of a mutual contract between these two parties will undoubtedly result in continued production of research results that are readily and validly criticized by individuals and user groups alike and which most probably will not be applied in land management activities. In the end, it will be the resources, different in the eyes of each user, that will be adversely affected and, in some cases, exploited.

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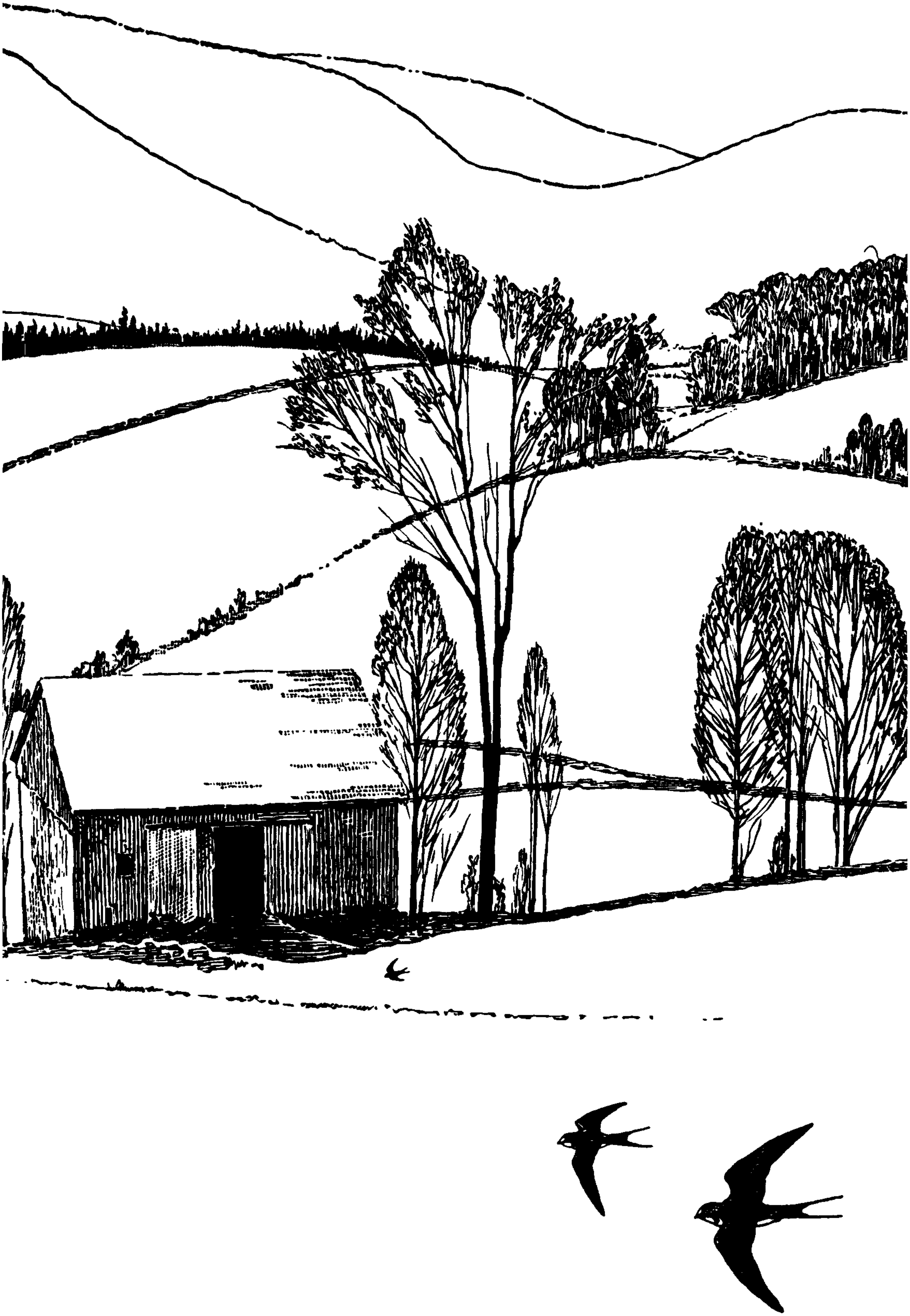

Special Session 8. *Progress and Needs in Wildlife Resource Education*

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Status of Extension Wildlife Programs in America

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Introduction

The future of wildlife conservation in America depends on the land-use decisions of private landowners, public land managers and policy makers at all levels of government. But the decisions of these people will benefit wildlife only if they have the knowledge necessary to understand the consequences for wildlife. Thus, educational programs are needed so people develop the understanding to make the "right" decisions regarding wildlife conservation.

Assuming the preceding statements are valid, no educational organization has greater potential to influence the future of wildlife conservation than the Cooperative Extension System (CES). Each year, CES programs bring up-to-date, relevant, research-based information on a variety of subjects to millions of people—individuals (youth and adults), families, groups, organizations, agencies and decision makers. Among the topics CES programs address nationally is wildlife conservation. Extension wildlife programs have been expanding in recent years and have had many significant accomplishments. CES has been and continues to be an important member of the wildlife conservation community.

This paper will review the history, nature, scope and impacts of CES programs relative to wildlife conservation. We will characterize recent and planned CES programming in wildlife conservation nationally.

The Cooperative Extension System

As the name implies, CES has a cooperative organizational structure involving three levels of government: (1) federal level—USDA-CES; (2) state level—state land-grant university; (3) local level—county Cooperative Extension associations. Cooperation occurs through systemwide program development, implementation, evaluation and funding. CES is a "grass-roots" organization because of the local level involvement in educational needs identification and program delivery. Increasingly broader perspectives are brought to program development by the state and federal partners, often moving the system from reactive and responsive programming to proactive programming on emerging issues. Thus, the partnership is complementary. Programs are responsive to the needs people have today (i.e., they are relevant), and anticipate or possibly help avoid problems in the future.

As Miller (1981) described, the CES ". . . provides factual, objective, practical, problem-centered and people-oriented information to enable people to help themselves—solve problems, make decisions, and take advantage of new opportunities. The people of each county, rural and urban, in every State and Territory in the nation are the point of delivery." In summary, CES is: (1) an educational organization; (2) cooperatively organized with links at the federal, state and local levels; (3) people-oriented; and (4) problem- or issue-focused. Additionally, CES is a nonformal educational organization—people participate in a CES program of their own volition because they perceive it to meet some salient interest or need.

Organizational Context

Historical Background[1]

The Smith-Lever Act of 1914 and subsequent amendments created the CES, which provided for cooperative agricultural extension work between the state land-grant colleges and the United States Department of Agriculture. The Smith-Lever Act focused on educational programs in agricultural and home economics subjects for rural audiences. However, some early conservationists who understood land-ownership and management needs perceived the potential effectiveness of an educational organization with a grass-roots delivery system. They encouraged use of CES to educate both landowners and resource users about wildlife conservation. Aldo Leopold (1929) stated, in *The Report of the Committee on American Wildlife Policy*, that "the enormous and powerful machinery for agricultural extension has so far not been employed." He was referring to the need for educational programs about wildlife conservation for farmers and other landowners.

In 1936, at the North American Wildlife Conference, Dr. C. B. Smith, Assistant Director of Extension, USDA discussed the need for extension wildlife specialists. He identified the need for two or three wildlife specialists at the national level to

[1]More detail on the historical development of wildlife programs in the CES are provided by Miller (1981).

cooperate with the U.S. Bureau of Biological Survey (precursor of the U.S. Fish and Wildlife Service) and U.S. Forest Service in promoting educational program development in wildlife conservation at the state and local levels. He also called for one or more persons in every state extension service to develop statewide educational programs in wildlife conservation. Dr. Smith concluded that ". . . the Extension Service is squarely behind this great conservation movement and will play its full part in stimulating interest and knowledge throughout the Nation in the how and why of wildlife restoration and conservation."

Despite the foresight, encouragement and support for the early and continued development of extension wildlife programs, the growth of this effort, although significant over the years in many states, was slow on a national level during the 45 years following Dr. Smith's statement. A chronology of CES program staffing in wildlife conservation follows:

- In 1936, a specialist was employed by USDA Extension Service to provide leadership for extension wildlife and fisheries programs. The same year, a specialist was employed by the Texas Agricultural Extension Service. The federal position was vacated in 1937 and not filled until 1969. The federal position was again vacated in 1970 and remained vacant until 1979.
- Between 1936 and the mid-1960s, because of the foresight of some state extension administrators and the needs expressed by land-grant colleges, state conservation agencies and private conservation organizations, a number of state extension services employed wildlife specialists. In 1960, 17 states had extension wildlife programs (Berryman 1960). By 1976, 23 states had such programs (Benson 1977).
- Probably the most important event in extension wildlife programming was the Renewable Resources Extension Act (RREA) (P.L. 95–306) of 1978. RREA "earmarked" funds (3D) to support natural resources programs. With RREA providing the basis for comprehensive natural resources educational programming, a National Program Leader for fish and wildlife programs was hired in 1979. RREA (recently reauthorized through the year 2000) gave impetus to expanded natural resources extension programs, including wildlife, across the nation. Although authorized in 1978 at $15 million annually for 10 years, no appropriations were available until 1982, when $2 million was appropriated. Appropriations since 1982 have ranged from $2 million to $2.5 million per year, with reductions from Gramm-Rudman-Hollings as mandated. For FY 88, the level of funding for RREA was $2.765 million. This funding, apportioned to states based on a formula, has enabled states to leverage Smith-Lever and other funding to strengthen natural resources programs and, in many cases, add positions. Nationwide, approximately 11 percent of the funding apportioned to states annually has been expended in support of extension wildlife programs. By 1980, 30 states had one or more extension wildlife specialists conducting educational programs (Miller 1981).
- Presently, 35 states have one or more specialists devoting all or part of their time to extension wildlife programs. Some state specialists have appointments that include research and instructional responsibilities.
- Another supportive and cooperative programming effort that began to bear fruit in the early 1980s was the coordination of program needs and funding between the Fish and Wildlife Service, Office of Extension Education and the CES.

These cooperatively funded programs helped leverage considerable expansion of needed programs and publications. These programs are continuing, but budget reductions in the last three years have reduced their impact.

Past Wildlife Program Focuses

Extension wildlife programs over the years have been based on needs perceived from several sources, and have varied from state to state. Little effort was made to focus programs on nationally identified needs. Consequently, programs generally reflected priorities identified at the state level by extension advisory groups, natural resource agencies and organizations, and the agricultural community. Nevertheless, programs largely were responsive to needs identified by county agents and their grass-roots clientele—private landowners and land managers.

The educational programs conducted by extension wildlife specialists have been identified in a number of papers over the years (including those by Bode 1937, Berryman 1960, 1966, 1977, Smith and Berryman 1962, Cornwell 1967, Almand 1969, Benson 1977, Swanson 1977, and others). Miller (1981) probably provided the most comprehensive list of extension wildlife program areas being addressed at the beginning of the decade of the '80s. Miller's list of program areas includes those that collectively received the vast majority of attention by extension wildlife specialists during the 1960s, 1970s and early 1980s.

National Initiatives for CES Programming

CES has recently undertaken a nationwide effort to concentrate its resources on eight national initiatives. Although these initiatives are still being clarified as the critical issues, goals and roles are being refined, they have been widely accepted by CES and various support groups at both federal and state levels. The eight national initiatives are:

- Competitiveness and profitability of American agriculture
- Alternative agricultural opportunities
- Water quality
- Conservation and management of natural resources
- Revitalizing rural America
- Improving nutrition, diet and health
- Family and economic well-being
- Building human capital

Two points must be kept in mind regarding the relationship of extension wildlife programming to these initiatives: (1) although most existing extension wildlife programs at the federal and state levels contribute to one or more of these national initiatives, this does not mean that other significant wildlife programs, planned or ongoing, will be abandoned because they do not fit into one or more of these initiatives; and (2) some states may concentrate their major extension wildlife efforts and resources into only some of these initiatives because of funding. Without further explanation, suffice it to say that the national initiatives will guide and influence extension programming over the next several years. Thus, extension wildlife programs can be expected to be developed within the context of these initiatives.

Modes of Extension Programming

The previous section presented the broad context for wildlife educational programming in CES. In essence, overall CES goals, national initiatives, and organizational structure represent the macro-theoretical framework for CES educational programming. Within these broad considerations, however, wildlife educational programs of various types are developed. Regardless of specific subject, programs typically take one or a combination of five general forms; these are the five modes of extension programming (Decker 1987): (1) evaluating and transferring information; (2) facilitating interaction; (3) stimulating change in practices; (4) policy education; and (5) personal development. These modes represent a theoretical framework for categorizing extension wildlife programs, regardless of specific content or audience. Brief descriptions of each mode of programming follow.

Evaluating and transferring information. To evaluate, synthesize and transfer relevant research-based information from the land-grant university system, USDA and other sources to the people who need it, in a form that will make the information easy to understand and use in decision making.

Facilitating interaction. To stimulate and facilitate interaction between individuals, agencies, organizations and institutions to "make something happen" that requires their mutual understanding or cooperation.

Stimulating change in practice. To improve people's ability and accelerate their progress in making decisions about implementing new practices by identifying and addressing their informational, educational and attitudinal needs.

Policy education. To empower private citizens, families, groups, organizations and public decision makers to identify and take action on the policy implications of a public issue by increasing their understanding of (1) the technical aspects of the issue, (2) public policy-making processes, and (3) opportunities for public involvement and influence, resulting in resolution of the issue.

Personal development. To build human capital by helping individuals develop a variety of life skills and personal knowledge, using subject matter from the land-grant university and other sources.

Different modes of programming are used to meet different kinds of objectives. This is where the notion and practice of nonformal educational *programming* are evident. People outside CES often do not grasp the comprehensive programming aspects of extension wildlife programs. They frequently equate "activity" with "program," probably because the activities and products (e.g., workshops and fact sheets, respectively) of Cooperative Extension programs are the elements readily observed by the public. A "program" is the entire series of learning experiences, related activities and products needed to meet the educational objectives established for a particular audience. The five modes of programming will be used later in this paper to depict the national situation for extension wildlife programming.

Extension Program Evaluation

Documentation of the impacts of extension wildlife programs has become increasingly important. At a general level are two types of program evaluation—formative and summative. Formative evaluation is aimed primarily at improving program; it is a monitoring activity to feed back information that can be used to adjust or fine-tune an ongoing program. Summative evaluation typically is used to assess the degree to which resources are used as specified and the impact such use has on people, wildlife or wildlife habitats. Ultimately, program evaluation generates information to serve program decisions—to modify, continue or terminate a program.

Many methods are employed across CES to evaluate programs. Surveys, pretest/post-test designs and analyses of secondary data (e.g., agency records) are common approaches to assessing program impact. As the decentralized nature of CES might suggest, some evaluations are local and narrow in scope. Others are broader—statewide and occasionally multistate in scope. We know of no comprehensive, national evaluation of particular extension wildlife programs. This makes it impossible to present a thorough assessment of the total impacts of such programs. Rather, examples will be used to illustrate the kinds of impacts extension wildlife programs have had on people and the wildlife resource.

Recent Program Experience

The Renewable Resources Extension Program accomplishment reports for 1985 and 1986 and the RREA five-year plan (1986–1990) provide a basis for an overview of the nature, scope and impact of recent extension wildlife programs nationally. The reports presented only accomplishments of programs supported by RREA funds; they did not include all extension wildlife program activity nationally. Nevertheless, they reflect the general character of extension wildlife programming. The percentages of RREA funds allocated by states for extension fish and wildlife, outdoor recreation, and environmental management and public policy programs were 36 percent and 17 percent for 1985 and 1986, respectively. Assuming half of the funds to these three areas was directed at wildlife programs, about $450,000 and $200,000 of RREA funds were spent on extension wildlife programs in 1985 and 1986, respectively.

The accomplishment reports indicate the principal topics for extension wildlife programs in recent years were (in order of greatest to least emphasis) habitat management, wildlife damage control, wildlife-related recreation enterprise development, and general wildlife appreciation and understanding. The target audiences for programs were: landowners (far and away the top group)—forestland owners, farmers, ranchers and residential property owners; youth; resource management professionals; recreationists (particularly sportsmen); and, infrequently, community decision makers and public policy makers. A variety of program delivery methods were used, including computer-simulation models, videotapes and other electronic media. However, traditional methods of extension program delivery such as face-to-face meetings (workshops, conferences, etc.), printed materials and demonstration areas were by far the mainstays for program delivery.

Documentation of program impacts is inconsistent. Where evaluations of program have been conducted, the results are generally impressive. Some examples of program impacts for the period 1983–1986 reported by USDA-Extension Service (1986) follow.

- Texas extension fish and wildlife management programs reached owners/managers of approximately 37 million acres, and helped them reduce losses from wildlife damage on 5.5 million acres. A 19-county pilot project to improve wildlife management and marketing of access opportunities on 2.3 million acres helped ranchers improve their annual income by over $7 million.
- New York, in cooperation with state and federal agencies, hosted the first Eastern Wildlife Damage Control Conference. A follow-up evaluation of more than 225 participants indicated the knowledge they gained resulted in savings of over $563,850 the first year.
- Colorado's educational programs for landowners/managers enabled participants to increase their collective income from fur trapping by about $700,000, reduce wildlife damage by over $450,000 and substantially increase income from wildlife enterprises.
- Louisiana's educational programs helped private landowners/managers improve wildlife and fish habitat management and control wildlife damage on more than 250,000 acres of lands, ponds and marsh, increasing the annual income to private landowners/managers by more than $4 million, and reducing losses from wildlife problem species by more than $1 million in 1984.
- North Carolina's educational program helped landowners/managers improve wildlife habitat on more than 80,000 acres, reduce damage caused by wildlife by 75 percent and increase income from wildlife resources (for some landowners) by more than 25 percent.
- Nebraska produced the Great Plains regional publication, "Prevention and Control of Wildlife Damage," an evaluation of which revealed an estimated potential annual savings of $16.3 million in time and resources for the people or agencies from 50 states, the District of Columbia and several foreign countries who purchased and used the handbook. Nebraska's efforts to double 4-H wildlife project enrollment since 1980 have resulted in the improvement of more than 2,500 acres of wildlife habitat on private lands annually by 4-Hers and volunteer leaders.

Current and Future Extension Wildlife Programming

CES recently completed two related planning efforts having considerable bearing on the nature of current and future extension wildlife programming. During 1985 and part of 1986, the second five-year plan for RREA was developed. During 1986 and part of 1987, CES developed plans for major programs (within states) for the period October 1987 through September 1991. Emerging from these planning efforts were the parameters for wildlife-related programming. The national initiatives discussed previously represent the major overall thrusts of CES programming for the near future; they encompass much of the program content resulting from the system-wide four-year planning. The 1986–1990 plan for RREA provides an approximation of the issues that the CES will be addressing in the near future, so we will use that plan as the basis for the following discussion.

Wildlife-related Goals of RREA for 1986–1990

Three national goals[2] identified for RREA are relevant to extension wildlife programming and to wildlife conservation nationally.

1. The national goal for wildlife management is to develop educational programs that will help landowners and managers of public and private lands, policy makers, and users to:
   - determine the best management practices to meet their wildlife objectives and understand how to implement those practices;
   - increase productivity and utilization of wildlife resources;
   - decrease economic losses, property damage and potential health hazards caused by some species; and
   - contribute to the formation of public policy that benefits wildlife, enhances the quality of life and is compatible with wise land-use principles.
2. The national goal for outdoor recreation is to develop and deliver educational programs that will help policy makers and owners, managers and users of land resources to:
   - recognize, plan and develop recreational opportunities; and
   - effectively manage outdoor recreational enterprises, consistent with other renewable resource uses and values.
3. The national goal of educational programs in environmental management and renewable resources public policy is to educate owners, managers, policy makers and users of forest and range resources about the role and value of sound management practices that maintain or improve renewable natural resources for environmental, social and economic benefit.

The second five-year plan (1986–1990) for Renewable Resources Extension Programming, as identified by the states, reveals that extension wildlife programs during the period can be expected to address five of the eight national initiatives (Table 1) and to operate in all five modes of programming (Table 2). The plan indicates the following issues are high priority for wildlife educational programs.

Improving habitat management. Landowners and managers need coordinated educational programs to help them learn to improve habitat management, develop management plans for economic returns and best utilize cropland retirement, conservation easements and set-aside programs to maximize profitability from alternative land use.

Wildlife damage control. Private landowners and managers need educational programs to learn how to use cost-effective technologies to prevent and/or control excessive losses caused by problem wildlife. Because wildlife damage control is an integral part of wildlife management, these programs provide a concurrent opportunity to teach landowners/managers to improve habitat management for and generate income from preferred wildlife species.

[2]The goals are paraphrased here; they can be reviewed in their entirety in "Renewable Resources Extension Program: Five-year Plan, 1986–90."

Table 1. National initiatives of the Cooperative Extension System addressed by extension wildlife programs aimed at RREA national issues.

Renewable Resources Extension Programming: national issues (1986–1990)	National initiatives							
	Conservation and management of natural resources	Revitalizing rural America	Alternative agricultural opportunities	Competitiveness and profitability of agriculture	Building human capital	Water quality	Improving nutrition, diet and health	Family and economic well-being
Wildlife and fisheries management								
Improving habitat management	X		X					
Wildlife damage control	X		X	X				
Resource management understanding	X	X			X			
Continuing education of professionals	X				X			
Conflict resolution/policy development	X	X						
Outdoor recreation								
Identifying and developing outdoor recreational enterprises	X	X	X	X				
Operating recreational enterprises		X	X	X				
Marketing recreational opportunities		X	X	X				
Environmental management and renewable resources public policy								
Improved decision making	X	X			X			

Resource management understanding. Critical decisions about wildlife management and use are better accepted when the public has accurate information about the purposes and scientific principles involved. Extension wildlife programs help people (adults and youth) understand wildlife management and the potential benefits that can be derived from investments of time and resources into improved management.

Continuing education of professionals. Extension wildlife programs play an important role in developing and conducting professional in-service training and continuing educational programs for other professionals for whom wildlife is an interest but not a primary focus. These programs also encourage interdisciplinary understanding and strengthen the communication, coordination and cooperation between agencies and organizations.

Table 2. Modes of programming anticipated for extension wildlife programs aimed at RREA national issues.

Renewable resources extension programming: national issues (1986–1990)	Mode of programming				
	Evaluating and transferring information	Facilitating interaction	Stimulating changes in practice	Policy education	Personal development
Wildlife and fisheries management					
Improving habitat management	X		X		
Wildlife damage control	X	X	X	X	
Resource management understanding	X	X		X	X
Continuing education of professionals	X	X	X	X	X
Conflict resolution policy development	X	X	X	X	
Outdoor recreation					
Identifying and developing outdoor recreational enterprises	X	X			
Operating recreational enterprises	X		X		
Marketing recreational opportunities	X	X	X		
Environmental management and renewable resources public policy					
Improved decision making	X	X		X	

Conflict resolution/policy development. A consistent nonadvocacy role by extension wildlife specialists is needed in educational programs to help resolve multiple-use conflicts and assist in providing a process for effective development of natural resources policy.

Identifying and developing outdoor recreational enterprises. Interest in the economic and enterprise potential of wildlife-related recreation on private lands is increasing. The economic returns to landowners serve as incentive for habitat management, and such management can provide excellent recreational opportunities for clients.

Operating recreational enterprises. Extension has made a significant contribution to educational programs that inform farmers about the conservation provisions of the 1985 Food Security (Farm) Act and the opportunities it affords to improve wildlife habitats. The profitable operation of wildlife-related enterprises can be enhanced by educational programs that help landowners to select and engage in management practices to produce the wildlife species desired.

Marketing recreational opportunities. Entrepreneurs need to understand the findings of studies on the characteristics of recreationists and wildlife recreation satisfactions so they can develop effective marketing strategies for their enterprises.

Improved decision making. Two elements of improved decision making are skill in decision-making techniques and access to relevant, reliable knowledge; extension wildlife programs play a critical role by delivering objective, research-based knowledge about wildlife resources to decision makers.

Conclusion

Extension wildlife programs will be addressing a variety of important issues in wildlife conservation over the next several years. Our evaluation of the nature and scope of anticipated programming indicates many opportunities for collaborative and cooperative efforts with the entire community of wildlife and other natural resources professionals, agencies and organizations. Although not discussed in this paper, many of the most valuable past programs have been such cooperative efforts. This will likely continue to be true in the future. The general evaluation of program emphases offered in this paper may help potential collaborators identify areas for cooperative programming.

In conclusion, extension wildlife programs have resulted in significant, documented impacts on people and wildlife resource. The national initiatives for CES provide a systemwide organizational context that will allow a breadth of programming related to wildlife conservation. The issues being addressed are important. If the programs are successful, they will continue to make valuable contributions toward wildlife conservation in America.

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Allocation Priorities Affecting Educational Programs Conducted by State Natural Resource Agencies

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Introduction

More than 40 years ago, Aldo Leopold (1940, 1942) foresaw the need to devote more resources and effort to public wildlife education. He expressed concern about the disproportionate level of human and financial resources being allocated to training professional wildlife managers rather than to broadening wildlife knowledge and appreciation among various segments of the American public. He contended that the posterity of wildlife resources depended not only on the effective management of these resources, but also on an informed public, particularly teachers.

While Leopold identified specific audiences for receiving wildlife education, it was not until 1975 that The Wildlife Society (TWS) provided goals and policies for implementing conservation education programming. TWS proposed a three-point policy, which emphasized developing and promoting educational programs, fostering interagency cooperation and communication, and establishing practical linkages between wildlife research results and educational programming (TWS 1975). However, there is evidence that suggest the wildlife profession has not responded well to the broad needs for public wildlife education and to these policy goals.

This evidence comes from two sources—a recent study of the attention given by the profession to wildlife education in its literature (Adams and Thomas 1986), and the present study of state natural resource agencies. The first study examined 9,078 articles published in four wildlife and two educational journals from 1973 to 1985. Among these articles, only 2.4 percent (N = 221) addressed wildlife education. The majority (n = 130) of those were published in the educational journals. Although findings indicated that the content and frequency of published research in wildlife journals dealt little with wildlife education, much was left to be determined regarding the contributions of state natural resource agencies to the public educational agencies. For example, in the present study, we assess resource allocation priorities to educational and other programs conducted by these agencies. We compare regionally

(1) the per-capita budgets for wildlife, fisheries, law enforcement, and information and education divisions within natural resource agencies, and (2) the per-capita budgets of their hunter and teacher education programs.

Method

In 1986, we conducted a mail-out survey following the Dillman (1978) method. Name and address information were obtained from the *Conservation Directory*. The survey instrument was developed and pretested according to the recommendations of division directors in Texas and Missouri. It was mailed subsequently to 49 state information and education (I&E) division directors. No structured I&E division was identified in Hawaii. Two weeks after the first mailing, nonrespondents were contacted to determine their receipt of the survey instrument and any difficulty with completing it. Two weeks hence, a letter and a second copy of the instrument were mailed to nonrespondents. The second mailing was followed, when needed, by telephone contacts.

