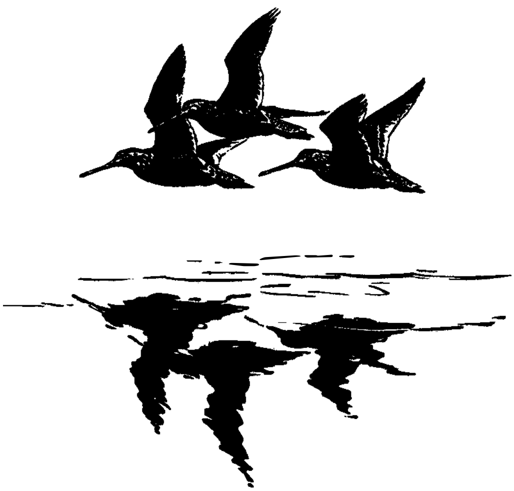
TRANSACTIONS
of the
Sixtieth North American
Wildlife and Natural Resources
Conference

Conference theme:

Balancing Social, Professional and Conservation Responsibilities

March 24–29, 1995
Minneapolis Hilton and Towers
Minneapolis, Minnesota

Edited by
Kelly G. Wadsworth *and* Richard E. McCabe



Published by the **Wildlife Management Institute**, Washington, D.C., 1995

These *Transactions* are reviewed and proofread by the Wildlife Management Institute. Unless peer review for scientific accuracy is initiated by the author(s) or Session chair, no such detailed editorial treatment is provided or implied. Conference presentations may not be included in the *Transactions* if the written papers do not follow the prescribed guidelines or if their content is deemed by the editors to be unsuitable.

Additional copies may be procured from the
WILDLIFE MANAGEMENT INSTITUTE
1101 14th Street, N.W., Suite 801
Washington, D.C. 20005

Transactions artwork by **Daniel P. Metz**
Composition by **AlphaTechnologies/mps**
Printing by **BookCrafters**

Transactions of the
60th
North American Wildlife and Natural Resources Conference
ISSN 0078-1355

Printed in
U.S.A.

CONTENTS

Special Symposium. **Visting the Past: Wildlife and Environmental History**

Opening Session. *North Star Illuminations*

Chair
Nils Hasselmo
University of Minnesota
Minneapolis, Minnesota

Cochair
Larry J. Wilson
International Association of Fish and Wildlife Agencies and
Iowa Department of Natural Resources
Des Moines, Iowa

Opening Statement

Rollin D. Sparrowe
Wildlife Management Institute
Washington, D.C.

Welcome to the 60th North American Wildlife and Natural Resources Conference. This year's Conference theme—"Balancing Social, Professional and Conservation Responsibilities"—could not be more appropriate, as a highly conservative U.S. Congress aggressively pursues changes that may dramatically affect natural resource management in North America. An historical perspective might be in order for this 60th anniversary.

The first North American Wildlife Conference was called by President Franklin D. Roosevelt in 1936, to bring together individuals, organizations and agencies interested in restoring and conserving wildlife resources. It included public and private interests from Canada, Mexico and the United States at a key time in resource management history. The country had been through an economic depression closely linked to decades of land abuse and resource exploitation. Forests had been cut and burned, industrial development had polluted waters, and plows had broken prairie soils that blew away in dust storms during the great droughts of the early 1930s. The crisis was visible, and people were understandably concerned by it. President Roosevelt's message called on people to face facts, analyze problems and work out remedies.

The proceedings of that Conference were produced as a Committee Print for the 74th Congress, Second Session, for use by the Special Committee on the Conservation of Wildlife Resources. The opening address was presented by "Ding" Darling, former Chief of the Bureau of Biological Survey and also a famous cartoonist and conservationist. His address was carried over radio by the National Broadcasting Company so that its important message would be broadly received.