The first of two sections of the survey instrument requested budget allocations made by the agency to wildlife (WM) and fisheries (FM) management, law enforcement (LE), information and education (I&E) divisions, and the agency overall. We defined "budget" as actual 1986 dollar allocations from all funding sources for each division.

The second section asked respondents to provide the dollar amount allocated to specific programs. We defined "programs" as activities or jobs identified in an agency's 1986 budget and which required specific personnel. Programs that were not available were excluded from summary calculations; in some state agencies, they were available but were not budgeted. These programs were treated as zero-budgeted. We focused our analysis on three programs (i.e., hunter education, in-service teacher education and Project WILD) because their audiences were more easily identifiable than those of other programs. This procedure also facilitated the calculation of per-capita budgets based on known populations of each group.

The 1986 annual operating budgets for the total agency, WM, FM, LE and I&E were adjusted per-capita. Mid-decade state population estimates were used in the per-capita calculations (U.S. Bureau of the Census 1986). Since population estimates generally underrepresent particular low-income groups and illegal aliens, per-capita values are maximum. Per-capita (PC) budgets were then averaged for each of nine census regions (Figure 1).

Results

Overall, agencies of 41 states (81 percent) participated in the survey; nonresponding states were Colorado, Connecticut, Georgia, Michigan, Minnesota, Mississippi, New York and West Virginia.

Variations in Agency Structures

Several variations of "typical" structural and functional features of departments of natural resources were observed and should be considered in data analyses. It became apparent during survey administration that the structure of these agencies

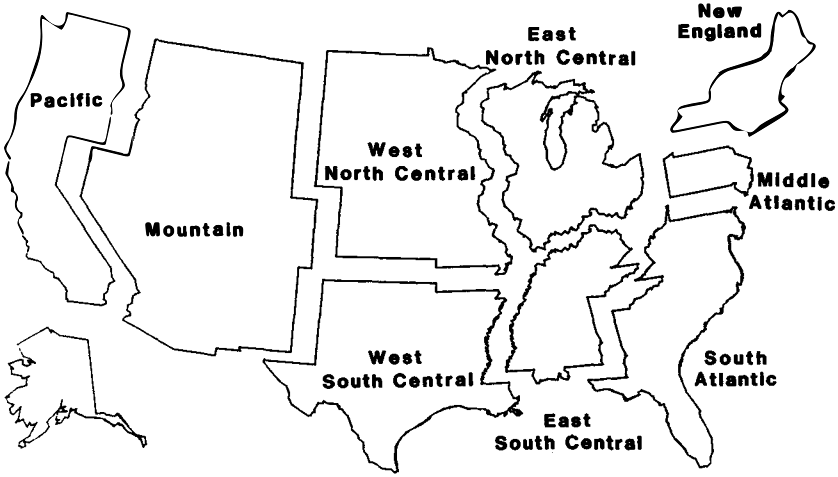

Figure 1: Study regions for examining budget allocation priorities of state natural resources agencies.

varied in terms of departmental titles, division types, personnel functions, budgetary-allocation procedures and educational program responsibilities within divisions. For example, wildlife law enforcement in Oregon and Alaska is handled by the highway patrol rather than by a natural resource agency. Hunter education is administered by the LE of WM divisions or highway patrol rather than by the I&E division in 16 states. In-service teacher education on wildlife in Illinois is conducted by the State Education Department rather than the Department of Natural Resources. Finally, several states reported that their operating budgets were undefined by amount or line item (Stone 1987).

Per-capita Budgets by Agency Division

Table 1 indicates that agency and division PC budgets varied among regions. The Pacific region had the largest average PC budget for the total agency. However, Alaska (PC = \$156.96) accounted for much of this high average. Compared with other regions, the Mountain (PC = \$18.48) and West North Central (PC = \$13.10) regions had the most states with consistently high PC budgets. The Middle Atlantic region (i.e., New Jersey and Pennsylvania) had the lowest average (PC = \$2.47) agency PC budget.

Among specific states, the highest PC budgets for the agency overall were reported by Delaware (PC = \$57.37), Wisconsin (PC = \$47.81), Wyoming (PC = \$43.23), Rhode Island (PC = \$33.15) and Montana (PC = \$32.52). The lowest total PC budgets were reported by Massachusetts (PC = \$0.86), New Jersey (PC = \$1.49), Ohio (PC = \$1.86) and Virginia (PC = \$2.62).

Regarding divisions within these agencies, I&E divisions accounted on average for 2.8 percent to the total agency budget. This compared with budget and personnel commitments of 14.5 percent for WM, 17.5 percent for FM and 16.3 percent for LE. Nationally, I&E divisions realized 83 percent lower budgets than other divisions. The national average PC budget by state natural resource agencies on information

Table 1. Regional population estimates (1985) and mean per-capita (PC) budgets (1986) reported by natural resource agencies (TA) and their wildlife management (WM), fisheries (FM), law enforcement (LE), and information and education (I&E) divisions.

Region (number of states)	Population estimates (1,000s)	Mean PC budgets				
		TA	WM	FM	LE	I&E
New England (5)	9,482	$12.22	$1.27	$ 1.59	$3.19	$0.25
Middle Atlantic (2)	19,409	$ 2.47	$1.44	$ 0.28	$0.44	$0.17
East North Central (4)	32,522	$17.14	$0.82	$ 1.04	$1.12	$0.12
West North Central (6)	13,361	$13.10	$1.90	$ 2.00	$1.80	$0.70
South Atlantic (6)[a]	31,665	$12.92	$0.76	$ 0.80	$1.75	$0.26
East South Central (3)	12,508	$ 7.66	$1.14	$ 0.70	$1.14	$0.33
West South Central (4)	26,443	$ 7.32	$1.20	$ 1.08	$1.70	$0.25
Mountain (7)	9,545	$18.48	$4.91	$ 4.30	$2.87	$0.94
Pacific (4)	33,774	$47.94	$8.00	$29.91	$8.32	$0.42

[a]Division data not reported by Delaware, therefore per-capita budgets are based on five states.

and education was $0.23. This was well below the average PC budget of $1.22 for WM $1.48 for FM and $1.38 for LE.

Regionally, the Pacific and Mountain states budgeted more per capita for WM, FM and LE divisions than did other areas of the nation (Table 1). Also, New England had among the highest average PC budgets for LE. None of the regions averaged $1.00 per capita for their I&E divisions. The Mountain and West North Central regions produced the highest averages of $0.94 and $0.70., respectively, for I&E divisions.

States having the highest and lowest PC budgets for each of the four divisions are identified in Table 2. Alaska, Wyoming, Montana and South Dakota had the highest PC budgets reported for each division. Wyoming (PC = $3.07) led the nation in 1986 PC budgets for its I&E division. In contrast, Illinois, Massachusetts, New Jersey, Ohio and Pennsylvania most often reported the lowest PC budgets. Illinois, Massachusetts and Ohio also had the lowest I&E PC budgets (PC < $0.10).

Per-capita Budgets for Educational Programs

Specific program emphases are examined in Table 3. It shows hunter and teacher populations, which are, respectively, the primary audiences for hunter education, in-service teacher education and Project WILD programs. Per-capita values were calculated using these population numbers obtained for each state. Regional averages were calculated subsequently.

Nationally, there were 13.5 million hunters and 1.7 million teachers in the responding states during 1985 (U.S. Bureau of the Census 1986). The sum PC budget for Project WILD was $61.37 ($\bar{x}$ = $1.70); for hunter education, it was $40.15 ($\bar{x}$ = $1.00); and for teacher education, it was $30.54 ($\bar{x}$ = $0.92).

Project WILD. Regional per-capita commitment to this program was greatest in the Mountain states (PC = $6.11) and lowest in the West South Central states (PC = $0.17). Six states had PC budgets of more that $2.00 (i.e., Wyoming—$26.18, North Dakota—$5.48, Nevada—$4.67, Utah—$3.70, Montana—$2.55,

Table 2. Highest and lowest state per-capita (PC) budgets reported by natural resource agencies for four major divisions.

Division	Highest state PC budgets	Lowest state PC budgets
Wildlife management	Alaska—$ 24.82	New Jersey—$0.22
	Wyoming— $ 15.68	New Mexico—$0.41
	Montana—$ 7.07	Ohio—$0.45
	South Dakota—$ 4.35	Massachusetts—$0.49
Fisheries management	Alaska—$105.65	Pennsylvania—$0.09
	Wyoming— $ 9.39	Ohio—$0.32
	Oregon—$ 9.31	Florida—$0.42
	South Dakota—$ 5.06	North Carolina—$0.45
Law enforcement	Alaska—$ 26.96	New Jersey—$0.29
	Wyoming—$ 6.88	Illinois—$0.43
	Maine—$ 5.32	Pennsylvania—$0.56
	South Dakota—$ 4.70	
	Montana—$ 4.70	
Information and education	Wyoming—$ 3.07	Illinois—$0.02
	Montana—$ 1.45	Massachusetts—$0.03
	Nebraska—$ 1.36	Ohio—$0.05
	Alaska—$ 1.09	Alabama—$0.06
		Maryland—$0.08
		Indiana—$0.09

and Idaho—$2.35). Ten of the 36 responding state I&E divisions reported no budgets; 5 states did not respond.

Hunter education. This program was most supported in the New England (PC = $2.03), South Central (PC = $1.95) and Middle Atlantic (PC = $1.10) regions. Every responding state agency had budgetary commitments to hunter education, unlike other programs. Most agencies had PC budgets of less that $2.00. The highest PC budgets were by Delaware (PC = $7.18), Rhode Island (PC = $4.12), North Dakota (PC = $2.72), Vermont (PC = $2.42) and New Jersey (PC = $2.05). The first two states provide and maintain special shooting areas as part of their hunter education program.

In-service teacher education. Among the nine regions, the West North Central states (PC = $4.28) had the greatest average per-capita support for teacher education; the Pacific states averaged the lowest support (PC = $0.00). None of the other regions averaged more than $1.00. Two states, Iowa (PC = $10.23) and Missouri (PC = $9.05), reported substantial budgets. Overall, 17 of 33 responding state I&E divisions indicated that they had no budgets for teacher education.

Discussion

Budget allocations reflect, in part, the programmatic priorities of natural resource agencies. These priorities are based on an agency's perceptions of constituency needs

Table 3. Regional 1986 mean per-capita (PC) budgets reported by natural resource agencies for hunter education (HED), teacher education (TED) and Project WILD (PW).

Region	Hunters (1,000s)	Teachers (1,000s)	Mean PC budgets		
			HED	TED	PW
New England	483	92.6	$ 2.03	$ 0.25	$ 0.46
Middle Atlantic	1,314	174.1	$ 1.10	$ 0.26	$ 0.22
East North Central	2,136	289.9	$ 0.38	$ 0.62	$ 0.79
West North Central	1,459	136.6	$ 0.78	$ 4.28	$ 0.98
South Central	1,753	275.7	$ 1.95	$ 0.33	$ 0.81
East South Central	1,274	108.5	$ 0.33	$ 0.00	$ 0.35
West South Central	2,549	273.4	$ 0.58	$ 0.70	$ 0.17
Mountain	1,029	90.8	$ 0.75	$ 0.33	$ 6.11
Pacific	1,556	240.8	$ 0.44	$ 0.00	$ 0.82
Total	13,555	1,682.4	$40.15	$30.54	$61.37
Responding states			40	33	36
Total program mean ($\bar{x}$)			$ 1.00	$ 0.92	$ 1.70

and tradition, and vary greatly between states. This study demonstrated that the educational component of wildlife management (Adams and Thomas 1986) is given budgetary recognition by most state agencies through allocations to their I&E divisions (Table 1). However, these allocations to I&E divisions are considerably lower than those for WM, FM, and LE. Regional variations in I&E per-capita allocations, particularly in the high range as evidenced in the Mountain and West North Central regions, may represent the results of establishing an historical precedent for and commitment to conservation education. For example, the Mountain Region is the origin of two, nationally recognized and utilized, conservation education programs, e.g., Project Learning Tree (PLT) and Project WILD (Adams et al. 1985). Both of these programs were developed through the cooperative efforts of Mountain Region educators, natural resource agencies and professional organizations. PLT and Project WILD became available in 1967 and 1981, respectively. In the West Central Region, the extensive public school, in-service teacher training and public conservation programs in Missouri are well-known. The Missouri programs are funded through a 1976 state constitutional amendment adding one-eighth cent to the state sales tax to provide funding ($26 million per year) for an expanded conservation program (Brohn 1977). Such events may explain why the I&E divisions in these two regions have higher-than-average PC budgets, when compared to other regions. Perhaps, the intensity of conservation education activity within these regions has raised the citizenry's level of awareness regarding the need for conservation education that, in turn, has led to larger budget allocations.

Average PC budget allocations of $1.70 and $0.92, respectively, for Project WILD and teacher education programs indicated that public school teachers are recognized by most state agencies as partners in the conservation education process (Table 3). Since both of these programs target teachers, the combined per-capita allocation for this audience or constituency is $2.62, compared with $1.00 per capita for hunters. An incorrect interpretation of these values is that agencies are allocating nearly three times more to teacher education than to hunter education. In fact, the products of mean program expenditures × total constituency revealed exactly the opposite result, e.g., for every $1.00 dedicated to teacher education and Project WILD combined, $3.00 were allocated to hunter education. Hunter education is a traditional and much-needed program because of its emphases on human safety and firearm training. However, investments in teacher education programs translate into far greater net-working potentials than is the case with hunter constituencies. On the average, each teacher has the potential of reaching 30 students annually. In our view, teachers represent a more well-organized, trained, advocacy group to increase public awareness and appreciation of wildlife values, when compared with hunters. A re-evaluation of the priority assignment given to hunter education when compared with teacher education at both state and federal levels, is recommended.

Finally, it should be emphasized that the results of this national study represent only one point in the historical development of conservation education programs within state agencies. Leopold's (1940, 1942) advise to allocate resources to public conservation education has occurred. The availability of future resources will depend on the ability to I&E divisions and state agencies to sensitize the public to a point where environmental and wildlife quality are integral components of human value systems. Preservation, conservation and enhancement of wildlife habitats should be a human imperative and consideration. I&E programs should have a high level of visibility and practicality if such human internalization of the conservation ethos is to be effective and pervasive in the long-term. Study findings on PC budget allocations to I&E divisions and selected agency programs cause one to question whether they may be insufficient for influencing or changing human attitudes and values, much less public opinion, on a prolonged, systematic basis across the United States.

Our society's high demand for wildlife resources requires informed and intelligent decisions regarding all aspects of wildlife management. This study provided baseline data on the budget allocations to WM, FM, LE and I&E. Applications of these data may enable agencies to identify their programmatic strengths and weaknesses. These data may also give the wildlife profession a better understanding of present emphases in the wildlife management process, leading to future management goals that more effectively target the majority public.

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Summary of Research Findings on Project WILD

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Introduction

There is a growing body of research related to Project WILD. This paper briefly describes the Project's overall approach to research and evaluation, summarizes some of the findings from a variety of studies related to the Project, and suggests a few additional areas in which interested researchers might contribute.

Approach to Research and Evaluation

Project WILD is a conservation and environmental education program designed especially for teachers of kindergarten through high school age students. Particularly because it is designed for a school audience, it is being developed with careful attention to educational standards for quality. The program's instructional materials undergo a variety of kinds of evaluation in the process of their development, and the Project's approaches to implementation of the materials are monitored and evaluated (Charles 1986a).

The process of education, by its nature, is difficult to evaluate with precision and accuracy. The most important outcomes of education are long-term, evidenced throughout a lifetime.

Compounding the difficulty of measuring the impact of a program like Project WILD is the fact that teaching about wildlife, habitat and conservation is not a priority within the curricula of the public schools of the United States and Canada. In order for wildlife education to become a part of public schooling, Project WILD's approach is to develop materials and support services to enable teachers to integrate wildlife-related instruction within the mainstream. The approach is, by nature, diffused. It is realistic, but its impacts are difficult to measure.

Despite these limitations, there is a variety of important and useful studies related to Project WILD. The sponsors of Project WILD conduct research as part of the development process to ensure the quality of the instructional materials. The sponsors also maintain an ongoing system for monitoring the quality of Project WILD workshops throughout the United States, and have, to date, conducted one major Survey of Use as a measure of the extent to which the Project materials are used by teachers following participation in a Project WILD workshop. In addition to research conducted officially as part of Project WILD, graduate students are undertaking an increasing number of studies.

Various and diverse approaches to evaluating Project WILD are needed, and should be conducted on a continuing basis.

Research related to Project WILD now exists in two categories—development and implementation. The major studies conducted to date are briefly described below.

Development

Development of Project WILD Elementary and Secondary Activity Guides

During the approximately three years of the initial development of the *Project WILD Elementary and Secondary Activity Guides*, traditional as well as innovative approaches to development of instructional materials were employed. Expert teachers, wildlife biologists and representatives of a variety of organizations with wildlife interest and expertise participated in a series of writing conferences. Instructional activities were developed to correspond to a conceptual framework that was reviewed for technical accuracy by literally hundreds of experts. The draft materials were reviewed and prepared for pilot testing. The pilot-testing phase was conducted by independent evaluators, removing the developers from the process of assessing the materials' effectiveness in accomplishing their stated objectives. Following the pre-testing process, the materials were revised and again reviewed for technical accuracy, educational validity, balance and fairness. At this point, during the 1982–83 school year, the Project WILD activities that were to become the basis for the *Project WILD Elementary and Secondary Activity Guides* were subjected to a field test conducted by independent evaluators. A summary of the findings of that study follows.

Project WILD evaluation: Final report of field test. M. Lynette Fleming (1983) conducted and reported this study. The purpose was to measure and interpret Project WILD's effect on students and teachers. Effects included changes in students' knowledge and attitudes about wildlife as well as teachers' reactions to the materials. This formal field test was conducted in three states, in three demographic areas within each state (rural, suburban and urban), and across all elementary and secondary grade levels. Two hundred fifty-nine teachers and more than 6,000 students were involved. The study employed both quantitative and qualitative techniques. The quantitative segment involved the development of cognitive and affective instruments for measuring change in students' knowledge and attitudes. The qualitative segment, based on ethnographic methodologies, included interviews, classroom observations and surveys.

Summarizing the results of this study, a few points may be made. Project WILD was found to be effective with kindergarten through high school students. Gains in student learning and attitude changes were greatest with the primary age students. The Project's success does not depend on grade level.

There was no significant difference in student learning when teachers received the materials through the mail or in a workshop, except with primary teachers. However, teachers generally indicated a workshop approach was preferred and positively affected their confidence in using the materials.

There were differences in student and teacher performance by state, apparently affected by the level of prior experience of teachers in using environmental education materials. There were gains in all states, though gains were smaller where the teachers had less background in teaching about wildlife and the environment.

Student success was not dependent on residence in rural, suburban or urban areas.

Teacher interest did affect student learning and attitudes.

Project WILD was used in an interdisiplinary manner, particularly in the elementary school grades. At the high school level, the greatest gains in student learning were found among students in language arts and English classes.

Fleming (1983) reported, "Student learning and attitudes about wildlife were positively affected by Project WILD."

She added: "The most significant finding in this study is differences in student performance across grade levels. Primary students gained most, followed by intermediate classes, then seventh through ninth grades, while tenth through twelfth grade students gained the least on both cognitive and affective measures." Contributing factors may have been that, "Elementary teachers were much more interested in teaching about wildlife than their secondary counterparts . . . . Elementary teachers did more Project WILD activities as well as a wider variety of activities than the other teachers." The more Project WILD activities a teacher used, the greater were the gains in student learning and attitude change consistent with the goals of Project WILD.

Following this major field test, the Project WILD activities were revised slightly to reflect some suggestions from the researcher. For example, changes were made in the format of the secondary materials to make them more obviously applicable to the traditional subject matter areas of high school teachers. Following these revisions, the materials were prepared for their first printing in graphic and typeset form, and made available officially for workshops to begin in the fall of 1983.

Implementation

Impact on Students

Evaluation report of the 1985 implementation of Project WILD in the elementary schools of Lee County, Florida. This study also was conducted and reported by Fleming (1985). The purpose was to determine the effects of Project WILD on kindergarten through fifth grade students in the Lee County, Florida schools. Student learning and attitudes toward wildlife were measured.

This study is similar to the major field test of the Project WILD instructional activities, described above. However, since it was conducted to determine the effectiveness of Project WILD with students in one school district—and was not used for purposes of revising the Project WILD materials as part of their development—it is included in this paper as one of the studies related to implementation of the Project materials.

In preparation for this study, 7 to 18 Project WILD activities were identified for each of the six grade levels (K through 5) to correspond to Lee County curriculum objectives. A control group was identified, which did not use any Project WILD activities. Project WILD activities were used by teachers in two other elementary schools in the district. One of these schools was also implementing a new science curriculum with a strong laboratory focus.

Based on an experimental/control group design, pretests were administered to students prior to instruction, and post-tests were given at the end of the experimental period. The instruments that were used were modified versions of those used during the original national-level Project WILD field test described above.

The three elementary schools involved in this study were identified as: "Control"—where no Project WILD activities were taught; "WILD"—the school implementing Project WILD as part of the district's instructional objectives; and "WILD+"—the school using both Project WILD and the district's proposed new science program.

Statistically significant differences were found across schools and grade levels on both the cognitive and affective instruments. The schools that implemented Project WILD were found to have made significantly greater gains than the Control school. Comparing cognitive gains, the WILD group did significantly better than both the WILD+ and the Control groups. The WILD school also differed significantly—in a positive direction, consistent with the goals of Project WILD—from the Control school on the affective, attitudinal measures.

Fleming (1985) reported: "The most surprising thing about this study is that, with the short amount of instructional time available, statistically significant differences were found in any areas. The trends seem very positive."

Use of Materials

Once the *Project WILD Elementary and Secondary Guides* were developed, the Project WILD model calls for these materials to be made available within the context of instructional workshops for teachers. The Project WILD Steering Committee, officially representing the sponsors of Project WILD, sets guidelines by which the Project WILD materials are made available. One component of these guidelines is a request for the materials to be offered free of charge to participants in Project WILD workshops of six hours in length. Procedures for reporting and monitoring these workshops were established from the beginning.

The data base for Project WILD at the national as well as at state levels is increasingly extensive. We know that, nationwide, Project WILD workshops actually average seven hours in length. We know that the Project WILD workshops are received enthusiastically by educators who participate in them. For example, analysis of data from the Participant Survey Forms that are used uniformly in Project WILD workshops throughout the 40 Project WILD states indicates that 99 percent of the workshop participants say the workshop they attended was either excellent or good. We continually monitor these forms. The results have not varied since 1983, when the Project's implementation first began.

Although we know that students in test conditions gain in knowledge about wildlife when their teachers use Project WILD, that student attitudes are positively affected in the direction of greater appreciation of wildlife and the importance of habitat, and that teachers respond enthusiastically to Project WILD workshops, the next valid question is, "Do teachers actually *use* the Project WILD materials with their students after they have participated in a Project WILD workshop?" One national-level and four state-level studies that address this question are summarized below.

1986 Project WILD survey of use and needs: Numerical summary of results. A questionnaire booklet comprised of 20 questions was developed, pilot tested and then mailed to a stratified random sample of teachers who had participated in Project WILD workshops from the fall of 1983 to the spring of 1986 (Charles 1986b). The questionnaire was mailed to a random sample of 20 percent of the teachers who had attended a Project WILD workshop in each participating state. There is no provision at present for address corrections on the mailing list at the national level, nor, because of cost, was an address correction requested. The questionnaire was mailed at bulk, nonprofit rates, with a standarized coverletter. This initial mailing was followed by a reminder postcard. Finally, another questionnaire with a second coverletter was mailed.

The survey population was 4,945. The rate of response was 49 percent. Analyzing the response rate on a state-by-state basis, it ranged from 29–71 percent.

A variety of interesting and useful questions was asked. Some of the responses are described here.

Of those responding to the questionnaire, 70 percent indicated that they used the Project WILD materials since the workshop. Within the 30 percent who had not yet used the materials, 63 percent said that they planned to in the future.

When asked their perception of student learning as a result of Project WILD, 91 percent of those responding said that their students had increased their awareness, knowledge, skills and/or attitudes related to "what wildlife is and what it needs in order to survive," and 87 percent related to "the overall importance of wildlife and its habitat."

Thirty-nine percent of the teachers responding said that, as a result of Project WILD, most of their students have "more responsible attitudes toward wildlife and the environment," 38 percent said "many," and 20 percent "some." Less than 3 percent said that very few or none of their students had acquired more responsible attitudes toward wildlife and the environment as a result of Project WILD.

When asked their goals in using Project WILD, 94 percent of those responding said, "to instill in students an appreciation of the importance of wildlife, its habitat and a healthy environment for both people and wildlife."

Although 86 percent of those responding said their reasons for using Project WILD in their teaching included "to be able to include concepts about wildlife and the environment in my curriculum," they also appear to be motivated by the inherent value of the Project WILD activities simply from an educational perspective—80 percent of the teachers cited as reason for using Project WILD, "to provide students with opportunities for learning that are interesting, useful, and instructionally sound," and 76 percent said "to support, enrich, and add variety to my teaching of basic subjects, skills, and concepts."

One particularly interesting finding is that 75 percent of the teachers responding have loaned or shown their Project WILD Activity Guide to at least one other teacher.

It is important to know how teachers actually use the Project WILD activities. They are designed for incorporation within a teacher's curriculum, based on that individual teacher's professional judgement. The materials are designed to correspond to skills and concepts typically included in school subjects including science, social studies, language arts and mathematics. However, given the nature of public schooling, it is up to the teacher to decide where and how to include attention to wildlife, habitat and conservation issues. Eighty-five percent of the teachers responding use Project WILD "by selecting and including Project WILD activities where appropriate in my existing curriculum." Not typical, but still appropriate and possible, 1 percent use Project WILD "as the basis for my total curriculum," and 4 percent "as the basis for a course I teach." Twenty-four percent use Project WILD "as the basis for one or more instructional units." This totals more than 100 percent because teachers sometimes selected more than one option.

Important to future planning for Project WILD, 67 percent of those responding said that, "It would help me if I were provided with additional materials from Project WILD to supplement the Guides, such as student worksheets and materials for learning centers." Signifying a reality of the public schools, 52 percent said it would be helpful if "I were given additional planning time in order to match up Project WILD activities with my existing curriculum materials."

Project WILD has either greatly or moderately increased the amount of time the teachers report spending on instruction about wildlife and the environment, with only 17 percent reporting no change in the amount of time, and less than 1 percent reporting a decrease in the amount of time spent.

The survey results provide insights into a variety of aspects of Project WILD's implementation. Space does not allow for additional description of the findings. In sum, this survey indicates that the Project WILD materials are being used. Based on the numbers of students the responding teachers indicated they actually teach using Project WILD, and applying formulas derived from these findings to the total numbers of teachers who had participated in Project WILD workshops from the fall of 1983 through the spring of 1986, it is conservatively estimated that more than 7 million students in elementary and secondary classrooms of the United States had received instruction through use of Project WILD during that period. The numbers continue to grow, and we will continue to monitor and evaluate our progress.

A statewide survey of Project WILD in Ohio. This study was conducted by Diane C. Cantrell (1986) at the request of the Ohio Department of Natural Resources, Division of Wildlife, and the Ohio Department of Education, Division of Inservice Instruction. It was a survey of the use of Project WILD in Ohio by participants who had attended a Project WILD workshop in the first year of the Project's implementation in the state.

This survey was also based on a questionnaire, mailed at first-class rates with a personal letter, a follow-up post card, and a complete second mailing with the questionnaire and a new coverletter. The survey was mailed to all those in Ohio who had participated in leadership workshops and were thus considered qualified to offer Project WILD workshops to others, plus a random sample of participants in introductory Project WILD teacher workshops. The response rate for completion of this 12-page questionnaire of 43 questions was 78 percent.

A wealth of information has been derived from this study. Its findings are generally consistent with those derived from the national-level Survey of Use that was conducted during approximately the same time period in 1986. For example, as with the national survey, 75 percent of the Ohioans reported loaning or showing their *Project WILD Activity Guide* to one or more other people. Ninety-four percent reportedly would recommend the materials to other educators; the national Survey found 96 percent indicating they would recommend Project WILD.

In addition to asking many of the same questions that were asked in the national survey, other questions were posed that the national survey did not address. For example, two-thirds of those responding had never heard about Project WILD prior to the workshop, and many knew little or nothing prior to attending. Forty-five percent wanted to attend the workshop because it "sounded interesting and fun"; 42 percent were "looking for new teaching strategies"; 31 percent were looking for new program ideas; 30 percent wanted to "learn more about wildlife"; 14 percent wanted to earn college credit; and 10 percent were required to attend. According to Cantrell (1986), "The majority of respondents attended the workshop on their own time (38% on weekends and 14% during vacations) while 37% received inservice release time (25% optional attendance and 12% required). Twenty-seven percent of all respondents received college credit." (It may be noted that some states have a higher percentage of teachers receiving college credit for participating in Project WILD workshops, and other states have a lower percentage than in this case.)

Ohio has data about the number of years of teaching experience and levels of education among those who responded to this survey. Thirty-two percent had taught for 16 or more years, 23 percent 1–5 years, 22 percent for 11–15 years, and 19 percent for 6–10 years; 3 percent had never taught. Forty-three percent had a Bachelor's degree plus additional hours, 23 percent had a Master's degree plus additional hours, 11 percent had a Bachelor's degree, 11 percent a Master's degree, 6 percent a high school diploma, 4 percent an Associate's degree and 3 percent a doctorate degree.

Participants in Ohio felt strongly that the workshop was helpful in preparing them to use the Project WILD materials. Follow-up after the workshop was not perceived as being strong. (From a national perspective, we would agree that follow-up of a continuing kind—offering additional workshop opportunities, materials and newsletters to enrich the teaching about it—is necessary. Additional work in this area is needed in all states; though some provide more continuing services than others.)

Eighty-one percent of the respondents reported using the Project WILD materials following the workshop. Sixteen percent of the 19 percent not using the materials were required to attend the workshop. Of those required to attend, 70 percent reported using Project WILD and 30 percent had not. According to Cantrell (1986), "This might suggest that those who are required to attend a workshop are less likely to use the materials afterwards." Further analysis of the Ohio data suggests that the rate of nonuse may have been influenced by the percentage of college students involved. Cantrell stated that, "College students represented 13% of nonusers while they only represented 5% of users. Many of the college students participated in Project WILD as part of a course they were taking and had not had the opportunity to use it yet. . . . In general, nonusers had less teaching experience and less education than users."

Cantrell (1986) concluded: "Based upon the first year of implementation of Project WILD in Ohio, it appears that the program is well regarded and well used by educators who have attended either a facilitator workshop or a teacher workshop. While the majority of these people are teachers (the targeted audience for Project WILD), the program serves a wide variety of educators as evidenced by the diversity of responses in the survey." She also recommended: "Since Project WILD serves a diversified audience, flexibility and variety should be emphasized as key elements in the implementation strategies. State leaders and facilitators should broaden their workshop approach to include effective followup."

Teacher use of Project WILD. This study has been conducted and is being reported by Dolly Zosel (1988), who has been actively involved with the implementation of Project WILD in Wisconsin. This study has been supported as part of her work with the Wisconsin Department of Natural Resources, co-sponsor of Project WILD in the state.

The objective of Zosel's study was to examine the use of the Project WILD materials by teachers who have participated in Project WILD workshops in Wisconsin.

As with the Ohio study of use, the Wisconsin findings are generally consistent with those found at the national level in the 1986 Survey of Use. Some of the same questions were asked, others were not.

A mail survey was conducted, and the response rate was 78 percent. Zosel (1988) noted, "Not only did respondents answer questions in the survey, almost all of them wrote additional comments on their experiences with the Project WILD program."

She reported, "Seventy-four percent of those responding used at least some of the activities. Of the 26% that did not use them, one half of these said they 'would use them but are not currently in a teaching situation where this is possible.' "

Zosel's study has yielded an important new finding for those of us working with the program at the national as well as state levels. The Project WILD Steering Committee recommends that the Project WILD materials be offered to teachers in instructional workshops of six hours or longer. We know from other research that the national average for workshop length is seven hours. We know from the national level Survey of Use conducted in 1986 that 80 percent or more of the teachers who participate in workshops of 10 hours or longer actually use the Project WILD activities with students. Zosel's study adds a new dimension by indicating clearly that *teachers who participated in workshops of seven hours or longer actually used more activities.* The combination of data from these two studies certainly lends support to the Steering Committee's strong recommendation for workshops of six hours or longer.

Another interesting and new finding from Zosel's study has to do with a characteristic of the teacher workshop itself. For many years, all Project WILD leadership workshops and many Project WILD teacher workshops have included a peer-teaching component. This is a time in the workshop when participants select a Project WILD activity and, with a short amount of time for preparation, actually teach the activity in an abbreviated fashion to other workshop participants. Zosel indicated that, "Teachers who had this opportunity to practice leading (activities) were more likely to use Project WILD and to use greater numbers of activities." Zosel also indicated that workshops that included this peer-teaching component had fewer teachers not using Project WILD at all following the workshop than did teachers in workshops where this component was not included.

Zosel has some data concerning another dimension for which we need additional research. She asked teachers if their students had been actively involved in any projects to benefit wildlife and the environment as a result of their experience with Project WILD. Thirty-eight percent of those responding said that their students had taken some action. Examples of action included building various types of bird houses and feeders, writing letters to politicians about wildlife issues, developing school nature areas, and doing volunteer work at environmental centers. One initiated a public information campaign in the community about wildlife issues. Some helped to restore prairie habitats. One was instrumental in the purchase and development of a school forest. Zosel noted, "Hopefully this is the tip of the iceberg. Some of these projects were done by first graders."

An assessment of the use and effectiveness of Project WILD by teachers and youth leaders in Oklahoma. This study was conducted and reported by Cindi Smith-Walters

(1988). It, too, employed a mailed questionnaire of 23 questions, sent to more than 2,000 Project WILD workshop participants in Oklahoma, accompanied by a personally signed letter. Two additional mailings were sent as reminders and encouragement to complete the questionnaire. The rate of response was 38 percent.

Again, the findings from this study are generally consistent with those of the national level Survey of Use conducted in 1986, as well as the surveys conducted in Ohio and Wisconsin, reported above.

In addition, this study included an analysis of urban, suburban and rural users of the Project WILD materials. According to Smith-Walters (1988), "No significant differences were found in their use, preferences, or attitudes concerning Project WILD."

Fifty-one percent of those responding to this survey indicated that they attended the Project WILD workshop "because they wanted to," 28.1 percent "attended voluntarily but were offered in-service or staff development points from their school," 11.1 percent "attended for college credit," and 8.9 percent attended "because they had no choice, attendance was mandatory."

Teachers in this survey were asked to rank order a list of educational aids that might be developed to assist them in using the Project WILD materials. According to Smith-Walters, "The most requested and highest in priority was wildlife resource centers for school districts," that would include a variety of tangible resource materials, including owl pellets, animal skulls, filmstrips and reference books. Smith-Walters stated that, "It is believed that dwindling school budgets and stagnant salaries of Oklahoma teachers have had an effect on the kinds and amounts of supplemental resource materials bought by schools and their staff. Teachers see these resource centers as a possible way to increase the amount of materials available to them for use with students." Another high ranking resource was described as "five to ten minute videos on wildlife concepts."

A case study analysis of curriculum implementation as exemplified by Project WILD in one midwestern state. This unusually detailed and thorough study, based on ethnographic research methodologies, was conducted and reported by Cantrell (1987). Cantrell examined the characteristics of Project WILD from a national as well as a state level and provided an analysis and description of factors that influence the use of Project WILD by teachers.

Cantrell (1987) stated: "The purpose of this study is to examine the process of curriculum implementation as exemplified by Project WILD in one midwestern state in order to increase understanding about this process and its relationship to what is currently known about curriculum implementation. The study uses naturalistic research techniques to follow the process from the national level to the actual use of the instructional materials in the classroom. It focuses on three major phases: 1) program adoption and planning; 2) inservice workshops; and 3) classroom use of materials."

The findings from this study also are consistent with those of the other formal studies related to Project WILD. The naturalistic approach in this study, involving literally hundreds of hours of interviews and observations, yielded a depth of insight and illustrations that is illuminating, interesting and useful. Given the breadth and depth of Cantrell's study, this brief description will only highlight some aspects of her findings.

One component of this study involved selection of a random sample of classroom teachers who had participated in a Project WILD workshop. Fifteen teachers were selected for in-depth interviews and observations. Of these 15 teachers, it was found that 13 (87 percent) had used one or more Project WILD activities with their students following their workshop experience. Two teachers (13 percent) had not used the Project WILD materials. Both of the nonusers were high school teachers.

Many of us who are involved with Project WILD have wondered about the impact of the activities that participants experience in Project WILD workshops. Cantrell (1987) found that participants tend to use the activities they experience in the workshop. However, she also found that teachers use additional activities. They find the activities simply by looking through the *Activity Guides* and finding activities that fit within their curriculum.

Cantrell reported, "When asked what criteria they used . . . the most frequent response related to complexity—easy to use, not complex, not complicated directions." Other criteria included correlation with the curriculum, whether the teacher found the activity personally appealing and thought students would, time involved to prepare or conduct the activity, ready availability of any necessary support material, and whether the activity taught important concepts in an understandable way.

The teachers' response to the effectiveness of the Project WILD activities was enthusiastic. Cantrell reported that, "Teachers cited a variety of evidence to support their belief that the activities were successful, that students enjoyed them, and that they achieved as a result of their participation in the activities."

She concluded that Project WILD is successful for a variety of reasons. Of the many attributes Cantrell cited, some of the most important factors contributing to its success, she believed, are its inherent flexibility, its respect for teachers' abilities and the quality of its educational materials.

Conclusion

Additional research related to Project WILD is needed. For example, we need to continue to monitor the quality of the program, making it possible to adjust and improve its materials and its implementation efforts. More research is needed with respect to student learning. Ideally, funding could be secured to conduct a longitudinal study to determine the effects of Project WILD on school students over a period of many years, into adulthood. Related to implementation, more research is needed to determine the comparative effectiveness of different workshop approaches—including length of time, components of workshops and kinds of follow-up services after workshops.

Within the constraints of present funding, research will continue in the following areas: (1) all new instructional materials will undergo expert review and formal pilot testing by independent evaluators; (2) implementation activities in all participating states will be continually monitored, including statistical indicators of progress and quality; and (3) another major Survey of Use will be conducted in 1990, including use of the *Project WILD Aquatic Education Activity Guide*.

The sponsors of Project WILD encourage graduate students, university faculty, school district evaluators, wildlife agency research specialists and other interested researchers to initiate studies related to Project WILD. The Project has limited funds and therefore typically does not provide financial assistance. However, the sponsors of Project WILD are pleased to cooperate with such efforts. Please simply contact me, Dr. Cheryl Charles, Director, Project WILD, P.O. Box 18060, Boulder, CO 80308–8060, for additional information.

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Effective Conservation Education by a Private Wildlife Organization: Teaching Children with *Ranger Rick*

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Introduction

Lester Brown (1981), in *Building a Sustainable Society*, observed that our future approach to environmental issues must differ substantially from our present approach; people will have to impose limits on human population growth, energy use and the depletion of natural resources. Until people appreciate that the quality of their lives is dependent on the health of their environment, then humankind has little hope of establishing a sustainable society.

Imparting such an understanding is a vital mission of conservation education. National conservation organizations, concurring with Hawkins and Vinton (1973:7) that "the solution to the environmental crisis . . . rests neither with scientists nor with government officials, but with a citizenry educated in environmental problem solving," have come to view their educational programs as fundamental to achieving their environmental missions.

Conservation education—teaches about the wise use of natural resources—is part of the broader domain of environmental education. Educators hope that people exposed to environmental education programs will ultimately become citizens who participate in solving environmental problems (Hungerford and Volk 1984). A number of environmental education professionals in both the formal and nonformal educational areas (Hungerford and Volk 1984) have agreed that the overriding goal of environmental education is "to aid citizens in becoming environmentally knowledgeable and, above all, skilled and dedicated citizens who are willing to work, individually and collectively, toward achieving and/or maintaining a dynamic equilibrium between quality of life and quality of the environment."[1] This environmental education goal encapsulates another essential mission of national conservation organizations—to make people not only knowledgeable about the environment, but to give them the skills to translate knowledge into environmental action.

Although research on the relationships between environmental knowledge, attitudes

[1]Adapted from Gary D. Harvey (1977), A conceptualization of environmental education. Pages 66–72 *in* J. L. Aldrich, A. M. Blackburn, and G. A. Abel, eds., A report on the North American regional seminar on environmental education, ERIC/SMEAC, Columbus, Ohio.

and behavior has been inconclusive (see Pomerantz 1985 for further discussion), educators largely believe that instructional objectives in environmental education must deal with all three areas (Hungerford et al. 1980). The educational methods used to encourage progression from environmental awareness to action are varied. The educational programs sponsored by the National Wildlife Federation (NWF), for example, are specifically designed with these different educational objectives in mind. They range from attempts to increase children's awareness and appreciation of the natural world through such magazines as *Ranger Rick* and *Your Big Backyard*, and such programs as "Backyard Wildlife Habitat" that instruct landowners in creating wildlife habitat, to Action Alerts that request citizens to become actively involved in the legislative process.

A significant component of the NWF's educational communications is its wildlife magazines. Historically, wildlife issues have elicited strong public concern (Kellert 1980). Studies have shown that the public responds enthusiastically to magazines and television documentaries that are devoted to wildlife (Fortner and Teates 1980, Pomerantz 1977, 1985). As a result, many conservation organizations have used the appealing nature of wildlife to teach broader messages about natural resource conservation and environmental protection (Hair and Pomerantz 1987). The fact that millions of people are members of conservation organizations such as the NWF and National Audubon Society and subscribe to their publications attests to the popularity of those publications. The question remains, though, do these publications effectively convey the conservation message?

Previous research has shown that the media, including magazines, newspapers, books and television, are a primary source of children's knowledge and have an important influence on their environmental attitudes (Eyers 1975, Fortner and Teates 1980, Pomerantz 1977, Richmond and Morgan 1977 inter alia). Studies of attitudes, values and cognitive development have shown that a significant time for acquiring knowledge and understanding about the environment is between ages 10 and 13 (Chemers and Altman 1977, Kellert and Westervelt 1983, More 1977, Pomerantz 1987 inter alia). Furthermore, the manner in which scientific or ecological material is presented affects learning (Pomerantz 1985, Ramsey and Rickson 1976, Robinson 1963).

Ranger Rick, published monthly by the NWF, afforded an opportunity to examine the effectiveness of a children's nature magazine in communicating environmental information to children. *Ranger Rick* is aimed at youth, ages 7 to 12, and focuses on basic ecological concepts, current environmental issues, and natural histories of a variety of plants and animals. The magazine carries a variety of articles, including features on the natural histories of animals, instructions for creating a backyard wildlife habitat, a puzzle or games page, letters from *Ranger Rick* readers, a question-and-answer page, and an adventure story. Scientific information is presented in straightforward objective manner, in storybook format, in verse, and from personal perspective. Color photos and illustrations are used extensively to depict wildlife and natural habitats.

The evaluation of *Ranger Rick* assessed the effectiveness of the magazine on children's environmental knowledge, attitudes and behavior, as well as the stylistic elements that contributed most to these domains. This paper presents the research findings and describes implications for using magazines for formal and nonformal environmental education efforts. We discuss how a private conservation organization utilizes this form of environmental education, and how its educational programs advance its environmental mission.

Methods

Multiple research methods were used to evaluate *Ranger Rick*, including: a content analysis of the magazine; a national mail survey of *Ranger Rick* subscribers; two pretest/post-test classroom experimental designs with elementary schoolchildren; and personal interviews of fifth graders. This paper reports primarily on the findings of the classroom study with fifth graders and the national mail survey.

Classroom Study

A pretest/post-test design was used in the classroom comparison of 491 fifth graders from 10 randomly selected elementary schools in Wake County, North Carolina. The schools were located in areas that ranged from rural to innercity. Two fifth grade classes in each of the 10 selected schools were assigned randomly to a treatment and control group. Both the pretest and post-test questionnaires were completed by 232 children in the treatment group and 259 in the control group.

In December 1981, both groups took a pretest questionnaire that was designed to evaluate the influence of *Ranger Rick* on (1) children's knowledge of basic ecological principles, common environmental problems, animals and plants; (2) attitudes toward animals and the environment; and (3) wildlife- and conservation-related behavior. Each student in the treatment group received a new issue of *Ranger Rick* during each of the months of January, February and March 1982. Teachers were instructed to distribute one issue of the magazine at the beginning of each month. Students were free to read the magazine during individual class reading time or to take the magazine home. No formal class discussion by the teacher occurred until after the post-test was administered. In April 1982, both groups took a post-test questionnaire (identical to the pretest), and then each student in the control group received three issues of *Ranger Rick* for participating in the study. (Details regarding questionnaire development and sample characteristics are provided in Pomerantz 1986.)

Questionnaire items were divided into four analysis categories—environmental knowledge, conservation attitudes, anthropomorphic attitudes, and wildlife-related behavior and desires. Multiple analysis of covariance (MANCOVA) (Lindeman et al. 1980) was used to identify significant differences between the responses of treatment and control subjects, males and females, and among children from the different areas of residence. Each set of post-test responses represented the dependent variables, and experimental group, sex, and residence were the independent variables. The pretest responses to the questionnaire items were the covariates. All reported adjusted means were calculated by adjusting the post-test mean by the mean value of the pretest mean, the covariate.

National Mail Survey

A second method used to evaluate *Ranger Rick* was a national mail survey. A mail questionnaire was sent to approximately 12,000 *Ranger Rick* subscribers nationwide. The sample was stratified by three geographic regions and by length of membership (long-term subscribers received the magazine > 2 years; short-term subscribers ≤ 2 years). After one mailing, 3,156 children responded, for an overall response rate of 26 percent. Due to the fairly low response rate, a telephone follow-up of a subsample (n = 205) of nonrespondents was conducted to determine non-response bias. A comparison of the telephone and mail surveys revealed that mail survey respondents were more avid *Ranger Rick* readers, more read other nature and science magazines and a greater percentage rated *Ranger Rick* as much better than other nature magazines. Mail survey respondents also had higher conservation attitude index scores than did nonrespondent subscribers.

The mail questionnaire was divided into two parts. Part I covered questions specifically about children's use and preferences of *Ranger Rick* magazine. Part II asked children about their conservation attitudes, anthropomorphic feelings and wildlife-related behavior. Part II questions were identical to those used in the classroom questionnaire for fifth graders.

The data from Part I were analyzed using Chi square tests to compare respondents according to length of subscribership, geographic region, area of residence, age and sex. Each category of questions in Part II (attitudes, anthropomorphism and behavior) was analyzed with MANCOVA to determine significant differences among four groups of respondents: (1) classroom control group; (2) classroom treatment group; (3) short-term *Ranger Rick* subscribers; and (4) long-term *Ranger Rick* subscribers. Age was used as the covariate in the analyses.

Results and Discussion

Knowledge

After a three-month exposure to *Ranger Rick* magazine, the mean total knowledge score of the classroom treatment group ($\bar{x} = 9.51$. S.E. $= 0.17$) was significantly higher ($P < 0.004$) than that of the control group ($\bar{x} = 8.50$, S.E. $= 0.30$). The children who read *Ranger Rick* increased their knowledge in portions of three different content areas, including animals, plants and ecological principles. The treatment group had higher scores on questions dealing with bird behavior, sea plants, game birds and forest ecology. In two other areas, marine animals and predators, children who read *Ranger Rick* had higher scores, though not significant to $P \leq 0.05$. The articles that presented this information ranged from five-page features with color photos to shorter articles with black-and-white illustrations. They were written in various styles, including straightforward narrative formats using scientific names and story formats that anthropomorphized animals.

Additional evidence of knowledge gain after reading *Ranger Rick* was provided by the preliminary research study of third through fifth graders, conducted in 1979 (Pomerantz 1980). In this study, *Ranger Rick* readers scored significantly higher than nonreaders on questions about ecological principles, environmental problems and animals. The two studies point strongly to the magazine's impact of children's knowledge in a variety of natural resource areas.

Attitudes and Behavior

By providing information in an engaging and entertaining way, *Ranger Rick* attempts to help children develop an appreciation of the natural world that will then be reflected in positive conservation attitudes and behaviors. To determine if children who read *Ranger Rick* magazine differed from those who did not, the national mail survey respondents were compared with the fifth grade treatment and control subjects for the classroom study. The two classroom groups did not differ significantly from each other in their conservation attitudes or behavior. Comparison of these two groups with short-term and long-term *Ranger Rick* subscribers did reveal attitudinal and behavioral differences.

Overall, mail survey respondents had higher index scores for conservation attitudes than did children from the classroom study. They expressed stronger conservation feelings on diverse issues, covering energy consumption, water pollution, overpopulation and habitat preservation. Children from the classroom study expressed more concern about the use of wild animals (Table 1).

The greatest percentage of children, 84 percent or more in all groups, expressed a positive conservation attitude on questions concerning water pollution and local environmental cleanup. Seventy-four percent or more responded positively to the issue of energy conservation. Fewer children (between 56 percent and 73 percent) expressed conservation ideals about issues of land use, air pollution, wildlife use and habitat preservation. When questioned about the problem of overpopulation, the

Table 1. Conservation attitude scores for classroom groups from fifth grade sample, Wake County, North Carolina and subscribership groups from national sample of *Ranger Rick* subscribers.

	Mean score (S.E.) of participating groups			
Attitude category	Classroom control	Classroom treatment	Short-term subscribers	Long-term subscribers
Water pollution*	4.39 (0.07)	4.40 (0.07)	4.65 (0.02)	4.71 (0.02)
Local environmental clean-up	4.38 (0.05)	4.34 (0.05)	4.44 (0.02)	4.38 (0.02)
Energy consumption*	3.95 (0.06)	3.97 (0.07)	4.28 (0.02)	4.40 (0.02)
Land-use regulation	3.56 (0.08)	3.58 (0.08)	3.44 (0.03)	3.52 (0.03)
Air pollution	3.81 (0.07)	3.74 (0.08)	3.81 (0.03)	3.84 (0.03)
Use of wild animals*	3.91 (0.08)	3.80 (0.08)	3.60 (0.03)	3.74 (0.03)
Habitat preservation*	3.75 (0.08)	3.86 (0.08)	4.05 (0.03)	4.14 (0.03)
Overpopulation*	1.64 (0.06)	1.64 (0.06)	2.20 (0.03)	2.15 (0.03)
Mean attitude score*	29.36 (0.24)	29.24 (0.26)	30.35 (0.10)	30.76 (0.10)

*Significant differences ($p < 0.01$) between the classroom groups and *Ranger Rick* subscribers.

MANCOVA results: Wilk's lamda = 0.924, $F(27, 10199) = 10.33$, $p < 0.0001$.

lowest percentage of children (≤ 14 percent) agreed that families should limit the number of children to two.

Three-fourths or more children agreed with a conservation approach when the questions required a societal rather than personal commitment. Fewer, between one-half and two-thirds, expressed a positive conservation attitude when they had to agree to limit personal behavior. Typically, fewer people will agree to conservation policies that involve making personal sacrifices (Eyers 1975, Perkes 1973), and this is well-reflected in these differences. Studies have shown that attitudes toward conservation issues differ depending on the area of concern. Specifically, Van Liere and Dunlap (1981) found that attitudes toward population issues differed from attitudes toward natural resources and pollution. The distinctly different attitudes of children, in this study, toward population regulation support their findings.

The most popular activities for all children were feeding wildlife, fishing, identifying plants and trees, and looking for wildlife. Except for hunting, significantly more mail survey respondents than children from the classroom study participated in a wide range of conservation and wildlife-related activities (Table 2). This is not to imply that the magazine was the sole or even primary motivator. The initial interest in nature activities most likely came form the child and/or parents, since these individuals obviously valued nature information enough to subscribe to the magazine. But for the subscriber-child, the magazine may provide direction in exploring the natural environment and demonstrating individual stewardship. For children exposed to *Ranger Rick* for the treatment period, the magazine may have provided motivation.

For example, children in the treatment group who were exposed to the magazine for only three months did show an increased desire to participate in outdoor activities. Children in the treatment group from urban settings expressed a greater desire to catch wild animals for nature study than did their peers in suburban and rural areas and urban children in the control group. Subjects in both the treatment and control groups cited two activities that they most desired to do but were not yet doing—writing to a government official on behalf of wildlife and helping a community in an environmental clean-up project.

Stylistic Elements of Ranger Rick

The national mail survey of *Ranger Rick* subscribers was also used to identify the magazine's components that most appealed to regular readers. The main reasons cited for reading *Ranger Rick* were: (1) to learn about animals (34 percent); (2) because it's fun to read (30 percent); and (3) to learn about conservation of plants and animals (25 percent). Ninety-eight percent of the respondents indicated they actually read the stories and did not just look at the pictures, and 84 percent found the language understandable. When asked what they liked most about *Ranger Rick*, the greatest number cited stories about animals (37 percent), followed by the adventure story (22 percent) and the pictures (19 percent). Respondents expressed little preference for reading about animals that live in faraway places versus those near their home. However, when asked which type of animal they most liked to read about, strong preferences emerged. The two most popular animals were deer (20 percent) and snakes (19 percent), followed by birds (14 percent) and rabbits (13 percent). Lions, insects, and fish were preferred by ≤ 11 percent of the respondents, and frogs were favored by only 3 percent. Respondents enjoyed reading about animals that are different and strange (51 percent) and about wild baby animals (43 percent), but had

Table 2. Participation in conservation and wildlife-oriented activities of classroom groups from fifth grade sample, Wake County, North Carolina, and subscribership groups from national sample of *Ranger Rick* subscribers.