Darling spoke of "the crisis," a decline of wildlife as a result of misusing the North American landscape. The problems he chronicled were all too familiar. The emphasis of his words and, indeed, the theme of the entire Conference concerned "the fundamental economic factors which bear upon the relation of wildlife resources to our material prosperity." Darling pointed out that "wealth will continue to exist on this continent only so long as the national resources of our soil and water continue to yield up their riches. When these are gone, prosperity, standards of living and happiness among our people will vanish with them." Darling talked of the need for wildlife education and nonpolitical wildlife management; he gave specific examples of resources that had been depleted and needed restoration; and he forcefully dispensed with the misperception that wildlife conservation was limited to the interests of sportsmen and bird lovers. That 1936 Conference led to reorganization of what now is the Wildlife Management Institute and creation of the National Wildlife Federation, the Cooperative Wildlife Research Units, the Federal Aid in Wildlife Restoration Program, and many legislative and joint actions to restore streams, fish and wildlife. The topics discussed would be familiar to any who have attended "North Americans," even in recent years. The most sobering realization is that most of the problems dealt with in 1936 still are with us.

Powerful winds of change now are blowing in Washington, D.C., in state legislatures and in the attitudes of people toward government across this country and in Canada. The prevailing mood is for significant cutback of the cost of government, to reduce the impact of regulations on citizens and "reform" many things. Unfortunately, environmental and wildlife conservation issues are the target of many actions from federal to local governments across the country. In general, wildlife matters are not being viewed or treated positively by lawmakers at every level. It is unsettling how many meetings and hearings degenerate into sidebar tirades against the Endangered Species Act and government infringement on private property rights.

Many states are aggressively pursuing "takings" legislation in attempt to protect private landowners from perceived and sometimes real intrusions by government. These range from restrictions on a landholder's use of property because of an endangered species, to frivolous challenges to the right of states to regulate wildlife harvest on private lands. A session at this Conference takes a thoughtful look at many sides of this difficult issue. In many states, the more radical bills have failed, but the concept has not lost its momentum.

The so-called "county revolution" in the West has seen a flurry of county-level laws that attempt, by proclaiming local jurisdiction, to preempt federal management of federal lands. Some of these laws have been challenged in court, yet most confrontations remain and some go beyond rhetoric in the local newspapers. Stories of federal land managers being threatened by local livestock permittees are increasingly common and must be addressed before the situations become more serious.

A strong run at politicizing state fish and wildlife agencies has begun. Legislation has been advanced in several western and midwestern states that would effectively politicize the agencies by overturning the time-tested separation between political appointees and professional managers. Add to this state-level directives by legislatures to cease work on endangered species, prohibit land acquisition, shift wildlife conservation funds from management to predator control and place bounties on federally listed endangered species. Damaging legislation has been put down by citizens rising up and speaking out. Let us leave this Conference as others did in 1936, with resolve to be as vigilant at the local level as we are in watching the theatrics in Washington!

Our Canadian colleagues are not exempt from changes affecting conservation programs. Reductions of as much as 50 percent in federal funding for natural resources are projected over a three-year period. Thousands of federal employees will be affected. As in the U.S., there may be opportunities for positive outcomes regarding agricultural policy, tax incentives for certain land protection and other issues. But the changes are widespread and very real.

The current administration continues its reinvention, downsizing and restructuring of federal resource management agencies. We are expecting today to hear of significant further changes at the Interior Department. The outcome of all of this is a legacy conservationists will live with well beyond the current administration, and there is significant reason for concern.

The Forest Service is emphasizing teams rather than line authority. Wildlife and fisheries are less visible in budgets and agency structure—making tracking of funds, programs and partnerships more difficult and less clear to supporters of the agency. The Forest Service has been downsized by 4,000 employees and intends to reduce by another 3,000—all before the current wave of recision and budget cutting threatened by the new Congress. The Bureau of Land Management likewise has reorganized into teams, up to the Washington level. Less direction and control down to the resource area level seem in progress, and who to contact about wildlife and fisheries resource issues suddenly is less clear.