	Percentage of each participating group			
Activity	Classroom control	Classroom treatment	Short-term subscribers	Long-term subscribers
Fed wildlife*	76.45	85.78	91.67	91.86
Fished	86.87	86.64	87.40	90.09
Identified plants and trees*	62.93	70.69	86.96	89.96
Looked for wildlife*	59.07	64.66	85.81	86.84
Caught animals for nature study*	23.55	29.31	82.57	83.71
Helped in community cleanup project*	31.66	41.38	47.46	50.44
Hunted*	37.45	43.97	22.46	22.35
Kept a wild animal for a pet	32.05	25.86	21.31	24.81
Wrote letter to government official on behalf of wildlife	7.72	9.91	8.02	10.86
Trapped animals for fur	3.09	3.88	1.59	2.15
Mean behavior score*				
$\bar{x}$ =	4.21	4.61	5.35	5.52
S.E. =	(0.12)	(0.12)	(0.03)	(0.03)

*Significant differences ($p < 0.0001$) between the classroom groups and *Ranger Rick* subscribers.

MANCOVA results: Wilk's lamda = 0.742, $F(30, 10432) = 37.21$, $p < 0.0001$.

little interest in stories about pets (6 percent). The majority liked seeing photos of scary or strange animals (65 percent), and 67 percent indicated they were not bothered when an animal in a story kills and eats another.

Respondents did not indicate a preference for reading about males or females in stories about children. Although more respondents said it did not matter if an adult or a child in a story taught them a skill (41 percent), 38 percent preferred to learn from an adult. The majority of respondents did the crafts, games and activities in the magazine—54 percent did them sometimes and 38 percent did them most to all of the time. Respondents typically read through an issue of *Ranger Rick* more than once—28 percent read it five times or more, 70 percent read it two to four times and 20 percent read an issue once. Sixty percent of the respondents read another nature or science magazine each month. The most popular magazines were *National Geographic* (29 percent), *World* (28 percent) and *Boy's Life* (17 percent). When asked to compare *Ranger Rick* with other children's magazines they read, 41 percent said it was "much better," 20 percent rated it a "little better," and 35 percent said it was "about the same as other magazines." Only 3 percent said it was a "little worse."

Research Implications for Conservation Education

The evaluation of *Ranger Rick* pointed out some of the more effective means of presenting conservation information, which could be used generically in other education communications. Clearly, *Ranger Rick* stories about animals were the most popular. The manner in which these stories were written and their subject matter influenced readers' preferences. A favorite *Ranger Rick* feature was the adventure story—the one column that anthropomorphizes animals in a storybook style. The magazine uses the adventure story as a primary means of conveying information about current environmental problems. However, the use of anthropomorphism to educate youngsters about the environment has often been criticized for its potential to create false perceptions about animals and their behavior. Research on *Ranger Rick* indicated that this did not happen.

In fact, *Ranger Rick* subscribers had a more realistic impression of the animal world than those in the classroom study who did not subscribe. On a series of questions designed to assess the degree to which children anthropomorphized animals, long-term *Ranger Rick* readers had the lowest anthropomorphism index scores. Furthermore, the human characteristics they attributed to animals were more accurate than were those of their peers who did not read the magazine. Love and meanness were two characteristics attributed to animals by more children from the classroom study, whereas thought and pain were the two qualities attributed by more *Ranger Rick* subscribers. These findings should allay some educators' fears about using stories that give animals human characteristics.

Pictures were also a favorite magazine feature. Nature magazines, whether for children or adults, abound with colorful pictures of plant and animal life. Initially, these photos can be used to stimulate interest. Research findings also indicated that magazine features that combine a detailed presentation of scientific information with a color photo display may more effectively communicate environmental information than do textbooks (see Pomerantz 1985 for a discussion of the comparison of magazine versus textbook stylization).

Conclusions

The classroom study demonstrated that children's knowledge of the natural world can be affected by a nature magazine such as *Ranger Rick*, and the national survey identified the magazine features that elicit children's most favorable responses. Also, mail survey respondents expressed more positive conservation attitudes, were more active in conservation and wildlife-related activities and less anthropomorphically oriented than children from the classroom study. Importantly, the majority of children from both studies indicated that magazines are their number one source of information about wildlife and the environment. These findings lend support to the use of nature magazines for effective conservation education.

Traditionally, nature magazines have been used for nonformal conservation education. *Ranger Rick* was created by the NWF in 1967 because few nature magazines existed to stimulate children's interest in the natural world. Today, this remains its primary objective, and its intended use is for leisure reading at home. The NWF recognizes, however, that the qualities that make *Ranger Rick* an effective nonformal educational tool can be applied to formal educational programs. Indeed, 76 percent of the mail survey respondents indicated that *Ranger Rick* helped them with their schoolwork in a variety of areas, including science, reading and art.

Different approaches are necessary to teach children in the classroom and a variety of educational programs have been created by the NWF for this purpose. Among them is a teacher's activity guide, *NatureScope*, designed to assist classroom teachers in hands-on environmental education activities at the elementary grades. A new supplement to *NatureScope* has recently been added, *Discovery Pac*, that tells how *Ranger Rick* articles can be transformed into classroom activities. This is one example of how an already successful nonformal educational approach can be combined with the necessary rigor of formal environmental education to communicate environmental understanding.

Ranger Rick is only part of a larger mosaic of conservation education programs developed by the NWF. As the research on *Ranger Rick* indicates, it is through such efforts that we can begin to impart an appreciation and understanding of the natural world that will hopefully result in a commitment to maintaining environmental quality.

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The Need for Wildlife Education Program Evaluation: A Case Study

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Introduction

Since the advent of the environmental awareness movement of the 1960s, many environmental and wildlife education curricula have been developed for the classroom. However, very few have been subjected to an evaluation (Borg and Gall 1983, Disinger 1981). One notable exception is Project WILD (Cheryl Charles personal communication: 1984). Curriculum developers who rely on intuition to determine the effectiveness of their educational efforts run considerable risk. The unknown tendencies of the curriculum cannot be adequately predicted even by those most familiar with the curriculum or the classroom. The least risk is that a curriculum may not achieve stated goals; worse, it may actually provide contrary results.

Rigorous curriculum evaluation reveals strengths and weaknesses in a curriculum. The evaluation may determine the appropriateness of the curriculum for particular educational settings (e.g., accelerated or special education students), identify subtle learning opportunities that were unknown to the curriculum developer, or detect misunderstandings that the curriculum may inadvertently convey.

The Evaluation Background section of this paper is intended to review some basic concepts of curriculum evaluation. The case study that follows illustrates not only the application of these concepts, but also reinforces the importance of evaluating the effects of curriculum development efforts.

Evaluation Background

Formative and Summative Evaluation

Evaluation can take place during curriculum development (formative) or at the implementation stage (summative). Findings of the formative evaluation are used to revise and improve the materials. In contrast to a formative evaluation, a summative evaluation facilitates making a decision to accept or reject curricular materials for a specific educational setting (Borg and Gall 1983, Scriven 1967).

Although a combination of formative and summative evaluation may be the ideal strategy, well-designed summative evaluations are often beyond the resources available to curriculum developers. The authors propose that formative evaluation be considered the minimal tool for curriculum development, and the focus of this paper will be on this approach.

Steps for Implementing an Evaluation

A comprehensive model for designing evaluations (adapted from Brinkerhoff et al. 1983) suggests the following steps: focusing the evaluation; designing the evaluation; collecting information; and analyzing and interpreting the evaluation results.

The first step, focusing the evaluation, prevents the evaluator from losing sight of the evaluation's boundaries. One method is to use established goals for environmental education, such as those suggested by Hungerford et al. (1980), to guide evaluations of environmental curricula. Alternatively, the evaluation could focus solely on selected goals (and objectives) established for the curriculum in question. Besides goals, the focus should also include the purpose, audience(s), specific objectives and limitations that the educational setting may present for the evaluation (Brinkerhoff et al. 1983).

To accomplish the second step, a variety of research designs are adaptable for curricular evaluation. For descriptive data, a treatment-test design is a simple and effective method for collecting teacher opinions. More complex designs are necessary for inferring changes in student knowledge and attitudes (Campbell and Stanley 1966, Isaac and Michael 1981).

Three methods commonly used for collecting information are tests or surveys, interviews, and observations. Sometimes, previously developed tests or surveys are available from the literature or from testing firms. If a standardized instrument that measures the content or attitudes delineated in the curriculum is used, many problems associated with developing a reliable and valid test are solved. To develop a survey or test, the evaluator first should review the objectives and outline the topics found in the curriculum. The evaluator then selects the most important topics and develops corresponding test items (Anderson 1972). A pilot test is useful to identify poor test items and to improve the reliability and validity of the instrument. Instrument reliability and validity may also be assessed by face validity panels and test-retest reliability (Isaac and Michael 1981).

Interview and observation techniques are usually more costly in time and money than testing or surveying. Interviewers or observers must be trained, and more time is spent with participants. However, interviewing allows the participants to elaborate on specific responses or actions. A further advantage is that the observer can describe, quantify and interpret classroom events from a perspective that teachers and students cannot provide.

The fourth step of the evaluation process is analysis and interpretation of the results. One key decision at this stage is determining the unit of analysis to be the school district, school, class or individual student. It is important that the unit of analysis matches the objectives of the evaluation. For example, if classes are of primary interest, then data should be analyzed by class and reported as class achievement, not student achievement. Burstein (1980:179) explained: "Studies using the student as the unit of analysis are more likely to yield accurate estimates of the factors influencing individual student achievement." Since each level of interaction offers a different perspective for analyzing the data, some studies may need more than one unit of analysis (Burstein 1980).

While the use of formative evaluation without a summative follow-up does not guarantee the revised curriculum will be successful in achieving goals and avoiding disaster, it does promise more success than does the use of an untried set of materials. The following study is a case in point.

Case Study of a Formative Evaluation

The evaluated curriculum, ''A Wild Grouse Chase,'' is a seventh through tenth grade science education unit sponsored by the Ruffed Grouse Society and developed by the Department of Fisheries and Wildlife, Michigan State University, for distribution in the Great Lakes region. This case study represents a functional yet relatively inexpensive formative evaluation applied to 32 Michigan teachers and their seventh and eighth grade students (Stout 1986).

The curriculum evaluation was a part of a four-step curriculum development process of curriculum design, field testing and evaluation, revision, and marketing/distribution. The purpose of the formative evaluation was: to determine the effectiveness of the curriculum in achieving objectives with students; to assess the acceptability of the curriculum to teachers; and to suggest needed revisions.

The curriculum components were an introductory filmstrip, student manual and teacher manual. The three- to five-week curriculum was expected to increase students' scientific skills and effective participation in small groups, as well as increase knowledge of some major ecology concepts (e.g., succession, population dynamics, habitat), the wildlife profession, natural resource decision making and ruffed grouse natural history. The curriculum followed a student-centered inquiry instructional method.

A complex assortment of objectives was evaluated using both individual students and teachers as units of analysis. Students were tested on knowledge and attitudes. Teachers' perceptions were collected on several dependent variables by survey and personal interview. Additional qualitative data were collected through: observation of one class using the curriculum; analysis of letters written by students from five teachers; and teachers' comments in telephone conversations or letters.

Also, an assessment of the student manual readability was conducted using the Fogg Index (Gunning 1953), which was chosen for its simplicity of application. Recent research suggests readability indices may differ for writing styles and can predict higher grade levels even though difficult words were previously defined. Readability indices do not measure comprehension. Revisions that simplify words or shorten sentence length may actually break the curriculum's continuity (Armbruster et al. 1985, Rush 1985, Smith and Smith 1984).

Sampling

A volunteer population was created by selecting teachers from the Michigan Science Teacher Association mailing list and interviewing five education administrators for names of potentially interested teachers throughout the state. A minimum of 20 teachers (10 teachers per group) was determined to provide an adequate sample, given existing budget constraints.

Using volunteers introduces some inherent bias into the sample. Volunteer participants have been documented to be more educated and intelligent, have more social approval, and are less conventional, authoritative, and conforming than nonvolunteers (Rosenthal and Rosnow 1975). In addition, they could be expected to be more interested in the subject matter and, therefore, in making the curriculum work.

However, these biases are assumed to simulate the market for this curriculum. The sample is not generalized to all teachers, but rather to those teachers in the educational system who are more interested in environmental education, wildlife education and/ or science education than are other teachers.

Initially, 35 teachers were recruited and randomly divided into experimental and control groups. Attrition due to changes in teaching assignments and other factors trimmed the number of participants to 17 experimental and 15 control group teachers, involving 871 experimental group and 694 control group students.

Experimental group teachers were asked to teach the curriculum and to pretest and post-test their students in return for a classroom set of the revised curriculum. Control group teachers who pretested and post-tested their students were also promised a classroom set of the revised curriculum.

Instrumentation

Since no existing instrument was found to be appropriate, one was developed for this evaluation. Attempts were made to establish some estimate of reliability and validity for the student test instrument. Experts in ruffed grouse management and environmental education reviewed the test to establish face and content validity. A pilot test was administered to an eighth grade class and subjected to item analysis. Weak items were revised or dropped (Isaac and Michael 1981).

Five topics for measurement were derived from the curriculum's goals—science, wildlife ecology and management, ruffed grouse natural history, wildlife values, and attitudes. The instrument contained 21 true/false, 22 multiple choice, 6 Likert scale, and 8 semantic differential scale items. Each semantic differential item (Heise 1970, Osgood et al. 1957) had six to seven adjective pairs (Figure 1). A simpler five-scale response format was chosen for seventh and eighth grade students, rather than the typical seven-scale response format.

Teachers were asked about: the curriculum's appropriateness of goals, objectives and content; class time required; student behavior; need for revisions; effectiveness of inquiry and small group methods; and the quality of curriculum components (student and teacher manuals, filmstrip).

Their opinions about the curriculum in general and about each specific activity were collected from two instruments. After teaching each activity, teachers completed two semantic differential scales (20 total adjective pairs), four open-ended items and

Science						
STRANGE	1	2	3	4	5	FAMILIAR
GOOD	1	2	3	4	5	BAD
DULL	1	2	3	4	5	FUN
INTERESTING	1	2	3	4	5	BORING
EASY	1	2	3	4	5	DIFFICULT
UNIMPORTANT	1	2	3	4	5	IMPORTANT
CAREER	1	2	3	4	5	HOBBY

Figure 1. Example of a semantic differential item from the case study.

one rating scale (five subscales) which evaluated that activity. After teaching the curriculum, teachers were questioned again to determine their evaluation of the entire curriculum (e.g., goals, objectives, instructional methods) and to obtain information on marketing strategies and demographics. The 31-item survey used Likert scales, semantic differential scales, dichotomous items, ranking and checklists.

Design

Changes in student knowledge and attitudes were tested using an experimental control group pretest/post-test design (Figure 2). The pretests were analyzed to check for any initial differences between the experimental and control groups or pretest variables. No significant differences were found. The same instrument was used both to pretest and post-test students to prevent the influence of differences between tests. If alternate unstandardized test forms had been used, the differences in the two instruments would have required a more complex quasi-experimental design (Glass and Stanley 1970). The control group was necessary to detect learning not associated with the treatment (e.g., learning from the pretest). No significant changes in test scores from pretest to post-test were found for control group students.

Results and Discussion

Results from both students and teachers suggested the curriculum was an effective and worthwhile environmental science unit. An analysis of covariance (ANCOVA) conducted on the students' post-test data (Table 1) indicated students learned about science, wildlife ecology, ruffed grouse natural history and management techniques, and changed their attitudes toward a more desirable response. The instrument did not detect any significant changes in wildlife values held by students. The Fogg Index applied to 10 random samples suggested an average seventh grade reading level.

A majority (65 percent) of teachers perceived that students had learned communication skills in small groups, and that all students learned major curricular concepts from the small group presentations. Teachers agreed that the curriculum's goals and objectives were appropriate for their classes, and approved of the curriculum content, format and instructional methods. Teachers were confident with inquiry techniques, but less confident using small groups. Responses indicated a workshop would increase effective use of the curriculum.

All teachers agreed that the curriculum worked well with high ability students. Most (71 percent) indicated average ability students could use the curriculum. Only 30 percent of the teachers felt that the curriculum was appropriate for low ability students. (However, one teacher commented that low ability students would learn from being in groups with high ability students.)

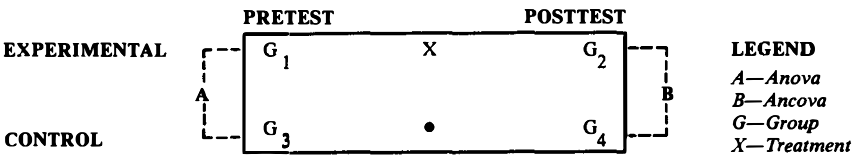

Figure 2. Experimental design and statistical tests from the case study.

Table 1. Analysis of covariance of post-test scores with pretest scores as covariate.

Scale	Maximum score	Group[a]	Mean	Standard deviation	df	F	Probability[b]
Science knowledge	20	Exp	9.4	3.5	870	43.0	0.001*
		Con	8.4	3.1	693		
Wildlife management knowledge	13	Exp	7.4	2.4	870	259.2	0.001*
		Con	5.7	2.1	693		
Ruffed grouse knowledge	5	Exp	3.0	1.4	870	468.3	0.001*
		Con	1.6	1.1	693		
Wildlife values	24	Exp	17.2	2.8	870	111.9	0.213
		Con	17.2	2.9	693		
Attitudes	260	Exp	175.7	19.7	870	112.8	0.001*
		Con	167.4	19.1	693		

[a]Exp = experimental group; Con = control group.
[b]= significant difference at 0.05 probability.

Curriculum length was identified as a problem by many teachers. Teachers preferred that curricular units of this type not exceed three weeks. Materials were revised so that a shortened version could be taught as an option to the longer version. Plans for using both versions were included in the revised teacher manual.

Perhaps the most significant result of the evaluation was that the curriculum had inadvertently generated some misunderstandings about ruffed grouse. More students (61 percent) responded on the post-test than on the pretest (29 percent) that ruffed grouse are *generally* scarce or endangered. Letters from students and observation of the class confirmed this finding.

The reason for this misunderstanding became apparent when we reviewed the curriculum unit. The unit presented a problem of a declining grouse population in a particular area and provided data for students to analyze in order to determine causes of the decline, and eventually to recommend management programs for increasing grouse numbers. The situation is common in local areas where early forest successional stages are replaced by less suitable grouse habitat. However, the notion of declining numbers had been "oversold" in the materials.

Students (and teachers) had overgeneralized the local problem used in the curriculum and inferred that this generally abundant species was being threatened throughout its range. It is noteworthy that this faulty design persisted even though the pilot materials had been carefully reviewed by a panel of experts in both wildlife management and education. Once identified, the problem was easily remedied during the revision. However, without an evaluation, this critical misunderstanding would have been perpetuated by further use of the materials in classrooms, and the goals and objectives of the curriculum would have been seriously undermined.

Concluding Remarks

Formative evaluation of environmental education curricula can be modified to meet the budget and resource constraints of curriculum developers. From the case study, it appears that the observation method is most informative for learning about the curriculum's use in the classroom. However, time and cost constraints usually preclude extensive use of this method, and mislearning by students may be overlooked unless student achievement is also assessed.

Surveying teachers via personal, telephone or written interviews is another alternative for evaluating curricula. The telephone survey method, although rather expensive, can provide a minimum criteria evaluation offering immediate feedback about curricular strengths and weaknesses. The less expensive mail survey method requires more time for feedback and quantitative analysis.

In this study, there was good agreement between teacher perceptions and student achievement. This supports the strategy of measuring teacher perceptions to assess curriculum effectiveness. However, teacher perceptions may not be adequate as a sole measure of curriculum effectiveness. One concern may be that teachers' own biases influence the evaluation (and perhaps the teaching) of a curriculum (Seimer et al. 1987). Further, agreement between teacher perception and actual student achievement was not strong enough to assure accurate assessments of some specific, critical questions of curriculum effectiveness.

There is a serious possibility that curricula may contain problems or create misunderstandings that are not anticipated by curriculum developers and consulting experts. These problems may exist in the curriculum activities themselves and/or may arise from teacher interpretation and use of the materials. Using two or more methods for gathering data is best for providing insights to improve the effectiveness of curricular materials and avoid undesirable results.

The importance of evaluating curricula cannot be overstressed. The wildlife management community is showing signs of turning to wildlife education as a key tool in future management programs. It is essential that wildlife education professionals apply the evaluation techniques that have been a traditional component of educational program development in order to monitor and improve our effectiveness in meeting the goals of wildlife education.

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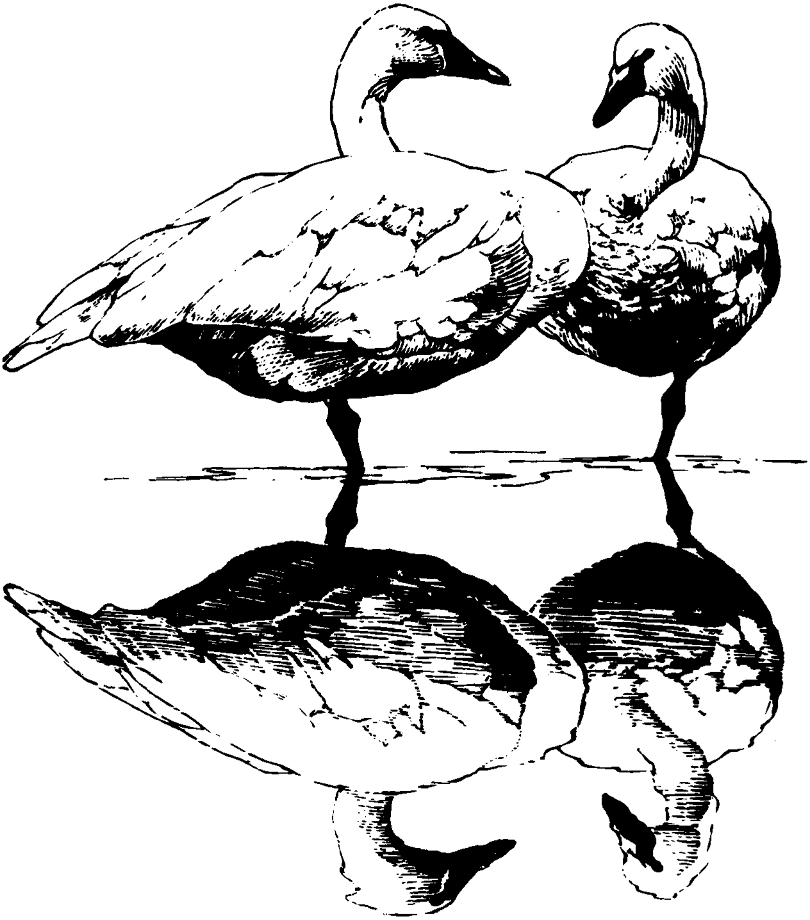

Special Session 9. *Aquaculture and Mariculture: Habitat and Management Implication*

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Aquaculture: An Overview for 1988

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Aquaculture was defined in the National Aquaculture Act of 1980 as the propagation of aquatic species in controlled and selected environments. This is an all inclusive definition that covers the culture of both plants and animals in freshwater, brackish water and saltwater. Animals include finfish, shellfish, and crustaceans and reptiles.

When plants and animals are cultured in brackish water or saltwater, the term mariculture is employed. A fish farmer is one who cultures fish for profit, whether the product is used for food, bait, as ornamental fish, for sale as weed-control agents–such as tilapia and the grass carp–or for stock-enhancement purposes. State and federal fish hatcheries conduct fish culture to produce finfish for stocking in the wild for enhancement of recreational fishing.

Aquaculture has been practiced for several thousand years. The first known publication on the subject appeared in 460 B.C. It was authored by Fen Li and entitled *Fish Culture Classics* (Parker in press).

In China, aquaculture has been integrated for over 100 years into the overall agriculture strategies of farming (Parker in press). The fish are fed with the waste plant and animal products resulting from agriculture.

The Japanese consume some 130 pounds (59 kg) of fish per year per person and, in order to supplement the wild fish captured from the ocean, utilize their wind-protected estuaries almost totally for mariculture. In this regard, Japanese estuaries are used as the Iowa farmer uses his fields. Instead of rows of corn, there are rows of cages, rafts and other devices for finfish, oyster, clam and seaweed culture. Absent from such ares are pleasure boats, fishermen, hunters or water skiers.

Aquaculture for enhancement stocking or introduction of new species is about 100 years old in the U.S. Aquaculture for food fish was started in the early 1950s for rainbow trout; catfish culture began in the early 1960s (Parker in press).

World aquaculture produced 2 billion pounds (907.2 million kg) of fish in 1966, but 21 billion pounds (9.525 billion kg) in 1982 (R. Wildman personal communication: 1987). Fifty percent of the fish consumed in Israel are cultured fish, while 30 percent of the fish consumed in China and India are cultured.[1] The U.S. production of aquacultural species in 1986 was only 500 million pounds (227 million kg). Such species primarily include rainbow trout, channel catfish, baitfish and ornamental fish.

Aquaculture has a very bright future, primarily because the world production of captive fisheries has seemed to peak at about 187 billion pounds (85 billion kg) annually (Food and Agriculture Organization 1987). Aquaculture currently represents about 12 percent of this total, but may double, triple or quadruple by the end of the century (R. Wildman personal communication: 1987). The National Academy of Science has predicted that aquaculture in the U.S. will produce 2 billion pounds (907.2 million kg) by the year 2000.

Aquaculture for stock-enhancement purposes also has a bright future. It has been estimated that by the year 2000, 60 million sport fishermen will take 800 million fishing trips. Our natural stocks of freshwater, brackish water and marine sport fish will not be able to supply this demand without hatchery supplementation. Hatchery supplementation of estuaries and oceans also is used for sea ranching of fish and shellfish for commercial harvest.

In fishery products, the U.S. currently has a $5 billion trade deficit, which will become greater as foreign aquaculture increases at a far greater rate than domestic aquaculture.[2] this is true because the domestic aquaculture suffers greatly from legal constraints. It is currently very difficult and costly to secure permits to establish aquaculture on one's own land and much more difficult to establish such operations in such public waters as estuaries, reservoirs, lakes and rivers.

Americans are eating more fish for reasons of health. We currently eat 14.7 pounds (6.7 kg) per capita, which is only about one-tenth the consumption by the Japanese. Nevertheless, a one-pound (0.45 kg) per-capita increase will be more than the catfish industry currently produces in poundage per year, and the catfish industry represents half of our current aquaculture production of 500 million pounds (227 million kg). This is not to imply that the increase in per-capita consumption will only occur from eating catfish or other aquaculture products.

What's in store for America? More aquaculture is the answer, because the price is right and the demand is increasing. Legal barriers to aquaculture in public and private waters will begin to lessen due to economic pressures. More ponds will be constructed on private lands, more intensive culture facilities that recycle water will be built—such facilities are low in consumption of water. More fish will be produced per acre as aquaculturists become more efficient.

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[1]Statement of R. O. Smitherman, Aquaculture Coordinator, U.S. Dept. of Agriculture, at hearing of U.S. House of Representatives' Committee on Science and Technology. 1986. 99th Cong., 2nd sess. (No. 119). U.S. Gov. Print. Off., Washington, D.C.

[2]Statement of B. Hougart, Aquaculture Coordinator, U.S. Dept. of Agriculture, at hearing of U.S. House of Representatives' Committee on Science and Technology. 1986. 99th Cong., 2nd sess. (No. 119). U.S. Gov. Print. Off., Washington, D.C.

New species such as hybrid striped bass, redfish, tilapia and saltwater shrimp will develop into significant industries (Stevens 1984). The opportunities among marine finfish species such as Atlantic salmon, other salmonids, and a host of warm and cool water species are virtually unlimited.

The cost to produce fish through aquaculture is decreasing, while the cost to capture wild fish is increasing. This provides a powerful incentive to practice aquaculture rather than to fish in the ocean. In addition, many captive fisheries are depleted and unable to reproduce sufficiently sometimes because of altered spawning and nursery habitats.

Research institutions both here and abroad have been working hand in glove with aquaculturists for 50–60 years. Research support in the field of nutrition, disease and bioengineering is available and increasing. Genetics in fish breeding has been practiced for years and, more recently, hybridization and triploidization have found favor. Really new is the implantation of the gene for growth hormone into the eggs of channel catfish, hopefully to increase growth through such genetic-engineering principles.

Aquaculture will continue to explode on a worldwide basis and also in America to the extent that we increase our consumption of fish.

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Parallelisms in Management of Fish and Wildlife[1]

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Introduction

With only minor differences in strategies and applications of technology, wildlife and fisheries sciences and management have similar developmental histories. Both deal principally with wild things in wild environments. Both have borrowed discoveries and technology from traditional fields of science, particularly the biological sciences. Even with habitats differing so greatly, fish and wildlife resources are subject to the same natural laws. Both fields have developed applied strategies: first, to produce goods of benefit to society; second, to provide extended recreation; and more recently, for ethical reasons, to extend protections to scarce forms of life and their habitats. Only minor differences exist in management strategies, mostly related to whether the organisms are warm- or cold-blooded vertebrates, and whether they live in a terrestrial or aquatic environments, both of which are subject to the same perturbations by human industries and influences on the land. Consequently, one should expect similar developmental histories of the two fields.

Leopold (1933) described the sequence of development of management strategies for wildlife to be the control of hunting (legislation), followed by predator control reservation of game lands (parks and reserves), artifical replenishment (restocking and restoration) and, finally, environmental manipulation (control of ecological requirements of wild things). Fisheries management strategies have followed somewhat similar paths (Benson 1970). Today, management of fish and wildlife includes a spectrum of habitat management and population management. They differ only in emphasis and products. Let's now look at some of the events that have shaped conservation and management of wildlife and fisheries resources.

Historical Parallelisms

Fish and wildlife stocks were considered practically inexhaustible from the time of settlement until the turn of the present century. Wildlife resources were there for the taking, and only a few people worried about the loss of habitat, the decrease in both sport and commercial catches of fish, and similar decreases in bags of upland

[1]Welder Wildlife Foundation Contribution No. 319.

birds and big game. During this period, however, regulations were about the only conservation measures used to protect wildlife and fish stocks. This period lasted through the 1920s. Palmer (1912) pointed out "that at the time of the Revolution, 12 of the 13 colonies had enacted closed seasons" on certain species, while several had also prohibited certain destructive equipment and methods and the export and sale of deerskins. All existing states had game laws by the 1880s (Leopold (1933), and market hunting was on its way out by the turn of the century. Over most of the land, however, laws lacked a sound base and were very feebly enforced.

The United States Fish Commission was established in 1871 as a result of diminishing stocks of saltwater fisheries off the New England coast (Reiger 1976). Spencer Fullerton Baird was made its first director. The Commission reported that commercial netters were most responsible for diminishing stocks of both saltwater and freshwater species. Nevertheless, its programs focused on restoration through culture, including propagation of the exotic European carp (*Cyprinus carpio*). The European carp came to be an unhappy result of "the fish culture idea" and our efforts to improve on nature by using exotics. While most fisheries were restored by natural reproduction, regulations to control catches were passed, and hatcheries to produce fish for restoring depleted stocks became the vogue.

At about the same time, in the late 1800s and first part of the 20th century, wildlife management also became entranced with pen-reared stocks of gamebirds. Sportsmen began to realize that the supply of native stocks were not inexhaustible and not present simply because of a beneficent providence. Private game farms were established by sportsmen's groups and, ultimately, by state and federal government agencies. Shooting preserves, *nee* game parks, also became a part of management strategies in the 1860s by wealthy sportsmen expecially in the East, and the setting aside of lands for wildlife finally culminated in state and federal lands for preserving wildlife and their habitats. Theodore Roosevelt's administration established 5 national parks, 17 national monuments and more than 50 wildlife refuges (Reiger 1976). The western United States was still virtually untouched, and hunting and fishing in that wild, open country was available to all who would journey to it. However, the introduction of several exotic fishes, including the carp and brown trout (*Salmo trutta*), and translocation of black bass (*Micropterus* spp.) into western waters had quite unsavory effects on native species.

The Lacey Act of 1900 was the most important piece of legislation protecting wildlife and fisheries stocks until the Federal Aid to Wildlife Restoration (Pittman-Robertson) Act was passed some 35 years later. The Lacey Act prohibited interstate commerce in these resources and thus prevented commercialization of products that had been responsible for declines in many species of fish and wildlife, especially birds and mammals.

Thus, fish and wildlife management ran parallel in providing recreational hunting and fishing during the early years. Both emphasized preservation of dwindling stocks of sport *and* commercial species.

By the late 1920s, it had become apparent that these strategies were useful but were not sufficient to protect wildlife and fisheries stocks. Losses of habitat and the decline in quality of game ranges were clearly the major causes of decreases in wildlife of both sport and commercial values. With Leopold's book, *Game Management*, published in 1933, a new era of wildlife management came into being.

Environmental or habitat management was the keystone of the philosophy. However, the uses of other strategies still had their place in producing and protecting wildlife species.

Similarly, manipulation of habitat became the principal strategy in fisheries management (e.g., Hubbs and Eschmeyer 1938). At about the same time as ecological thought began to shape wildlife science, control of pollutants, management of watersheds for protecting wetlands, uses of various stocks of forage and predator fishes in population management, and the creation of ponds and lakes through engineering programs became very much in fashion. Nonetheless, "put-and-take" fisheries with hatchery-reared stocks remained important fisheries programs in many state resource agencies. As better understanding of the resources was developed, regulations became increasingly tailored to management objectives and had stronger scientific bases.

Until the last two decades, and beginning in the 1960s, fish and wildlife management was, for the most part, game management. The environmental movement of the late 1960s and 1970s saw dramatic changes in programs—wildlife came to include much more than game, and state and federal agencies responded to the will of society to protect all forms of life regardless of their traditional, tangible or foreseeable values to society. Animal rights and welfare organizations became prominent in conservation affairs and, while they threatened hunting and fishing recreation, their impacts were important urging in protection of scarce forms of life. Diversity and multiple-use management became key perspectives and goals of conservation organizations in and out of government.

The environmental movement affected both wildlife and fisheries sciences. The Endangered Species Preservation Act of 1966, the National Environmental Policy Act of 1970, and the Fish and Wildlife Conservation Act of 1980 undoubtedly were the most important pieces of legislation affecting wildlife and fisheries stocks, game and nongame, since the Pittman-Robertson Act of 1936 and Dingell-Johnson Act of 1950. It is interesting to note that wildlife legislation usually preceded, but not by many years, similar legislation for fisheries. Terrestrial wildlife apparently was able to capture the interest of society more quickly than did fisheries. Sportsmen—i.e., hunters and fishermen in most cases—were in the forefront of conservation efforts that resulted in legislation protecting all forms of life, game and nongame.

Current Parallelisms

Commercialization of wildlife and fisheries resources is the current management trend in many areas of the world. Hunting recreation is becoming a valuable, saleable commodity, especially on private lands where management can integrate production of game with conventional agricultural products.

The shooting preserve concept in wildlife management, wherein pen-reared birds were released in put-and-take systems, still has considerable favor, especially near cities and where native stocks are insufficient to provide hunting opportunity for all who wish to go afield. Many state wildlife and fish departments still operate farms for producing pheasants for release, and the number of shooting preserves has increased since the 1950s when they showed some decline (Kozicky 1987). It is expected that stocking of pen-reared game will expand as land resources and habitat decline in amount and quality.

The parallel to commercialization of wildlife in the fisheries resources is fee fishing. Private fee-fishing enterprises are largely restricted to urban and suburban areas, where high demand allows adequate profit margins. With recent attention to providing recreational opportunities for urban residents, public agency involvement with urban fisheries, based on both captive and wild stocks, has expanded substantially (Allen 1984). Both public and private production of fish for put-and-take and put-grow-and-take is being employed to supply this need.

Fee hunting and fishing and other forms of extended recreation for which charges are made have been extremely valuable in promotion of management for wildlife and fisheries resources (Teer 1968, Burger and Teer 1981). The system takes many forms, from outright leasing of land for exclusive use by the lessees to safari-type systems in which hunters are guided for taking game or on photographic missions. This may occur on both private and public lands. The two, large, public land agencies of the federal government, the Bureau of Land Management and the Forest Service, are considering fees for extended recreation on public lands, especially in the 17 western states. Parenthetically, we might add that the matter of commercialization of extended recreation in the western states is a very controversial matter. Nonetheless, if experiences of developing nations in conservation affairs have a lesson for the affluent ones, it is that we can expect the marketplace to be the major determinant of land use on both private and public lands. Wildlife habitat is in the balance and, thus, the new trends in fee hunting on private lands and fee fishing in managed streams and fish-out ponds are important to the future of wildlife and fisheries resources.

Fish culture has re-emerged as a two-pronged influence in fisheries management—the generally public production of fish for stocking primarily for recreational purposes, and the generally private production of foodfish, commonly regarded as aquaculture. The role of fish culture in fisheries management is on its soundest basis ever (Stroud 1986), nevertheless, the role of public hatcheries, especially at the federal level, has been frequently questioned (e.g., U.S. Fish and Wildlife Service 1986) in light of improved availability of sport fishes from commercial sources.

Aquaculture is a less definite parallel to commercialization of hunting recreation. Perhaps it is more appropriate to compare it with production agriculture, because it comprises a system whereby animals are penned, fed, and otherwise husbanded and harvested much the same as feedlot livestock. Many species can be carried through their entire life cycles in captivity, and the use of fish for producing food is an economically important and growing industry throughout the world. Nonetheless, at the present time, stocks of fish for aquaculture commonly have their origin from wild stocks. Likewise, the nation's waterways are subject to escape of cultured organisms and influence from aquacultural enterprise discharges. These effects, along with those of wildlife habitat disruptions through land modification for aquaculture, reiterate the similarities of aquaculture to agriculture. With our current knowledge of ecology, both aquatic and terrestrial, and our understanding of the parallelism of our fields, we should be able to have rational, multiple-use development to our mutual benefit.

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Mariculture:
An Aid or Hindrance to Management

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Introduction

Natural production can no longer satisfy the growing global demand for fish and shellfish. Analysts estimate that aquaculture provides at least 10 percent of today's global harvest, and a doubling of aquaculture production is expected by 2000 (Anonymous 1987a).

Biological, economic and social implications of aquaculture are receiving increased attention by fishery policy makers and managers. This report describes trends in global fisheries and aquaculture, provides examples of progress in mariculture, and discusses some institutional prerequisites for continued progress of aquaculture.

Global Growth of Fisheries

There have been three periods in growth of world fisheries since World War II. The first lasted more than two decades and was characterized by rapid growth (6.0 percent per year). The second lasted one decade and was characterized by slow growth (0.3 percent per year). A third period has been underway for nearly a decade. It is characterized by intermediate growth of about 3.0 percent per year. Figure 1 illustrates these changes in global harvest.

There was a rapid build-up of distant-water fishing fleets after World War II—notably by Japan, USSR, South Korea and several European nations. National goals were initially to supply domestic markets and subsequently to engage in foreign trade in fishery products. Harvest nearly quadrupled from capture fisheries during the 1950s and 1960s, but aquaculture remained a minor contributor. Many desirable natural stocks became depleted. Coastal nations began to exercise control over foreign fishing fleets in the 1960s. Most had declared jurisdiction over fishery resources within 200 nautical miles of land by the mid-1970s. International treaties to protect certain pelagic species (namely, salmon and tuna) from overharvest also became more effective in the 1970s.

The decade of the 1970s was a period of change in management regimes for marine fisheries. Uncontrolled harvest was ended on many fishing grounds, and management for conservation goals was becoming more effective. Global growth of harvest of natural stocks was virtually at a standstill. Interest in aquaculture was increasing, and new aquaculture technologies were emerging.

Growth of global harvest resumed in the 1980s. Factors contributing to this resumption include: important marine stocks are now managed to avoid overharvest; fisheries are being developed on previously underutilized species; and Aquaculture has become a growth industry.

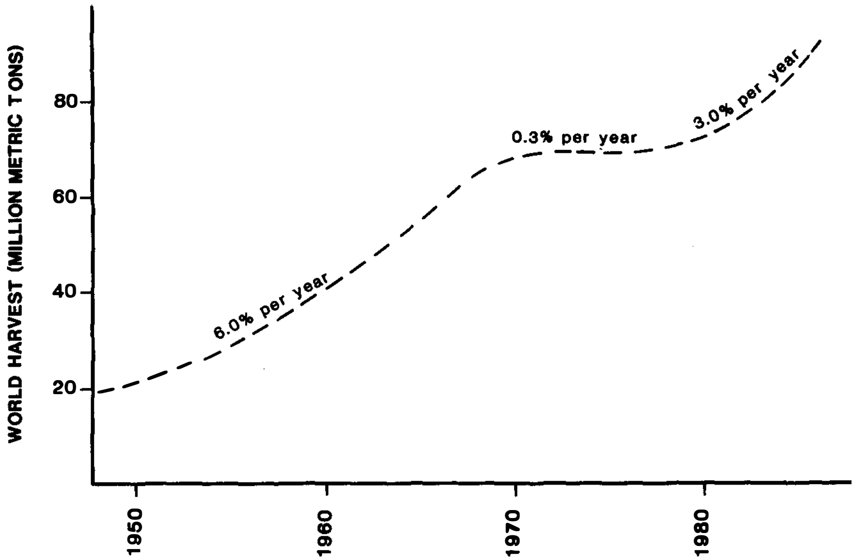

Figure 1. Rates of growth of world harvest of fish and shellfish.

Trends in Aquaculture Production

Global aquaculture production presently appears to be about equally divided between freshwater and marine waters. Fish production is dominant in freshwater and shellfish production in marine waters.

Few countries report accurate statistics on aquaculture production. Much of the global production resulting from stocking of natural waters with hatchery juveniles (ranching) is incorporated in statistics for capture fisheries. So estimates of aquaculture production are likely to be conservative.

It has been estimated (Anonymous 1987b) that aquaculture production (exclusive of plants) was 8.7 million metric tons in 1983, or about 11 percent of the total global harvest of fish and shellfish. The forecast was for a 0.3-percent annual growth of capture fisheries and a 5.5-percent annual growth of aquaculture from 1983 to 2000. Based on these projections, aquaculture would contribute 23 percent of the global harvest in 2000. However, increases in global harvest reported by the Food and Agriculture Organization of the United Nations for the period 1983 through 1986 (Figure 1) show that total growth has been about 3.0 percent per year. If one assumes that aquaculture production will continue to grow at 5.5 percent per year, and total harvest at 3.0 percent per year, the relative contribution of aquaculture to global harvest of fish and shellfish in 2000 will be 16 percent (Figure 2).

Mariculture

Seafoods are widely recognized as a healthful source of nutrients for humans, and per-capita consumption is increasing in many countries (Nierentz and Josupiet 1987). Annual per-capita consumption of seafoods by Americans remained near 11 pounds

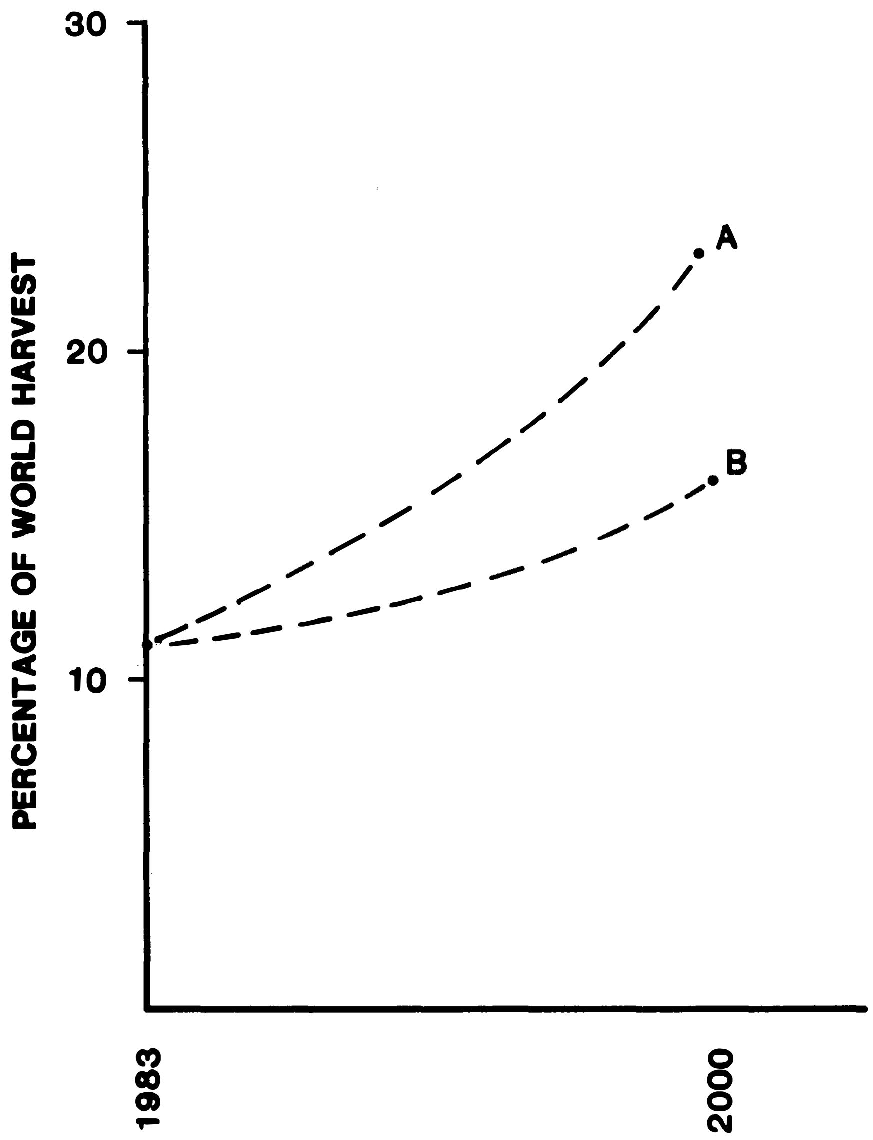

Figure 2. Predicted contribution of aquaculture to world harvest of fish and shellfish in 2000. Curve "A" assumes 0.3 percent annual growth of capture fisheries and 5.5 percent annual growth of aquaculture. Curve "B" assumes 3.0 percent annual growth of total harvest and 5.5 percent annual growth of aquaculture.

(5 kg) for decades, but it began to increase slowly in the 1970s, reaching 14.8 pounds (6.7 kg) in 1986 (Anonymous 1987c). If per-capita consumption continues to increase at the present rate (2.0 percent per year) consumption by Americans will double by 2020.

A growing world demand for seafoods results from combined effects of growth of population and per-capita consumption. Natural stocks are incapable of satisfying demand for many high-valued seafoods. Prices are increasing, and there is growing interest in mariculture. Examples of developing mariculture industries are described below.

Yellowtail

Japan has placed considerable emphasis on mariculture to compensate for restrictions on high seas fisheries imposed by extended jurisdiction laws enacted by most coastal nations. A broad variety of seafoods are grown in Japan. One early success was with yellowtail (*Seriola quinqueradiata*), a marine fish belonging to the family Carangidae. The technology is simple—wild juveniles are placed in floating cages and fed natural or artificial foods until they reached market size. Commercial production began in the late 1950s and reached 30,000 metric tons by 1968 and 150,000 metric tons by 1984. Production has been doubling in about seven years, but the likelihood for continued rapid growth is in question for two reasons. First, protected sites for floating cages are nearly fully developed in Japanese coastal waters. Second, the government has placed restrictions on collection of wild juveniles to stock cages (Anonymous 1986a). Two technological advances will be needed if yellowtail mariculture is to continue to grow in Japan: (1) a technology for cage culture in the open sea; and (2) a technology for artificial production of seed stock.

Technological barriers such as these are typical of developing mariculture industries. Such obstacles to growth are often temporary, provided economic incentives for solutions are adequate.

Shrimp

Shrimp is the most important class of seafoods entering international trade, presently accounting for about 20 percent of the total value of world trade in fish and shellfish commodities (Nierentz and Josupiet 1987). Natural stocks are being heavily exploited throughout the world, and many are overfished. Increased future supplies are likely to be provided by mariculture.

The capture fisheries harvested 1.7 million metric tons of shrimp in 1984, and mariculture produced an additional 0.1 million metric tons (6 percent of world supply). A preliminary assessment of the 1986 world harvest (Anonymous 1987d) indicates that mariculture production tripled in only two years to 0.3 million metric tons (about 15 percent of world supply), while the catch by capture fisheries remained about the same. The National Marine Fisheries Service projects that mariculture will contribute 25 percent of the global shrimp supply by 1990 (Anonymous 1987d). Others (Anonymous 1986b, Chauvin 1986, Nierentz and Josupeit 1987) offer somewhat more conservative expectations for growth of shrimp mariculture into the twenty-first century.

Technology for shrimp mariculture is undergoing a transition from extensive culture systems, where diked lowlands are flooded with seawater and stocked with wild juveniles, to intensive culture systems where seed stock is produced in hatcheries. Shrimp farming is in an early phase of development and growth, and is a high risk enterprise. Business failures are common due to inadequate technology, lack of attention to markets and interference from institutions that do not have profit orientation (Eys 1986). The outlook, nevertheless is for steady growth of shrimp mariculture because expanding markets can no longer be supplied by capture fisheries, and economic incentives are likely to make the industry more attractive to investors.

Groundfish

Groundfish are the most important food fish group consumed in Europe and North America. Practically all stocks are fully exploited and many have been overfished. Fisheries on natural stocks are, for the most part, intensively managed for conservation purposes. Per-capita consumption is decreasing due to supply shortages.

The modern history of groundfish mariculture dates back to the mid-1900s (Shelbourne 1968). Technical barriers to a viable groundfish mariculture industry remain largely unresolved. However, a growing shortage of natural stocks has greatly strengthened the outlook for mariculture and stimulated new initiatives on development of groundfish mariculture in Europe (Slashi 1986, Anonymous 1987e). Speculative interest on the part of investors is especially high in Norway, where the government has received several hundred applications for permits to farm groundfish (Anonymous 1987c).

Salmon

Depletion of natural stocks of salmon from overfishing and degradation of habitat has a long history (Netboy 1980). Development and application of hatchery techniques for stocking natural waters to ranch salmon were underway before the turn of the century, but the widespread use of hatcheries did not gain momentum until the 1950s. Development of industrial salmon ranching received a major boost in the late 1960s, when Japan began to develop strategies to counter reductions in high seas harvests forced by the U.S., Canada and USSR (Nasaka in press). Alaska turned to industrial ranching in the 1970s to assist the recovery of economically depressed salmon fisheries (McNeil 1980). The USSR has recently undertaken the modernization and expansion of salmon hatcheries in the Far East (F. N. Roukhlov personal communication: 1987).

The number of juvenile salmon released for ranching marine waters has approximately doubled per decade in the last four decades. Japan has been the leader, and ranched chum salmon (*Oncorhynchus keta*) (Figure 3) has become the principal source of salmon for Japanese markets (Nasaka in press).

Although ranching still dominates aquaculture production of salmon, salmon farming has flourished in recent years. Farmed salmon are grown to market size in captivity, whereas ranched salmon are released into natural waters and recaptured as maturing adults. Global harvest from farming was about 50,000 metric tons in 1986 and is expected to exceed 200,000 metric tons by 1990 (Anonymous 1987g). Norway is presently the leading producer of farmed salmon, followed by the United Kingdom and Japan. Other nations, especially Chile and Canada, are encouraging investments in salmon farming and are expected to become major participants in the industry.

Implications for Management

Capture fisheries have traditionally been managed under a regime in which fish and shellfish are considered to be common property resources. Rights to ownership

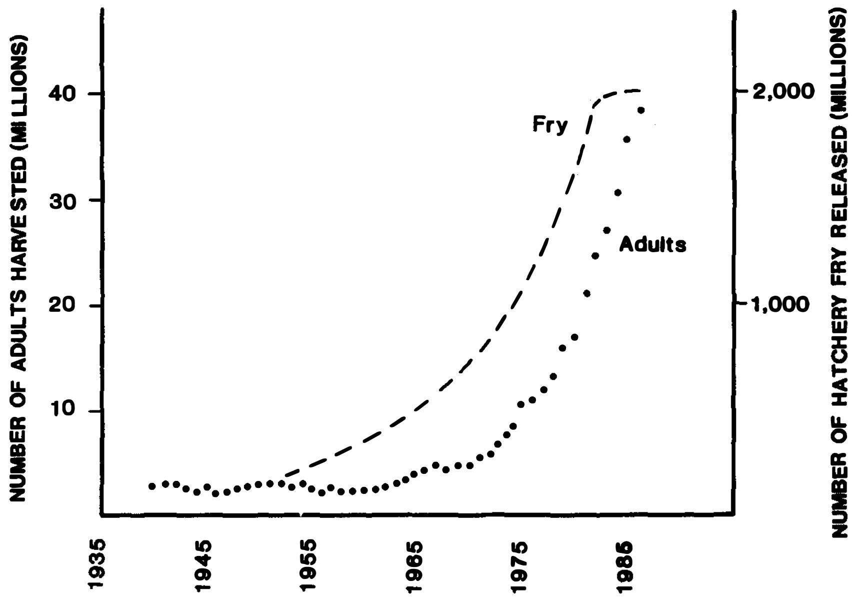

Figure 3. Production of ranched salmon in Japan.

do not exist prior to capture under a common-property concept, and fishers have limited incentive to restrain fishing efforts voluntarily to avoid overexploitation. Institutional arrangements to control entry into capture fisheries are typically non-existent or ineffective, and fishing effort tends to increase to a level where the cost of harvesting equals or exceeds the value of the catch. Furthermore, management agencies often have little or no responsibility for economic performance of a fishery. Economic inefficiencies are often imposed on fishers to reduce harvest rates and protect stocks from over fishing.

Government sometimes operates aquaculture facilities (namely, hatcheries) to supplement recruitment to stocks that are managed for capture fisheries. Conservation objectives are often used to justify investments in public aquaculture. Economic benefits accrue primarily to sport and commercial fisheries, and tax revenues invested in government aquaculture facilities often represent subsidies to these capture fisheries.

Nongovernmental institutions can participate in aquaculture only if the state is willing to grant rights to property and use of public resources. These rights relate to stocks of fish and shellfish, to space for growing them, and to water necessary for their survival and growth. Depending on circumstances, a nongovernmental aquaculture operation may require rights from government to: obtain seed stock from natural populations or from hatcheries operated by the state; acquire and use water; discharge effluent water; acquire and use space (uplands, tidelands, deep water); acquire exclusive harvest rights; transport stocks from one location to another; release stocks into natural waters for ranching; etc.

In many sovereignties, public institutions responsible for managing capture fisheries also have major responsibilities for the regulation of aquaculture. Traditions and priorities of these agencies tend to relate more to conservation goals for managing capture fisheries than to development goals to stimulate growth of aquaculture.

A variety of interest groups sometimes oppose aquaculture. The issues that motivate opposition typically relate to competition for scarce resources and markets. Salmon aquaculture, which is growing rapidly where ecological conditions are suitable and where soveriegnties are willing to grant rights necessary for economic success, provides recent examples of controversies over aquaculture development. Three examples in the Pacific Northwest and Alaska are cited here.

Much of the early development of salmon farming occurred in Washington State, and the emerging industry seemed destined for sustained growth (Nyegaard 1973). However, owners of shoreline residential property became opposed to floating cages for aesthetic reasons. Agencies responsible for land and water use planning and zoning responded to this opposition by erecting administrative barriers to growth of the industry (Anonymous 1987h). Investors in salmon farming are as a consequence, by-passing Washington State and going to other soveriegnties, such as British Columbia and Chile, where institutional barriers are less onerous.

Oregon was among the first states in the U.S. to allow nongovernmental institutions to participate in salmon ranching, and sizeable investments of private capital were made to stimulate development of an industry (Lannan 1980). Large runs of maturing salmon returning to coastal ranches have stimulated local economies. These runs have also contributed stray adult spawners to streams in close proximity to salmon ranches. Environmentalists have argued that natural stocks have been placed in jeopardy from a presumed loss of genetic fitness resulting from interbreeding with ranched stocks. Public policy makers and manager responded to these concerns by erecting administrative barriers that greatly restrict future growth of the industry and flexibility of salmon ranchers to increase productivity. While Oregon places restrictions on growth of salmon ranching, other sovereignties bordering the north Pacific Ocean continue to expand production. The number of juveniles released annually into the north Pacific presently exceeds 4 billion and possibly accounts for one-third of the total biomass of salmon harvested annually. Global harvest from ranched stocks conceivably could exceed the harvest from natural stocks by 2000 (McNeil in press), but Oregon appears to be turning away from active participation in the growth of salmon ranching.

Fear of competition for markets has stimulated opposition from Alaska commercial fishermen to salmon farming. A bill to authorize salmon farming has failed in the Alaska legislature because of strong opposition from the commercial fishing lobby (Anonymous 1987i). Meanwhile, Alaska's southern neighbor, British Columbia, is actively pursuing a salmon farming "gold rush" (Fitzgerald 1987).

Conclusions

The title of this presentation poses a question: mariculture—an aid or hindrance to management? However, after analyzing growth of fisheries and aquaculture and assessing institutional issues, I am now of the opinion that the question should be restated: management—an aid or hindrance to mariculture?

Mariculture has become an important contributor to the global supply of fish and shellfish. Its importance realtive to capture fisheries is steadily increasing. Public agencies responsible for fisheries are typically oriented to capture fisheries, and their programs typically place greater emphasis on conservation of natural stocks than on economic efficiency and growth. Mariculture has added a requirement for new dimensions in public policy concerning seafoods and to the responsibilities of fishery managers and policy makers. Trade-offs between conservation and development will become more common as the transition from hunting to farming aquatic food resources continues. Fishery agencies should place greater emphasis on economic development as the fishery economy expands through aquaculture.

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The Roles of Life-cycle Theory, Aquaculture and Economics in Marine Fisheries Management

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Introduction

Marine recreational fishing has enjoyed great popularity in the United States, attracting major investments of discretionary time and money. Based on preliminary information from the latest (1985) national survey of fishing participation, fishing in marine waters represents approximately 15 percent of the total recreational fishing activity in trips for anglers 12 years of age and older (172.6 million trips). That represents nearly three times as many marine angling days as were taken in 1955 (58.6 million). Sport fishermen also harvest an enormous quantity of fish for food. The National Marine Fisheries Service estimated a marine sport catch of 717 million pounds in 1985, which accounted for approximately 30 percent of the total (recreational and commercial) U.S. marine finfish harvest that was used for food.

Demands for recreational output from renewable marine coastal fishery resources are expected to continue to grow in the future. One reason is the projected movement of the United States' population to the coastal zone. Davenport (1980) reported that more than 50 percent of the United States' population lived in the coastal zone in 1980 and, by 1990, this portion is expected to increase to 75 percent. Another reason for the forecasted increase in demand for marine recreational fishing is that fish for the American table has become a luxury commodity at retail outlets, with prices commonly exceeding those for beef and other meats.

The American public selects fishing as a most favored form of recreational pursuit for a number of reasons. According to various surveys of marine recreational fishermen, "fish-associated" objectives, such as "to catch fish," dominate the reasons offered by respondees for their participation in marine sport fishing. For certain, a wide array of satisfactions in addition to catching fish for fun or food are inherent in a successful fishing trip. The one distinct difference, or specialty, which distinguishes fishing from other water-associated recreational activities is the act, or the expectation, of catching fish.

The nation's common property marine fish resources are publicly owned. As such, they are available to all and of great importance not only to the recreational consumer and industry but also to the commercial fishing industry. Americans are increasing their consumption of seafood—up from 10.9 pounds per capita in 1966 to 14.5 pounds in 1985. Expectations are that this trend will continue into the future. Commercial fisheries products that find public acceptance and demand in the marketplace result in attracting more entrants to an open-access commercial fishery. Each participating harvester acts independently of what is good for the entire fishery. As a consequence a "tragedy of the commons" results, and the stock is overfished.

Many marine fish species are shared stocks and harvested by both commercial and recreational interests. Historically as exploitation by commercial and recreational harvesters escalated, stocks of species of particularly high value to recreational anglers began to deteriorate. National fishing and hunting surveys documented that the steady and rapid growth of marine sport fishing witnessed in the 1950s and 1960s slowed significantly after 1975, a trend that continues to this date. The decline in growth in marine recreational fishing has been associated with the decline of favorite food species along the United States' coasts (Martin 1983).

The pattern of discovery, exploitation and resulting depressed stock conditions, as noted, has been a familiar one in marine fishery resource utilization. One observer has suggested, that fishery resources subjected to increasing societal demand exhibit a certain life-cycle over time (Smith 1986). The three stages in the life-cycle consist of an initial use of the resource for food production, followed by utilization for recreation and, finally, a third phase consisting of nonconsumptive or aesthetic use. The life-cycle is fueled by changing public values associated with particular fish stocks and declines in those stocks.

When the number of resource users exceeds the natural ability of an ecosystem to produce adequate numbers of targeted species to meet all associated demands, government must respond with management. Management has been defined as having two components—conservation and allocation.

As already noted, the prime ingredient for sustaining and expanding recreational fishing is fish. As a nation, we must make a conscious and dedicated effort to make the best use of our collective fisheries. Best use, or optimum yield from any common property resource, must consider a mix of benefits, including those of social and economic significance. As a society, our record of managing many common-property resources (inland fisheries, as well as terrestrial and migratory wildlife stocks), clearly reflects such changing values and changing use patterns consistent with the proposed life-cycle. The allocation of terrestrial wildlife and freshwater fishery resources between competing sport and commercial user-groups clearly reflects societal allocations favoring their use for recreational purposes. Although exploited commercially for many years, no common-property terrestrial wildlife stocks, and few freshwater fishery stocks, continue to enter today's commercial markets legally.

Such difficult allocation judgments, which must address the question of best use, or highest societal value of a common property resource, historically have not been made by marine fishery regulatory bodies. Rather, management strategies are generally developed with an underlying strategy of maintaining traditional user-group participation in the fishery. Management appears to be driven by the objective of minimizing impacts on existing user-groups, rather than optimizing benefits from the resource to its owners, the public. However, there is a slowly growing appreciation that maximized protein landings on a sustained basis is not necessarily equated with highest value or societal benefit yield from a common-property wild fish stock, particularly one of great recreational demand.

Economic Considerations for the Life-cycle Theory

The life-cycle theory argues that, as exploitation of a fishery progresses, stock size declines such that commercial use eventually ceases. Economic theory states that, in an open access fishery, effort will increase until all profits from the fishery accruing to the commercial fishery are lost (Anderson 1977). Therefore, to a limited extent, the economic theory of open access and the life-cycle hypothesis follow similar logic. The difference is that, in the economic theory, the commercial fishery remains in existence, although it is overcapitalized and does not return profits to participants. The life-cycle theory argues that the exploitation and subsequent stock decline will progress until a commercial fishery is no longer feasible and recreational exploitation remains.

As a fishery progresses through its life-cycle, various economic costs and benefits are realized. The impression the concept of a life-cycle may leave is that progression from one stage to the next is undesirable, and an unfortunate artifact of the common-property regime. This may be the case; however, it may also be the case that the net benefits (total benefits minus total costs) are greater at stages that are well-into the life-cycle. This section of the paper discusses the economic considerations of each stage of the life-cycle.

Stage 1: Commercial Exploitation

The life-cycle theory suggests that commercial exploitation is the first use of a virgin fish stock. Commercial fisheries have certain economic benefits. Like all economic benefits they fall into two general categories—economic value and economic impact. The economic values resulting from a commercial fishery are:

Consumptive-use value. Harvesters, processors and distributors value the opportunity to use a fish stock as part of their businesses. This value is reflected approximately by the profits they earn. Consumers, who generally purchase the fish in restaurants or retail markets, also place a consumptive-use value on the fish stock. This consumer value is measured by the difference between the most a consumer would pay for the fish and the amount he/she actually pays.

Nonconsumptive-use value. These are values that accrue to individuals who are in contact with the commercial fishery, but are not consumers of the resource during their contact. An example would be the people who enjoy walking around the fish docks and observing the fish, the fishing boats and the fishermen.

Indirect-use value. These are values that may be associated with a commercial fishery that accrue to individuals who are only indirectly in contact with the fishery. Examples would include individuals who enjoy viewing photographs or artwork of commercial fisheries, watching television shows about commercial fishing, and reading articles or books about commercial fishing.

Non-use value. These are values related to a resource that are not related to current use of the resource. Non-use values are categorized as option and existence values. Option value for a commercial fishery refers to the value of the option to someday be in the seafood business and/or to someday consume fish. An existence value reflects the value people place on knowing something exists. For example, there may be a value associated with the existence of a commercial fishery.

Economic impact. The second broad category of economic benefits is economic impacts. The economic impacts of commercial fishing refer to activity that occurs in local, state, regional and/or national economies due to the fishery. Impacts are calculated in terms of such variables as sales, taxes, jobs, income and/or output. The impacts are derived from economic activity that occurs in the harvesting, processing and distribution market levels, and extend into other sectors of the economy as the harvesting, processing and distribution sectors purchase goods and services from other industries in the economic region of concern. These impacts extend further as wage and salary earners in each of the affected businesses make purchases with their earnings.

Stage 2: Recreational Exploitation

As the life-cycle of the fishery progresses, commercial use is no longer as viable and recreational use predominates. This may be an artifact of the health of the resource, or a change in the regulations affecting the fishery that prohibit commercial use. Such regulations are often set in place after the commercial fishery decimates a stock.

Economic benefits of a recreational fishery follow the same broad categories as those for commercial fishing. Economic benefits are disaggregated into two general categories—economic values and economic impacts. Economic values related to recreational fishing can be categorized as follows:

Consumptive-use value. This is the value that sport fishermen place on the opportunity to go sport fishing and use the resource. Part of the value is expressed in the form of expenditures made to go fishing. The angler may place an additional value on the fish stock over what he/she spend to go fishing.

Nonconsumptive-use value. As in the commercial fishery, the relevance of nonconsumptive-use value to recreational fisheries is esoteric, but such values may exist. People may derive value from observing a recreational fishery, such as walking the bank of a salmon river during the spring run.

Indirect-use value. Value may be derived from the indirect use of a recreational fishery, such as through reading about the sport, watching television shows on recreational fishing and admiring artwork that focuses on recreational fishing.

Non-use value. Option and existence values bear similar relevance to recreational fisheries as to commercial fisheries. There may be a value in having the option to participate someday in the recreational fishery. In addition, individuals may place a value in knowing simply that recreational fishing exists, and/or may place a value in knowing that their offspring (or others) will have the opportunity to sport fish in the future.

Economic impact. Recreational fisheries generate economic benefits in the form of economic impacts. These impacts result from the expenditures made by sport fishermen in the course of going recreational fishing. The impacts are measured in terms of jobs, sales, taxes, income and/or output, and extend beyond the initial expenditures as the businesses that supply goods and services to sport fishermen purchase inputs to produce those goods and services. Further economic impacts result from the expenditures made by the employees of all affected businesses with the wages and salaries they earned due to purchases by recreational fishermen.

Stage 3: Nonconsumptive Uses Only

Recreational fishermen can also overexploit a fishery such that it is no longer possible to use the fishery. The life-cycle theory suggests that recreational use can lead to a third stage where only nonconsumptive uses are permitted. This final stage of the life-cycle is where the stock has declined to such a degree that only nonconsumptive uses are permitted or possible. In the case of a fishery, these uses might include catch-and-release fishing, fish observation either in the water (i.e., skin diving) or from outside the water (i.e., observing salmon runs up fish ladders), and other nonconsumptive uses.

Many of the concepts of economic value would still apply at this stage. Certainly people will value the nonconsumptive activity and the fish stock as part of that activity. Indirect use through magazines, television, etc., would also have value. Many of the non-use values would remain. Existence values that are motivated by altruistic feelings toward the fishery would prevail, such as valuing that the fish stocks are not extinct. A bequest value, in terms of the value placed on one's offspring (or others) having the opportunity to participate in a nonconsumptive activity, would also be relevant. Finally, some economic impacts would exist due to expenditures made to partake in nonconsumptive activities.

Roles and Effects of Aquaculture

The preceding subsections have sought to identify possible economic benefits that might exist at different stages of the life-cycle of a fishery. As the fishery moves through its life-cycle, managers should be aware of what benefits are being earned and what benefits are being foregone by allowing the fish stock to progress through the cycle. Decisions oriented toward optimizing many of these benefit concepts may call for regulations to be put in place that do not allow the resource to progress through the three stages.

While consumers demand high quality seafood products for restaurant or home consumption, they are not particularly concerned where the seafood originates. Recreational and commercial fishing interests should staunchly support development of aquaculture and mariculture to help meet the public demand for commodity products while relieving pressure on wild stocks, many of which are currently in stressed conditions.

Impact on Commercial Fisheries

If harvesting of the fish stock in the wild were to be replaced with aquaculture, very little of the consumptive-use value in the commercial fishery would be lost. Processors, distributors and consumers would still receive the same product they do with the harvest of a wild stock. Commercial fishermen would lose all their consumptive-use value. However, the economic theory of open access indicates that this result will occur anyway. Even if this were not the case, profits to commercial fishermen would be replaced with profits to fish farmers. While there would be individual losses and gains, the net change would be much less negative and possibly positive.

The nonconsumptive-use values would be lost once the commercial fishery ceased. While the existence of the values is uncertain, it is unlikely that they could be replaced by aquaculture or some other means to observe a commercial fishery.

It is unclear whether indirect values associated with a commercial fishery would be lost as the fishery progressed to the next stage of the life-cycle. If the mediums by which individuals partook of the commercial fishery remained, such as books, articles, photographs and video-tapes, much of the indirect values might remain. In fact, their value could increase if they associated a "historical" value with their indirect use.

The non-use values would be lost as the fishery progressed to the next stage of the life-cycle. The exception would be the option value of someday consuming seafood which would remain due to aquaculture. However, the option of becoming a commercial fishermen would be lost. So too would the existence values associated with the harvesting component of the commercial fishery, since it would no longer exist.

If fish were available from aquaculture, in lieu of commercial harvesting, economic impact losses would only occur in the harvesting sector and those sectors that provide goods and services to commercial fishermen. These losses would be offset by activity in the aquaculture industry and economic sectors that supply goods and services to the aquaculture businesses.

Impact on Recreational Fisheries

Unlike the commercial fishery, the recreational fishery does not have an alternative to fishing on a wild stock. While most of the economic benefits associated with a commercial fishery can be sustained by aquaculture, there is not a similar substitute for the recreational fishery. Put-and-take fishing offers one alternative, but it is unfeasible to expect put-and-take fishing to be able to replace the stocks needed to support recreational fishing to the extent that aquaculture can replace the catch from a wild stock in a commercial fishery.

Aquacultural Developments

Recent developments in commercial fishing industry production evidence an active shift from reliance on hunting wild stocks to development of aquaculture to meet consumer demands. The aquaculture industry is providing increasing quantities of high quality products. In the United States, an estimated 25 million pounds of salmon are produced for commodity demand each year. private aquaculture produces 40 percent of our oysters, most of the catfish (the quantity of pond-reared catfish has grown dramatically in recent years, reaching more than 280 million pounds in 1987), crayfish, nearly 100 percent of the freshwater trout and lesser amounts of other species, for a total of about 400 million pounds (Buck 1987).

Recent developments in Norway in the pen-rearing of Atlantic salmon (*Salmo salar*) have enabled that nation to acquire a major and growing share of the frozen salmon market. According to Lee (1987), Norway will increase production levels by 1990 to between 90 and 100 metric tons of pen-reared Atlantic salmon. This, Lee pointed out, is nearly twice the present worldwide production of coho (*Oncorhynchus kisutch*) and chinook salmon (*Oncorhynchus tshawytscha*).

Innovative, private aquaculture ventures are also underway to provide certain other species where the wild stocks are currently under stress. Development of full production programs to raise striped bass (*Morone saxatilis*) for the commodity market are known to be underway in California, North Carolina and Maryland. Red drum (*Sciaenops ocellata*) are being raised for the market in at least three locations—Texas, South Carolina and Florida.

It would appear that there exists an obvious general solution to the losses of economic benefits in fisheries that are likely to occur due to the progression through the life-cycle. The start of the problem of resource overexploitation occurs with the open-access commercial harvesters. An alternative to this fishery is found with aquaculture. Most, if not all, of the economic benefits associated with the commercial fishery remain by switching from the use of wild stocks to stocks developed through aquabusiness. The common-property wild stocks can be used to generate other societal benefits, such as those produced through recreational fisheries and nonconsumptive uses. If recreational fisheries are properly managed, the tendency to progress to the "final stage" would be avoided. In fact, proper management should allow for opportunities for nonconsumptive use, given that this type of use can produce important societal values. While the same point is true for the commercial fishery, the history of fishery resource management suggests that this is not logistically possible. Therefore, in fisheries that would progress through the life-cycle, the apparent solution is to use aquaculture to satisfy the commodity market for seafood, and allow wild stocks to generate other societal benefits through wise management.

In summary, there are increased demands being placed by recreational and commercial interests on marine fishery resources. Without management measures being put in place, these demands will force fisheries through the life-cycle. In their regulatory processes, managers should take into account the various economic benefits and costs that result from moving through the life-cycle. Aquaculture represents a means by which economic costs can be minimized and economic benefits can be maximized in moving from a commercial fishery to a recreational/nonconsumptive fishery. Therefore, resource managers should make every effort to foster the intelligent development of the aquaculture industry and recreational fishery regulations as an alternative to the deterioration of wild fish stocks though over-exploitation.

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Aquaculture—Natural Resource Managers' Ally?

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Introduction

Continual adaption and change are necessary for biological organisms, political systems, businesses and managers of natural resources to maintain their positions in the world. Just as Darwin's finches adapted to unfilled niches to avoid competition and to survive side-by-side, aquaculturists, commercial fishery operators, anglers, natural resource managers and others must adapt to rapidly changing conditions. Conflict becomes inevitable as demands on a limited resource exceed the maximum sustainable yield. However, conflicts can be avoided, or at least reduced, if competing interests recognize the positive aspects of change and that continual change is the only way to maintain homeostatic conditions. Aquaculture, which has been described as "the emerging giant," has drastically altered management of some aquatic resources and has the potential to alter others. My objectives here are to explore some of the ways in which aquaculture may affect natural resource managers and some possible actions that may reduce conflict between producers of farm-raised fish and managers of wild stocks.

The first professional managers of natural aquatic resources in the United States were probably the fish culturists who lobbied Congress in 1871 to establish the Commission on Fisheries, with Spencer F. Baird, Assistant Secretary of the Smithsonian Institute, as the first commissioner (Thompson 1970). These early managers lobbied Congress to appropriate funds for the propagation and introduction of shads (*Alosa* spp.), salmonids (*Salmo* spp.) and other valuable fishes throughout the country. The goals of both public officials and private producers were to provide fish for the food market and to provide species acceptable to new immigrants. To help meet this goal, they probably first introduced the common carp (*Cyprinus carpio*) into this country from France in 1831 or 1832 (Radonski et al. 1984) and, by 1875, the fish were well-established in California and New York (Bowen 1970). With some fanfare and at the request of Spencer Baird, Congress appropriated $5,000 in 1877 to construct culture ponds to rear common carp on the grounds of the Washington Monument. Over the next several years, farm-raised fish, including introduced brown trout (*Salmo trutta*) and common carp, were promoted by private aquaculturists and government officials to increase angling opportunities. These culturists voiced their concerns about pollution from manufacturing plants, sawmills, dams, siltation, and other industrial and municipal sources (Thompson 1970). Fish culturists sought to preserve the aquatic environment to support fish and fishing.

After the death of Spencer Baird in 1887, the value of cultured fish in the management of natural resources began to be questioned and funding for research became more limited. By 1897, when *A Manual for Fish Culture* was published by the Commission, fish culture was a well-developed practice of state and federal fish hatcheries, as well as in the private business sector (Brice 1897). The manual contained descriptions for the culture of more than 40 species or groups of finfish, plus lobsters, oysters, clams and frogs. Fry produced in hatcheries were widely stocked along the Atlantic Coast from about 1870 to 1900; the programs then were abandoned because they did not appear to influence commercial landings of shad, striped bass or other estuarine fishes.

Conflicts of Aquaculturists and Natural Resource Managers

Now, about 100 years later, resource managers view aquatic resources as part of the public domain and consider that hacthery-produced fish to be one more tool to be used to manage these aquatic resources (McCraren 1986). Private producers view aquaculture as agriculture in the aquatic environment and believe the products produced should be treated no differently than poultry, beef or soybeans. These opposing views are a major source of conflict.

Channel catfish (*Ictalurus punctatus*) and chiefly rainbow trout (*Salmo gairdneri*), the most commonly cultured fishes, are defined as agriculture crops in come states—channel catfish in Mississippi, trout in Idaho and all farm-raised aquatic organisms in Missouri—and these farm-raised fish are not regulated by the state conservation and natural resources agencies. Other species, such as striped bass (*Morone saxatilis*), red drum (*Sciaenops ocellata*) and largemouth bass (*Micropterus salmoides*), are now attracting the interest of commercial producers (Durpee and Huner 1984) and may ultimately force changes in existing regulations. Will these changes harm or benefit anglers, commercial operators, consumers and the nation's aquatic resources?

Demand for Game Fish Increases

According to a survey conducted by the U. S. Fish and Wildlife Service in 1985, 58 million anglers spent $28.2 billion in 987 million angler days (U. S. Fish and Wildlife Service 1986). Sport fishing is projected to double by the year 2030. The fishing pressure on public waters is expected to increase much more rapidly than the ability of the resource to produce. Even today, some anglers have abandoned public waters to fish in more productive private waters. The public waters of Texas yield slightly less than 1 legal-size bass in 10 hours of fishing, whereas 30–40 bass can be taken from privately owned and managed lakes in only 3 or 4 hours (Trosclair 1987a). Land owners are willing to buy catchable-size fish to be stocked in private ponds for recreational purposes. For example, a company in Bryan, Texas has sold 1-kilogram rainbow trout to landowners in Texas to stock for recreational fishing.

Other aquaculturists are producing hybrids of striped bass and white bass, Florida strain largemouth bass and other warmwater species for food and sport fish. In Danbury, Texas, some anglers have paid $900 per day for the opportunity to catch 3-kilogram trophy-size bass in private waters and other fishermen routinely pay $90 in the off-season and $165 per day in the peak season to catch 1- to 2-kilogram fish (K. Zwhar personal communication: 1988). Largemouth bass are being reared in protected nursery ponds and then transferred into larger ponds for recreational use. Anglers may catch and release multiple fish but keep only their largest one as a trophy. Various personal services, such as catering of meals, and use of lodges and equipment, are included in the $300–900 daily charges, but fewer services are provided for the $90 per day charge. Are these practices the same as sport fishing in public waters? Are they indicative of future practices? Or are they just an innovative way to harvest an agricultural crop?

States require most anglers fishing in state waters to have a valid recreational fishing license. However, in some states, such as Alabama, Arkansas and Missouri, anglers fishing in privately owned water for farm-raised fish are exempt from licensing requirements. Although these establishments provide recreational opportunities, the catch of fish is frequently so high that it resembles a supermarket activity. In a single day, anglers have harvested more than 500 kilograms of channel catfish from a 0.1-hectare pond in Longview, Texas (R. Lackey personal communication: 1988). Do activities such as these relieve the fishing pressure on public waters? I believe that they do—at least they provide recreational opportunities in excess of those available on public waters. To the extent that fishing in private waters removes fishermen from public waters, these programs work in concert with—not in conflict with—public programs.

Game Fish or Food Fish?

Natural resource managers have often been reluctant to allow the sale of farm-raised fish. The two major obstacles preventing the sale of the hybrids of striped bass × white bass (*M. chrysops*) were identified by Carlberg and Van Olst (1987) as: "1) The inability or unwillingness of enforcement agencies to distinguish farm-raised hybrids from wild-caught striped bass that are prohibited from sale in many states, and 2) laws prohibiting the sale of striped bass because it is a game fish." Producers of channel catfish and trout faced these same obstacles as they developed commercial markets for farm-raised fish. How were conflicts resolved? To my knowledge, both farm-raised catfish and trout can be legally sold in all states. Before 1960, when there were only 160 hectares or commercial catfish ponds, there were significant commercial fisheries for catfish in inland waters, such as the Tennessee and Mississippi rivers. Today, after numerous incidences of environmental degradation, including release or spills or mercury, PCBs, chlorinated hydrocarbons, and other toxicants and contaminants, the public no longer associates quality and safety with wild-caught species, but more frequently with farm-raised products. In 1987, about 182,000 metric tons (S. Hinote personal communication: 1988) of farm-raised catfish and 23,000 metric tons of farm-raised trout were processed as food fish. Existing catfish-processing plants had the capacity to process more than 227,000 metric tons per year (Trosclair 1987b). Many other farm-raised fish were sold directly to consumers or for restocking as recreational fish. The development of the catfish and trout industries appears to have almost eliminated the importance of the commercial catch. Fishing pressure on wild stocks of these inland species may continue until the last fish is caught, but the relative value of the wild fish will decline as farm production increases. The commercial production of Atlantic salmon has similarly expanded at a phenomenal rate in the past three to four years. About 50,000 metric tons of farm-raised Atlantic salmon were imported into the United States in 1987, whereas, commercial landings from the Atlantic Ocean were only about 10,000 metric tons. Foreign investors from Norway, Sweden, Iceland and Japan have recently established several net-pen fish farms to culture both Atlantic and Pacific salmonids in North America. Most of these farms have been placed in Canadian waters, primarily British Columbia, because regulations there are less restrictive than in the United States (Morrison 1987). Alaska fishermen recognize the threat of this foreign competition, and even though they would prefer to continue to fish for wild stocks, they recognize the potential profit of net-pen culture and are ready to "jump on the band wagon and farm salmon" when state laws are modified to permit this activity (Rosenberry 1987).

Demand for Food Increases

The demands for fish and fishery products in this country are expected to expand faster than the supply of fish will. Imports of fish and fishery products into the United States were valued at $365 million in 1960 and $7.6 billion in 1986, when the imports consisted of $2.8 billion worth to nonedible products (animal feeds, industrial products, etc.) and $4.8 billion for edible fishery products. Imports expanded at an average annual rate of $278 million from 1960–1986 and increased much more rapidly after 1980 than before 1980. The annual per-capita comsumption of fish increased over 20 percent from 1975–1986, when the per-capita rate reached 6.7 kilograms; it is expected to be 13.6 kilograms by the year 2020. The world's catch of fish (millions of metric tons) was 27 in 1954, 57 in 1966, 74 in 1976, 83 in 1984 and 90 in 1986 (McIntyre 1987, Parker in press). The catch has increased with the demand only because previously unused resources—those formerly classified as trash fish—are now being captured and processed into consumer-acceptable forms, such as imitation lobster, shrimp and scallops. The ocean's resources are recognized as finite, having an estimated maximum sustainable yield of about 100–120 million metric tons. The expansion of demand in a market with limited supply is expected to continue to drive prices up and make fish farming even more lucrative than it is today, when more than 11 percent of global fish landings are produced by aquaculture (McIntyre 1987). The forecast is for the global yield from aquaculture to increase to 22 million tons by the year 2000, when farm-raised species will represent 25 percent of the world's harvest of aquatic organisms (Rhodes 1987).

Distinguishing Between Wild and Farm-reared Fish

Aquaculturists, resource managers and law enforcement personnel have tools and techniques today that were not available when many of the rules and regulations were written to protect aquatic resources. For example, few of the states' laws address hybrid fish. In some states—e.g., Maryland—hybrid striped bass were considered to be striped bass for purposes of regulation. In other states—e.g., New Jersey and Massachusetts—hybrids were not even mentioned in the regulations. Some states—e.g., Florida, Virginia, North Carolina, Georgia and Mississippi—began to re-examine and modify their laws in 1987 to allow for possession and sale of farm-raised striped bass and hybrids (Smith 1988).

The availability of reproductively sterile hybrids and triploid fish has promoted some states to re-evaluate and modify their regulations for some species. For example, in 1978, grass carp (*Ctenopharyngodon idella*) had been in at least 35 states at one time or another, regardless of the species legal status (Guillory and Gasaway 1978). By 1987, however, 12 states had no restrictions on the species, 15 had specific policies for them, 4 permitted research with triploid forms and the other 19 states technically prohibited all grass carp, even though some exceptions were made (Allen and Wattendorf 1987). Presumably sterile hybrids of grass carp × bighead carp (*Aristichthys nobilis*) were first legalized in some states, but preference shifted to the use of triploid grass carp. For grass carp, the impetus to modify state regulations came not only from the producers, but also from state fishery biologists seeking to use these highly herbivorous fishes for biological control of aquatic vegetation in public waters. Anglers, boaters and owners of lakefront property became the driving force to modify regulations. Producers of triploid grass carp use specialized medical equipment—a Coulter[1] counter (cost about $20,000 each) to verify that each fish certified as a triploid does indeed have three and not two (diploid) sets of chromosomes (Wattendorf 1986). The equipment and procedures for this test are expensive; the test cannot be performed in the field by law enforcement personnel. Nevertheless, the procedures and paper trails established seem to provide a workable solution acceptable to law enforcement personnel, resource managers and aquaculturists.

The production of monosex—either all-male or all-female— populations is another tool available to aquaculturists and resource managers to limit reproduction of fish. A considerable amount of research has been conducted to develop monosex populations of tilapia to limit reproduction in culture ponds. Techniques used include production of hybrids with highly skewed ratios of males and females, and production of all-male populations by feeding androgenic steriods to immature genetic females to induce sex-reversal. Other techniques used to alter sex ratios include gynogenetic production of female fish by fertilizing eggs with sperm that has been irradiated with ultraviolet light to denature the genetic material, the DNA. Once development of the egg has been activated by the irradiated sperm, eggs are shocked by exposure to heat, cold or pressure to disrupt normal cell development and produce a diploid zygote with no genetic contribution from the male (Benfey and Sutterlin 1984). Some of these resulting all-female fish can then be fed androgenic hormones to produce functional males (genetically female) and mated back with their siblings to produce a second generation of all female fish.

When these techniques are further perfected, they will allow aquaculturists to produce fish with selected traits, such as rapid growth, disease resistance and tolerance to high or low temperature. It is expected that desirable traits can be propagated in cultured species much more rapidly with these techniques than through the normal process of selective mating.

Similar techinques will almost assuredly be used to produce sterile exotic fish for recreational fishermen. If anglers will pay $300–900 per day for the opportunity to catch a trophy-sized largemouth bass weighing 3–4 kilograms what would they pay to catch a 50-kilogram freshwater fish? Several exiotic species, including Nile perch (*Lates niloticus*), reach or surpass this size. How long will it be before reproductively sterile exotic fish are available in private waters to anglers? Once trophy-size sterile exotics are available, will there be a demand for put-grow-and-take fisheries in public waters? Will sterile classification reduce the threat to native stocks enough to make these fish acceptable? If grass carp can be used as an example, I fully expect to see other sterile exotics, produced by fish farmers and in state hatcheries, to be stocked by resource managers for sport fishermen.

In several states, laws have been modified or regulations developed to allow the possession, culture and sale of farm-raised fish as food fish, bait or for restocking. In other states, regulations prohibit the sale of all game fish as food fish, but do not limit the possession, culture and sale of fish for restocking.

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[1]Reference to trade names or manufacturers does not imply endorsement by the United States Government.

Law Enforcement

Laws designed to protect game fish appear to be one of the major restraints limiting expansion of aquaculture in many states and the expansion of culture of species other than catfish and trout. Law enforcement personnel are probably not ''unwilling'' (Carlberg and Van Olst 1987) to distinguish between wild-caught and farm-raised fish, but cannot do so within their existing budgets and with field techniques now available to them. Prohibition on the sale of game fish as food fish creates an illegal market somewhat similar to that for alcohol during the era when all sales of alcoholic beverages were illegal in the United States. The increasing demand for fish and fishery products is expected to stimulate the illegal market. However, farm-raised fish could fill the market and reduce poaching of wild stocks. Poaching pressure would decline only when economic incentives were lowered to make it unattractive; some enforcement personnel do not expect the aquaculture production of highly desirable fish, such as hybrid striped bass, ever to be abundant enough to meet the market demand (D. Searcy personal communication: 1988). Some enforcement personnel further believe that protecting wild stocks of fish from poaching in the presence of legal sales of farm-raised fish creates enforcement problems even greater than alcohol sales during prohibition.

Tools that law enforcement personnel could use to distinguish between wild and cultured fish are now being used in other areas of law enforcement. Forensic scientists are developing techniques (i.e., capillary zone electrophoresis—mass spectrometry, CZE-MS) that will sample volumes one billionth of a liter is size to detect and analyze compounds at concentrations one thousandth of that possible with existing techniques (Hattangadi 1988). The analyses of fragmented DNA molecules yields genetic fingerprints that have been used to provide positive identification of individuals when the only evidence at the scene of a crime was a small sample of dried blood, semem or other tissue (Weiss 1988). The technique of electrophoresis with isoletric focusing has been used to determine species of raw muscle tissue (D'Andrea and Leedham 1985) to distinguish between trout and salmon (Sutton 1982) and to identify the four species of *Morone* and their congeneric hybrids (Harvey and Fries in press).

The equipment for electrophoresis and other analytical assay techniques is commonly available in most universities and even in some fish hatcheries. Other techniques to distinguish between wild and cultured fish include analysis of daily growth rings on scales or otholites, scale-shape analysis, elemental composition of scales and bone, lipid profile analysis, detection of such tracer compounds as tetracycline and calacine in farm-raised fish, and morphometric differences. Some of these techniques have been used to distinguish striped bass taken from freshwater from those taken from saltwater (Belanger et al. 1987) and between Chesapeake Bay and Hudson River stocks (Fabrizio 1987). These and other sophisticated techniques are routinely used in forensic laboratories (Weiss 1988), but may require more laboratory support than current fish and wildlife enforcement budgets provide unless priorities are altered. These techniques, in conjunction with paper-trails to document source and movement of farm-raised fish, are tools now available to enforcement personnel. It is expected that, if there is a real market for field test kits that would allow enforcement personnel to distinguish between farm-reared and wild fish, such products will be developed. Law enforcement personnel now use a field kit that detects lead, to distinguish between game taken with a bow and arrow and that taken by gunshot.

Similar field tests may be developed to detect trace elements in farm-raised fish. For several years, kits have been available that enable diabetics to monitor their blood sugar and for women to test for pregnancy. Pharmaceutical firms are attempting to develop a simple and rapid test to detect the virus responsible for AIDS—the fatal anti-immune dificiency syndrome. Similar on-the-spot tests used in the medical field can very likely be adapted to detect chemical and biochemical differences in cultured and wild fish. It is even conceivable that, through bioengineering, future cultured fish may have hidden marks that become visible or undergo a color change when exposed to ultraviolet light or some other activator. A blue microbe has been developed (and patented) that will degrade PCBs; the blue color allows the organism to be easily traced in the environment and distinguished from other wild-type bacteria.

Techniques available to law enforcement personnel today include use of various markers and tags to identify fish and trace them through the market system. For example, fish have been marked with tetracycline (which fluoresces under ultraviolet light), fluorescent pigments (Scientific Marking Materials, Inc., Seattle, Washington) and color-coded plastic chips, Microtaggants (Klar and Parker 1986). Some law enforcement personnel have used these materials to mark fish in illegal nets and then to trace them through the market system. In at least one case, PIT tags (passive inductive transponders—Biosonics, Inc., Seattle Washington) were used to identify fish stolen from the Southeastern Fish Cultural Laboratory of the U. S. Fish and Wildlife Service, Marion, Alabama. The PIT tag is a small glass-encased electronic device that can be implanted, with the aid of a special syringe, in fish or other animals. The PIT tag derives power from an external transmitter to drive an internal transmitter and broadcast a unique 12-digit hexadecimal number detected and displayed on a monitor. Another type of small internal tag, the coded-wire tag, was used to mark about 1.2 million hatchery-reared striped bass released into Chesapeake Bay from 1985 through 1987, and has been used to mark millions of salmonids along the Pacific Northwest coast of the United States and throughout the world. Similar techniques might be used by management biologists to access stocks in inland reservoirs. Law enforcement personnel could then use this mark to identify fish taken from state waters.

In August 1987, at a conference on aquaculture in South Carolina, law enforcement personnel proposed a resolution that all states establish a 12-digit numbering system to identify individually all hybrid striped bass produced on farms for the food fish market. Under this proposal, each fish would bear a unique tag. After conversations with some commercial producers in Alabama, Arkansas, California and Mississippi, it seems improbable to me that this proposal will gain support of the aquaculture industry. It appears more likely to strengthen the resolve of aquaculturists that aquaculture is agriculture and increase pressure to have hybrid striped bass classified as farm products not controlled by natural resource managers. How will aquaculturists and resource managers deal with other cultured species—red drum, orangemouth corvina (*Cynoscion xanthulus*), Florida pompano (*Tranchinotus carolinus*)—and the numerous hybrid crosses that will surely be made? It seems reasonable that cultured fish will become much more important in the American economy. The culture of Florida pompano was of interest a few years ago, but never developed into an economically viable commercial industry. The Florida pompano fishery is now only one-tenth of that 12 years ago, due to overharvest (McMasters 1987). Florida pompano have reportedly retailed for $26 per kilogram, when particularly scarce, and in

1987, commonly sold for $11 per kilogram (up from $4.40 per kilogram in 1974). Even though earlier attempts to produce Florida pompano on farms failed financially and they are not farm products today, it seems very likely that production will become economically feasible as the demand increases.

Benefits of Cooperation

It is time for natural resources managers and aquacultrists to evaluate where we are and where we are going. There appears to be room for compromise on both sides. For example, trout, catfish, salmon, beef steaks, pork loins and chicken are not individually numbered as a condition of marketing. Food fish and shellfish, unless specifically identified as an injurious species, may be imported into the United States and are not required to be numbered individually or even federally inspected. Boxes must be clearly labeled to identify contents, shipper and consignee. So why, the aquaculturists ask, should trade in American-produced farm products be restricted by the cumbersome process of individually tagging selected farm-reared aquatic species? Although some aquaculturists may wish to identify all farm-raised crops as agriculture, they must recognize the potential impact of cultured fish on wild stocks and work with resource managers to reduce the chances for damage. Until domesticated brood stocks are developed, aquaculturists must depend on wild stocks and work closely with natural resource managers to protect those stocks from overexploitation and genetic alteration. Maintaining high quality in the aquatic environment is of prime importance to both aquaculturists and resource managers.

It seems that, as demand for aquatic resources increases with the continual growth of the world's population, strict preservationists and potential exploiters must both alter their positions and agree to some changes. The combined demands of anglers, recreational fisherman and commercial fishermen exceed the supply of fish on a worldwide basis. Either catches must become severly limited as demand increases or aquaculture must expand to fill the void. Projections have been made that, within the next 50 years, aquaculture products will equal or surpass the wild production of fish (Larkin 1988). Some sport fishermen in Texas and other states have already recognized the value of aquaculture to their interests and have helped to fund and establish hactheries to culture red drum and other species to be stocked in coastal and inland waters (Rutledge 1986). It appears that aquaculture holds tremendous potential for sportsmen, consumers and producers, and it could become an even stronger tool of natural resource managers.

In summary, it appears that aquaculture can provide at least nine useful benefits.

1. Provide fish for commercial markets to lessen the pressure on wild stocks.
2. Allow some commercial stocks to be redirected to the sport fishery where they have greater economic value.
3. Provide specialty fish for management purposes.
4. Provide recreational opportunities on private waters, thus reducing fishing pressure on public waters.
5. Provide employment for significant numbers of individuals.
6. Stabilize price flucuations in markets.
7. Provide products for export markets.
8. Provide fish for markets now being filled through import.
9. Improve the nation's foreign trade balance.

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Special Visual Presentation. *Landscape Linkages: The Dispersal Corridor Approach to Wildlife Conservation*[1]

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Introduction

The forests of the southeastern United States have long been known for their unique characteristics and products. In the 17th century, the value of animal skins exported from the South equaled all other products combined (Wing 1965). Some of America's most unique wildlife species—such as the Ivory-billed woodpecker (*Campephilus principalis*), Carolina parakeet (*Conuropsis carolinensis*) and red-cockaded woodpecker (*Picoides borealis*)—ranged widely throughout the Southeast. But the formerly expansive forests are becoming fragmented into isolated habitat islands.

Fragmentation restricts wildlife access to life requirements and other members of the species. In and of themselves, the fragments are not large enough to maintain viable populations of many of the more than 50 threatened and endangered species of vertebrates that occur in the Southeast.

Many animals depend on long-range mobility for survival. Even the evolution of flowers, nectar and fruit were driven by the advantages provided by movement. The necessity for wildlife to move freely between areas, such as terrestrial and aquatic habitats, is a basic biological principle. Habitat fragmentation, caused by urbanization and development of natural areas, severely hinders this mobility, with negative consequences to our shared environment.

In rapid growth states such as Florida, one of the most serious isolating forces is the increase of high speed, hard surface highways. In Florida alone, the construction of new primary and secondary highways has averaged over 4 miles (7 km) per day during the last 50 years (Florida Department of Transportation statistics). These highways facilitate easy movement by man, but they also serve as death traps for wildlife, and create habitat islands by blocking natural wildlife-movement corridors. The direct consequences for wildlife are obvious—as many as 100 million animals are killed on American highways each year. But in the long run, the indirect consequences of these barriers may prove significantly more important.

The effectiveness of an isolated tract of forest in providing wildlife habitat should be judged by considering overall community integrity and the ecosystem processes that maintain it. The smaller the habitat island, the quicker the wildlife community

[1]Edited script from a Special Visual Presentation by the same title.

will decay. Throughout the Southeast, rapid human population growth and urbanization will lead to the continued loss of natural habitat. In Florida, for example, about 150,000 acres (61,000 ha) of forest habitat are lost each year (USDA Forest Service 1988). This has the effect of creating habitat islands even when successful conservation and acquisition programs have been executed. A case in point is the 150,000-acre (61,000 ha) Loxahatchee Refuge in southern Florida, which is the second largest national wildlife refuge in the eastern United States. And yet, it is an island of natural habitat in a sea of human development. Urban development to the east and intensive agricultural land use to the west make this but a small patch of wildlife habitat. Some large animal species are still present here, but their continued existence is threatened.

Consequences of Habitat Fragmentation

The consequences of habitat fragmentation are measurable in many ways, but the direct effects on wildlife species occur in four principal categories. One is the increasing restriction and isolation of large, wide-ranging species, such as the black bear (*Ursus americanus*).

In Florida less than 10 percent of the natural areas smaller than 1,000 acres (400 ha) in size are inhabited by bears; only 20 percent of the areas smaller than 7,000 acres (3,000 ha) are inhabited; and tracts must be at least 100,000 acres (40,000 ha) and near to a much larger area before a 57 percent occupancy rate is achieved. A tract of habitat must be at least 500,000 (200,000 ha) contiguous acres before a viable population of black bears can be assured.

Black bear distribution throughout most of the Southeast is now centered on the large federal land holdings, such as the national forests and national parks. Unless action is taken soon, Florida black bears will also become restricted to large federal land holdings by the year 2000.

A second consequence of habitat fragmentation is the loss of genetic integrity and viability from within the species, as suggested by the case of the endangered Florida panther (*Felis concolor coryi*).

The Florida panther formerly ranged throughout the southeastern United States. Like the black bear, its distribution has become progressively more restricted, so that only a remnant population now exists on the 2.5 million contiguous public acres (1 million ha) in southern Florida. Evidence indicates that the Florida panther is manifesting the consequences of inbreeding caused by evershrinking and increasingly isolated habitat. Research on all of the adult male panthers that have been analyzed reveals a 95-percent level of sperm infertility (USFWS 1987). This is most probably because of inbreeding, and illustrates that even habitat islands of hundreds of thousands of acres in size will not suffice in and of themselves to conserve the larger species of wildlife in perpetuity.

A third consequence of habitat fragmentation is the loss of "area sensitive" or "forest interior species." These are species that depend on a specific size of habitat area for breeding success and existence.

Breeding bird surveys of 12 northern Florida hardwood forest fragments as large as 75 acres (30 ha) in size revealed the absence of 21 species, or 47 percent of the species known to breed in mesic hardwood forests (Harris and Wallace 1984). But even more importantly, 7 of 13 species (54 percent) that only breed in mesic hardwoods did not occur in any of the forest fragments. Because of their dependency on mesic hardwood forests for habitat, their absence should be considered more serious than if they could breed in widely different habitat types.

Along with fragmentation of the forest habitat comes an opening of the landscape. This paves the way for the fourth principal consequences of habitat fragmentation—an increase in backyard or weedy species, such as the parasitic brown-headed cowbird (*Molothrus ater*), raccoon (*Procyon lotor*) and opossum (*Didelphis virginiana*). Opening of the eastern forest landscape has allowed these species to expand their range of occurrence and abundance in geographical areas where they formerly did not occur or were rare. Many of them now serve as important nest predators, nest parasites and cavity competitors that negatively impact several threatened and endangered species.

The cowbird must lay its eggs in the nest of a host species. Several species of birds, such as Kirtland's warbler (*Dendroica kirtlandii*), have been seriously affected by this nest parasitism, and we now suspect that the likely extinction of Bachman's warbler (*Vermivora bachmanii*) may be partly due to this alien source of nest mortality.

Development of a Habitat Corridor Approach

The need for animals to move for survival has been documented throughout history. Dramatic examples of animal migrations can be drawn from all the classes of vertebrates.

Herds of migratory caribou (*Rangifer tarandus*) still move over open tracts of North American tundra, and such western ungulates as elk (*Cervus elaphus*) and mule deer (*Odocoileus hemionus*) migrate altitudinally as they move between summer and winter range. At least 150 species of North American birds migrate seasonally between their northern breeding grounds and the overwintering grounds of the South (Keast and Morton 1980).

Legends of migrant species are old, and details of migration have been researched for nearly 100 years. But only recently has research demonstrated that even resident species, such as black bear and otter (*Lutra canadensis*), move a great deal in their day-to-day wanderings. Most of this movement is associated with the need for adults to interact during the reproductive season, the need for young animals to disperse or the need to use different habitats during different seasons. Not uncommonly, this is because upland environments provide the richest habitats during summer and fall, while lowland swamps provide food and refuge during winter months.

Like animals, plants also need to move. But unlike animals, plants move at the reproductive stage and not as adults. The evolution of flowering plants hinges on their ability to attract animals such as hummingbirds to carry pollen from one flower to another, and thus cross-pollinate them. Cross-pollination is synonymous with outbreeding, the opposite of inbreeding. Just as the flowering plants evolved a reliance on animals to cross-pollinate, so too did most flowering plant species evolve fruits and seeds that depend on animals for their dispersal. Apples, cherries, berries and nuts have their evolutionary history dependent on the prospect that animals will consume the fruit and disperse the seed.

Recent research documents the wide ranges that even resident animals must move daily and seasonally. Otters move 10 miles (16 km) along stream courses or sometimes several miles overland to get from one small lake to another (Melquist and Hornocker 1983). A single Florida black bear may encompass a home range of 15,000 acres or 20 square miles (52 km^2) (J. Wooding and D. Maehr personal communications). The average home range size of the Florida panther is nearly 200 square miles (520 km^2), and the widest ranging dominant panther males may wonder over twice this area (U.S. Fish and Wildlife Service 1987). Most of the widest-ranging species are carnivores that must live on prey populations distributed throughout the landscape. Many are also furbearers that live or travel along water's edge, and this implies that their home range is long and narrow.

If we choose for these animals to survive, we must be willing to take actions necessary to alleviate the problems they face during movement. We have the following choices: (1) allow these populations to dwindle away, and accept the problems they cause when we do not plan for their occurrence; or (2) develop strategies of conservation planning in concert with growth planning.

One such strategy is the development of "landscape linkages" and "wildlife corridors," in order to maintain the remaining natural movement passages and reconnect the major habitat islands as they formerly occurred in the natural landscape.

A History of Corridor Management

United States federal wildlife legislation began with attention to migration and migrant species and is still very much hinged on these principles of movement. The location and nature of bird migration corridors and corridor management policies are taught in elementary wildlife conservation and waterfowl management courses throughout the United States. Use of the migration corridor approach has been critical to restoration of North America's waterfowl populations, and restoration of the whooping crane (*Grus americana*) is based on the development of a series of "stepping stone" habitat islands along the 3000-mile (4800 km) migration corridor of that species. The following lists other examples where wildlife managers have successfully utilized the dispersal corridor approach.

- Fish ladders have been used widely in order to allow movement of migrating fish around hydro-electric dams and power generating plants.
- The pipeline carrying oil southward from Alaska's north slope is elevated to allow passage of migrating caribou.
- Seasonal migration of the elk of Jackson Hole, Wyoming, is a key issue in the management of that species. Highways in Wyoming, Colorado and other western states include underpasses that allow for the passage of elk and mule deer.
- In Florida, 33 underpasses are now being designed into the 150-mile (240 km) extension of Interstate 75 that will cross the Everglades.
- A combination of boat speed zones and policies governing the operation of canal locks is used to reduce mortality of migrating manatees (*Trichechus manatus*).
- In addition to the species-by-species approach described, numerous examples can also be cited where specific park and refuge designs have included linkages or corridors.
- The Queets River corridor spans 20 miles (31 km) between the generally high elevation Olympic National Park in Washington and the Pacific Ocean. Seasonal

migrations of steelhead (*Salmo gairdreri*), salmon (*Oncorhynchus* spp.), Roosevelt elk (*C.e. roosevelti*) and Columbia black-tailed deer (*O.h. columbianus*) are made possible by this corridor linkage.

- The La Zona Protectora Park in Costa Rica is a 15-mile (24 km) long and 1–2 mile wide (1.5–3.2 km) riparian forest corridor that allows parkland to span 9,000 feet (2,600 m) of elevation and interconnect the lowland La Selva Biological Reserve with the high elevation Braulio Carrillo National Park. At least 35 species of altitudinal migrant vertebrates will utilize this corridor for seasonal and dispersal movements (Pringle et al. 1984).
- The first official U.S. national reserve, the Pinelands National Reserve, is specifically designed to allow a series of riparian landscape corridors to interconnect fragmented and isolated tracts throughout the highly developed pine barrens landscape in New Jersey (Anonymous 1980).
- In Louisiana, wildlife management areas in the Atchafalaya basin have been "linked up" in order to provide sufficient size and linear expanse for wildlife to move seasonally (Anonymous 1985).

These examples demonstrate that the will, ingenuity and technology for facilitating animal movement exist whenever and wherever specific needs have been demonstrated. But at this late date, can we afford the luxury of species-by-species and case-by-case emergencies before action is taken? Shouldn't we proceed from the basis of widespread research and move forward with general planning and acquisition principles at this point?

Natural Movement Passages Can be Achieved

Both state and federal mandates for the preservation of biotic diversity and the maintenance of viable populations of all wildlife imply that we should go beyond the endangered species approach and put a greater emphasis on entire communities. A conservation policy is required that explicitly recognizes the need for animals to move, the maintenance and re-establishment of natural corridors, and the consolidation of areas large enough to maintain viable populations.

During the last 25 years, the combined expenditure for conservation land acquisition within the State of Florida has reached approximately $1 billion. The State of Florida is presently spending about $100 million per year for the purchase of conservation and recreational lands, rivers, and beaches. The successes of this campaign are evident from the statewide map of public lands that presently exist (Florida Natural Areas Inventory). But, it is also clear that most of the areas are small, widely distributed and interspersed throughout the landscape. Parcels are acquired on a case-by-case basis without regard for an integrated statewide system of habitats.

Analysis of the size frequency distribution of the largest 315 natural areas in Florida shows that: 255 (> 80 percent) of these areas are < 10,000 acres (4,000 ha) in size; 184 areas (58 percent) are < 1,000 acres (400 ha); and more than 150 are < 500 acres (200 ha) in size. Only six areas are large enough to maintain viable populations of black bear, and only one assembly of areas in southern Florida has been large enough to maintain the Florida panther until now.

Although we do not know how many areas support viable populations of bobcat (*Lynx rufus*), mink (*Mustela vison*), otter or weasel (*Mustela* spp.), we do know that

100 percent of the areas support abundant populations of middle-sized omnivorous mammals, such as armadillo (*Dasypus novemcinctus*), opossum, raccoon and skunk (*Spilogale putorius*). These are the common backyard species that proliferate under such a conservation program. Conservation programming to date has been highly successful at restoring and enhancing populations of hundreds of species of small-to-medium size, but it does not ensure survival or maintenance of viable populations of the larger, wide-ranging species. We must adopt a new approach if we are to conserve these species.

The development of landscape linkages and wildlife corridors will help eliminate the consequences of habitat fragmentation. Numerous opportunities throughout Florida and the Southeast exist where exceptionally large gains in conservation efficiency and effectiveness can be made with only a small amount of added investment. Certain of these are cited below.

Conecuh National Forest/Blackwater River State Forest/Elgin Air Force Base Linkage

In lower Alabama and Panhandle Florida, there is close proximity of three large publicly owned conservation areas administered by three different state and federal agencies. The Conecuh National Forest is a 171,000-acre (69,000 ha) tract that lies contiguous with the 183,00-acre (74,000 ha) Blackwater River State Forest in Florida. Only 5 miles (8 km) to the south lies the 460,000-acre (187,000 ha) Eglin Air Force Base (Figure 1). The specific land sections in Santa Rosa County that remain in private ownership are in a rural, forested, low-intensity land-use area. If a landscape linkage that guaranteed the opportunity for wildlife movement could be assured, several threatened and endangered species would benefit directly, and overall wildlife conservation opportunities would be greatly enhanced.

For example, the endangered red-cockaded woodpecker, which formerly occurred from Texas to New Jersey, will soon be limited to about 20 public land areas that are large enough to support viable populations. The Conecuh National Forest has the potential to support only 125 red-cockaded colonies. Eglin Air Force Base has the potential to support a much larger number of colonies. Ensuring a future habitat linkage between these areas would create a 817,000-acre (331,000 ha) tract that is large enough to maintain a viable population of this increasingly endangered species. A 2.5-mile wide (4 km) linkage necessary to create this large contiguous block represents only a 1 percent addition to the presently owned acreage (Figure 1).

Okefenokee National Wildlife Refuge/Osceola National Forest Linkage

In southeastern Georgia and northeastern Florida lies the Okefenokee National Wildlife Refuge, a highly primitive area that constitutes one of the largest wilderness areas in the East (Figure 2). Ten miles (16 km) to the south lies the 160,000-acre (65,000 ha) Osceola National Forest. Standing alone, the Osceola National Forest will not constitute a viable area for red-cockaded woodpeckers, black bears or other endangered species. Official protection of a landscape linkage that assures opportunity for movement and genetic interchange between these areas is necessary for maintenance of a viable population of endangered red-cockaded woodpeckers, as well as black bears. A consolidated federal land holding will also greatly enhance the area's suitability as a reintroduction area for the endangered Florida panther and captive-

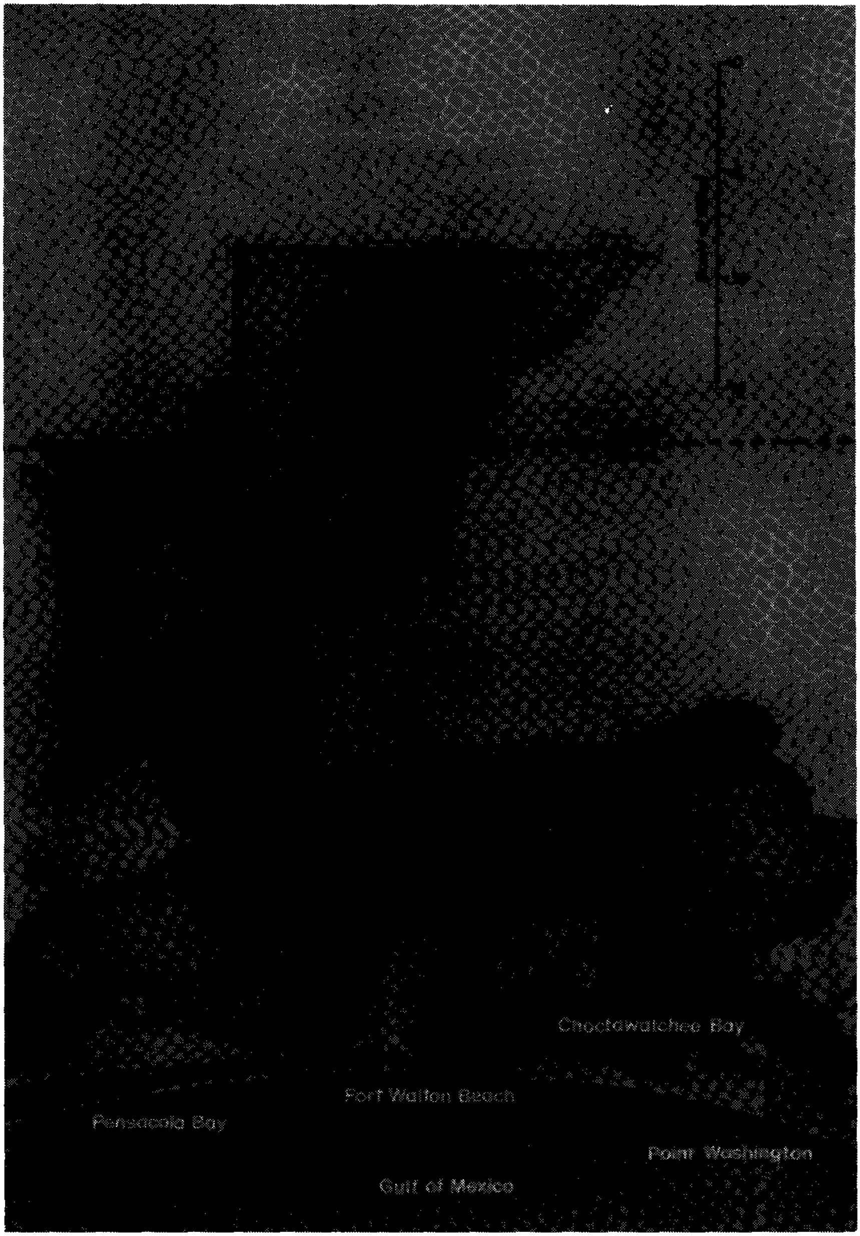

Figure 1. Conecuh National Forest/Blackwater River State Forest/Elgin Air Force Base linkage. Conecuh NF = 171,000 acres (69,000 ha); Blackwater River SF = 183,000 acres (74,000 ha); Elgin AFB = 463,000 acres (187,000 ha); Σ = 817,000 acres (330,000 ha). *Linkage*: 5 by 2.5 miles = 12.5 square miles (8 by 4 km = 32km^2); < 1 percent of three areas combined. Circle dot pattern is linkage area.

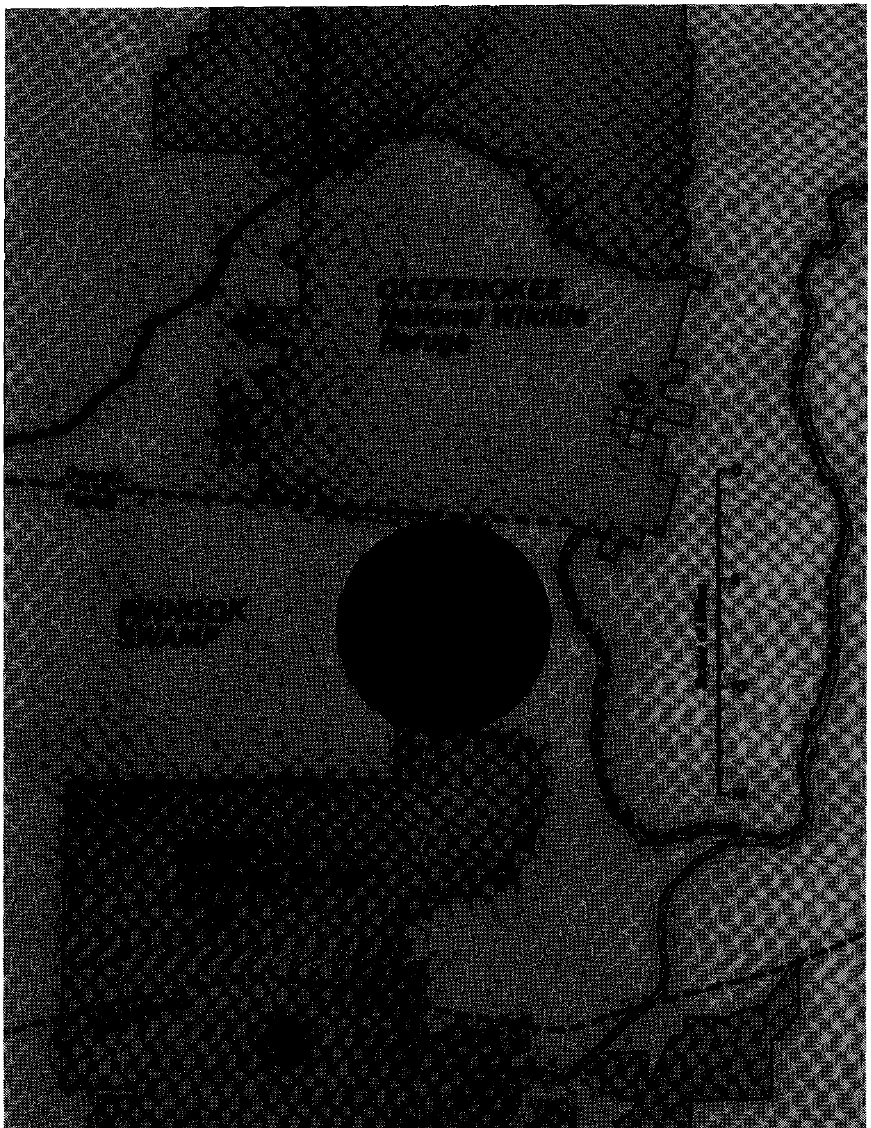

Figure 2. Okefenokee National Wildlife Refuge/Osceola National Forest linkage. Okefenokee NWR = 380,000 acres (154,000 ha); Osceola NF = 162,000 acres (66,000 ha); Σ = 542,000 acres (220,000 ha). *Linkage*: 7 by 2.5 miles = 17.5 square miles (11 by 4 km = 44 km^2); 2 percent of two areas combined. Circle dot pattern is linkage area.

reared whooping cranes. At some future date, this area could prove to be important as a red wolf (*Canis rufus*) reintroduction site as well.

Apalachicola National Forest/St. Marks National Wildlife Refuge/ Nature Conservancy's Coastal Corridor Linkage

The Apalachicola National Forest near Tallahassee, Florida, is one of the larger national forests in the southeastern U.S. To the southeast of the Apalachicola lies the two-parcel, 65,000-acre (26,000 ha) St. Marks National Wildlife Refuge (Figure 3). In this example, a small connecting linkage would create a contiguous public domain holding of nearly 700,000 acres (282,000 ha) and provide greatly enhanced opportunities for further linkages with the Nature Conservancy's 75,000-acre (30,000 ha) coastal corridor that spans nearly 70 miles (112 km) along the Gulf of Mexico. Again, only a 2.5-mile (4 km) wide corridor that constitutes less than 1 percent of the combined area is needed. It would greatly enhance the region's suitability for maintenance of viable populations of Florida panther, and allow bobcat, black bear and many smaller species to exist in the St. Mark's National Wildlife Refuge for a much longer time into the future.

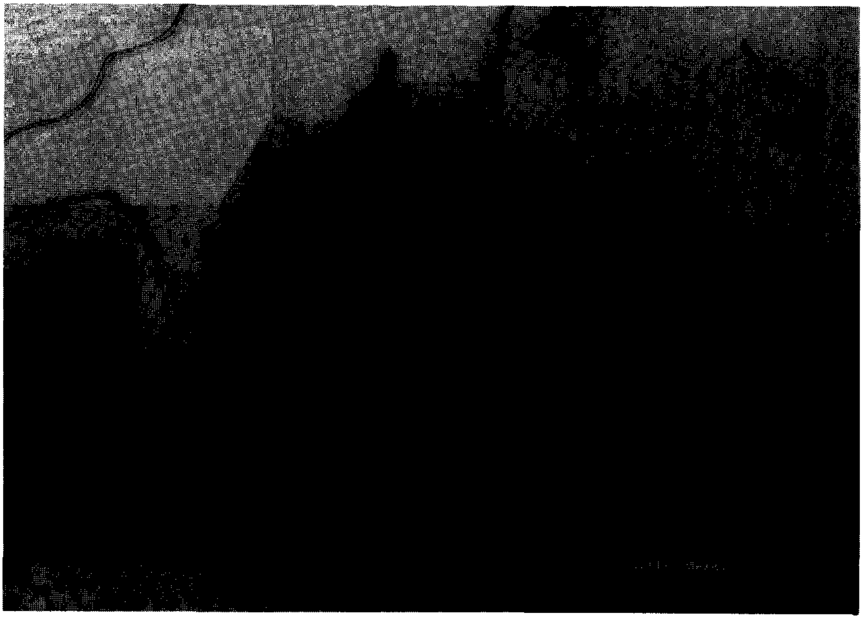

Figure 3. Apalachicola National Forest/St. Marks National Wildlife Refuge/Nature Conservancy's coastal corridor linkage. Apalachicola NF = 632,000 acres (256,000 ha); St. Marks NWF = 65,000 acres (26,000 ha); Nature Conservancy coastal corridor (not detailed) = 75,000 acres (30,000 ha); Σ = 772,000 acres (352,000 ha). *Linkage*: 4.5 by 2.5 miles = 11.25 square miles (7.2 by 4 km = 29 km^2); $<$ 1 percent of first two areas combined. Circle dot pattern is linkage area.

Loxahatchee National Wildlife Refuge/Corbett Wildlife Management Area/White Belt Ranch Linkage

The Loxahatchee is the second largest national wildlife refuge in the eastern United States, but because it occurs in southern Florida, human population growth and development on the eastern boundary and intensive agricultural development on the west have virtually isolated the more northern areas as habitat islands (Figure 4). Loxahatchee is linked to other Everglades conservation areas to the south, but, unfortunately, not linked with the state-owned areas to the north.

Corbett Wildlife Management Area and the White Belt Ranch property represent an investment of 80,000 acres (32,000 ha) that will soon be isolated as a disjunct habitat island. In and of themselves, they are not large enough for maintenance of a single pair of endangered Florida panthers. Only by linking these state-owned habitat islands with the large, contiguous public acreage to the south will they serve as habitat for the several species of larger mammals.

Ocala National Forest/Lake Woodruff National Wildlife Refuge/State Parks Linkages

In 1908, the U.S. Forest Service designated 430,000 acres (174,000 ha) near Ocala as the first national forest east of the Mississippi. In 1963, the U.S. Fish and Wildlife Service purchased the contiguous 18,000-acre (7,300 ha) Lake Woodruff National Wildlife Refuge (Figure 5). By 1967, the State of Florida had established Hontoon Island State Park. Next came Wekiva Springs State Park in 1969 and Blue Springs State Park in 1972. Lower Wekiva River State Preserve was added in 1976, as was Rock Springs Run State Preserve in 1983. The State began negotiating title to two additional areas in 1985, and is now considering the purchase of yet two more areas as early as 1988. These eleven separate acquisitions are all contiguous and total nearly 500,000 acres (200,000 ha) (Figure 5).

However, two critical areas remain in private ownership. If these two designated areas could be protected, then we would have succeeded in bringing an entire river system under protection. The remaining two areas would constitute about a 2 percent addition to the combined contiguous conservation land assembly.

Conclusion

Dozens of additional opportunities exist throughout the Southeast. In many cases, such as the Apalachicola River corridor, the Kissimmee River corridor, the Cross-Florida Barge Canal and The Nature Conservancy's recent Gulf Coast Big Bend Project, most of the work has already been accomplished. The consequences of not making these linkage investments now are dramatic. Within a very short time, commercial development in the form of restaurants, resorts and housing developments will have closed these historical movement passages and all future linkage options. We must either act quickly or accept the fact that these investments in isolated wildlife habitat acquisitions will not contribute to the needs of the larger mammal species.

Figure 4. Loxahatchee National Wildlife Refuge/J. W. Corbett Wildlife Management Area/White Belt Ranch linkage. Loxahatchee NWR = 146,000 acres (59,000 ha); Corbett WMA = 58,000 acres (24,000 ha); White Belt Ranch = 22,000 acres (9,000 ha); Σ = 226,000 acres (92,000 ha). *Linkage*: 10 by 2.5 miles = 25 square miles (16 by 4 km = 64 km^2); 7.1 percent of three areas combined.

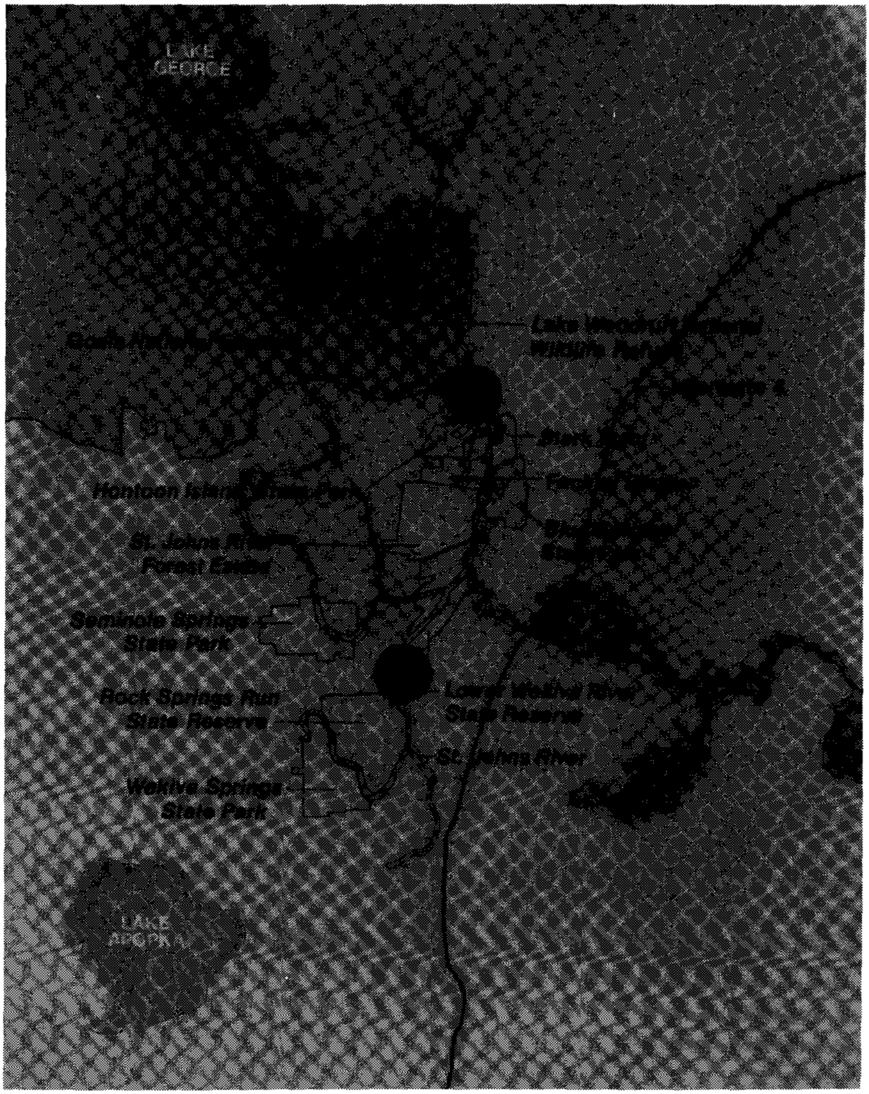

Figure 5. Ocala National Forest/Lake Woodruff National Wildlife Refuge/State Parks linkage. Ocala NF = 430,000 acres (174,000 ha); Lake Woodruff NWF = 18,400 acres (7,400 ha); Hontoon Island SP = 1,600 acres (600 ha); Wekiva Springs SP = 6,400 acres (2,600 ha); Lower Wekiva River SReserve = 4,500 acres (1,800 ha); Rock Springs Rung SReserve = 8,700 acres (3,500 ha); Stark Tract, Seminole Springs SP = 4,300 acres (1,700 ha); Fechtal Ranch, St. Johns River Forest Estate = 10,600 acres (4,300 ha); Σ = 486,600 acres (195.9 ha). *Linkage*: 5 by 2.5 miles = 12.5 square miles (8 by 4 km = 32 km^2); 1.6 percent of nine areas combined. Circle dot patterns are linkage areas.

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Special Related Meeting Session. *Conservation Biology: An Introduction*

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What's So New About Conservation Biology?

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Conservation biology is an emerging synthetic discipline that deals with the basic issue of eroding biological diversity (Soulé 1985). It derives its theoretical basis from the pure sciences, such as population genetics, demography, biogeography and community ecology. However, it uses the resulting principles to address applied problems in conservation, such as the loss of genetic diversity, loss of species diversity and loss of diversity of ecosystems. Conservation biology now joins forestry, wildlife management and fisheries management as the newest player in the arena of applied ecology.

Although conservation biology has a relatively brief history, its antecedents (which are shared with other established branches of conservation) have established a long tradition. Conservation biology attained self-consciousness at a conference held at the University of California at San Diego in 1978. The resulting book, *Conservation*

Biology (Soulé and Wilcox 1980), formalized the discipline and announced its existence to the scientific community. A 1982 conference on the application of genetics to the management of wild plant and animal populations focused on the role of population genetics in conservation (Schoenwald-Cox et al. 1983). A second conference on conservation biology was held at the University of Michigan in 1985, further expanding the body of literature dealing with the emerging field (Soulé 1986). The Society for Conservation Biology was conceived at that meeting. Later that year, the Society was formally incorporated, and publication of its journal *Conservation Biology* commenced in 1987 (Soulé 1987a).

Relationship with Wildlife Management

Conservation biology clearly shares many common interests and approaches with wildlife management. Both deal with the conservation of living organisms and share concern over the consequences of the degradation of the earthly environment by human activities. At a personal level, most members of both disciplines share an interest and background in natural history, and consider themselves to be naturalists.

Conservation biology and wildlife management differ, however, in a number of ways. These differences ensure that the entry of conservation biology will enrich and broaden the field of conservation. Indeed, a review of the 889 papers published in *The Journal of Wildlife Management* (1982–87) revealed that only 75 (8 percent) were on topics that would be appropriate for publication in *Conservation Biology*.

Table 1 contrasts conservation biology and wildlife management on the basis of several areas where overlap between the two is low. Wildlife managers seek to manipulate the sizes of animal populations—maintaining them at sizes appropriate for sustained yields, reducing them when they are judged overabundant and increasing them when they are judged too scarce or endangered. Conservation biologists seek to maintain the diversity of life—the genetic diversity within species, the species diversity within ecosystems and the diversity of ecosystems in the biosphere.

The pardigms that form the foundations of wildlife management derive from a long tradition of empirical fieldwork, and *The Journal of Wildlife Management* shows a strong bias toward the empirical approach. Conservation biology derives its paradigms from both theoretical and empirical approaches and, indeed, *Conservation Biology* features a strong theoretical slant.

Wildlife managers deal with higher vertebrates, especially birds and mammals. Typically, even among these higher vertebrates, only select groups of species receive

Table 1. Some fundamental differences between wildlife management and conservation biology.

Basis for comparison	Wildlife management	Conservation biology
Central goal	Manipulations of population size	Maintenance of biological diversity
Basis for paradigms	Mostly empirical	Mostly theoretical
Taxonomic bias	Higher vertebrates	All taxa
	Special species featured	Species treated equitably
Educational background	More uniform	More diverse
Professional affiliation	Primarily agencies	Primarily academia

the most attention—game species, endangered species, pest species. Conservation biology has no taxonomic bias and, at least in principle, treats all taxa equitably.

Wildlife managers share a common educational experience, usually obtained in a wildlife biology or natural resource program. The certification guidelines of The Wildlife Society further assure a uniform educational background. Conservation biology, in contrast, is a synthetic discipline whose practitioners hail from a diverse range of backgrounds, including population genetics, demography, community ecology, ecosystem ecology and evolutionary biology. This diversity, at least during the initial development of the field, precludes the sharing of an extensive common body of knowledge among conservation biologists. This has been both a source of mutual enrichment and conflict.

Most wildlife managers are employed by government agencies, whereas most conservation biologists are employed in academia. This immediately contrasts them as managers versus researchers—two groups that have not traditionally had the closest of rapport.

Contributions to Resource Management

Although conservation biologists are likely to make future contributions to resource management, at least three major contributions have already become clear. First, there is a new focus on the issue of biological diversity. Second, there are new approaches and concepts dealing with the dynamics and management of small populations that would, without attention, not be viable. And, third, there are new perspectives and outlooks on the challenges of conservation.

Concern over diversity has been around for a long time. Aldo Leopold's admonition that saving every cog and wheel is the first prerequisite of intelligent tinkering remains one of the most eloquent statements of the goal. Conservation biologists are helping demonstrate how biological diversity and resource development can be compatible goals. Although certain of our laws pertaining to biological diversity, such as the Endangered Species Act and the National Forest Management Act, predate the emergence of conservation biology, the current high level of attention on diversity issues probably would not have come from traditional wildlife managers.

Conservation biology has introduced new concepts and methods for assessing biological conditions and planning conservation strategies. These have come from such fields as biogeography, ethology, population genetics, landscape ecology, epidemiology and demography. They have proved to be intellectually stimulating and useful for dealing with real problems, such as the recovery of an endangered species, protection of small populations or ecosystems, or management of parks and preserves.

The biggest contribution, though, is likely to result from the addition of new perspectives and philosophies to solving the complex problems of conservation. The infusion of new ideas into the field can only be viewed as a positive event.

Areas for Cooperation

Wildlife managers and conservation biologists must begin to integrate their skills and learn more about each other's field. Professional wildlife managers should read the conservation biology literature, attend workshops and training sessions on issues such as population viability analysis (Soulé 1987b). Degree programs in wildlife management should include coursework that prepares students for understanding and using the products of conservation biology.

Conservation biologists must recognize and become familiar with the field of wildlife management, through its literature and its strong tradition of empirically based conservation. Theories generated in the halls of academia often can be tested by existing data sets, which cannot and should not be ignored. The new conservation biologists must also make an effort to go beyond theory and make sure their contributions are relevant in the real world.

We must plan our work with each other on both individual and organizational levels. We must publish in each other's journals and hold joint meetings. We must not dwell on what we are or what exclusive territory we hold; our efforts must be melded toward common goals. Rigorous scientific investigation of nature is not the exclusive prerogative of any one discipline, neither is the application of scientific discoveries to conservation and management. We share these approaches despite what we call ourselves or what our histories as organizations or individuals have been.

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Craig Altop, Dale R. Evans, Pat Janik, Phil Janik, Calvin J. Lensink, Michael Scott, Lynn Sprague, Walter Stieglitz, Robert B. Weeden

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