The benefits of team approaches to management are known in small organizations with specific missions. The feasibility of team approaches is not demonstrated under the conditions being pursued at these important agencies. There are similar proposals to reorganize the National Park Service. And the Fish and Wildlife Service now is moving to disburse its supervision and management to the level of its newly identified ecoregions. Some will remember a failed approach to managing by area offices in the past.

Yet, we are told that there will be greater accountability by individuals in the chain of command in these agencies. One might ask how that can be with more contact points, less clarity about who is responsible for what, and a feeling of disorganization and chaos that is projected to outside partners. With the fierce determination by elected officials at the state and federal levels to overturn environmental restrictions, how better to set these agencies up to be vulnerable to pressure tactics, threats and manipulation on many fronts? This, again, is an area where grassroots support will be needed more than ever.

Secretary of the Interior Babbitt appeared at this Conference two years ago and announced formation of the National Biological Survey. Now called the National Biological Service, the agency faces a significant backlash linked to property rights, fear of regulation under the Endangered Species Act and general paranoia about government. Significant also, NBS appears to be bearing the brunt of attempts to make the Secretary pay for perceived transgressions in attempts to reform grazing rights and mineral exploration in the West.

Early on, our Institute and others expressed concern at the separation of science from the management agencies, and the former's concentration as a visible target for future budget cutters. That future is upon us, and the science in Interior clearly is at risk. Along with several other programs, the National Biological Service has been identified for elimination by the new, conservative Congress.

The mantra at Interior has been "provide good science through NBS." The early stated objective in facing the threat of discontinuance of NBS has been "save the science." Yet, in response to the threat of fund recision, Interior has put up draconian removal of research programs, artfully placed to affect key members of Congress. Can it possibly pass any test of logic to say that Interior's lowest priorities are fish and wildlife research in Alaska, basic data for management of sport and commercial use of Great Lakes fishes, research on salmon in the Northwest, or large river, wetland and migratory bird work at its newest facility in Louisiana?

What bothers Congress and many conservation interests is that Interior started this defense of science with enough unexpended NBS funds to pay for the recision, yet, it has staffed four new regional offices and is keeping expensive programs in information transfer—all at the expense of risking the facilities, research programs, and, most of all, the lives and careers of hundreds of fish and wildlife professionals.

Many wonder who is approaching this more irresponsibly, a Congress carrying the paranoia of those who see threats in new information, or an Interior unwilling to abandon expensive new programs at the expense of the science foundations that sustain resource management?

There is a tremendous opportunity with the 1995 Farm Bill. A session at this Conference focuses on identification of actual wildlife needs from different regions of the U.S. Data clearly demonstrate the value of the Conservation Reserve Program (CRP) to ground-nesting birds, ranging from waterfowl to lark buntings. The CRP and all farm programs are potential targets of budget-cutting zeal with the reform-minded Congress. This is a situation that demands unity in the conservation community, yet, we are not united in purpose for resource conservation through the 1995 Farm Bill.

Despite a seemingly endless series of conferences in Washington that have effectively highlighted the conservation potentials of CRP and the Farm Bill, plus workshops around the country to be highlighted here, conservation and environmental interests are going in different directions. Some are arguing that the funding has limited value in the Great Plains and should be transferred to areas of high population centers, where there are many environmental problems and lots of endangered species. In fact, data demonstrate that, while there can be significant adjustments in some of the lands signed up for habitat protection under CRP, the wildlife benefits are widespread and economically powerful. We are working with a Congress that understands fundamental soil and water conservation, and wildlife benefits of use to local communities more than it understands more esoteric concepts of preserving biological diversity or ecosystems. We need to get the conservation community together to focus on achievable goals that can receive wide support.

Congress surely will reexamine wetland protection mechanisms. Regulatory remedies, such as Swampbuster provisions in the Farm Bill and 404 permitting under the Clean Water Act, are targeted for evisceration or removal. We know that Swampbuster has slowed the rate of wetland loss and that without it, loss rates again will increase. Many organizations that should know better are shying away from support of anything that smacks of regulation. We who value wetland-dependent wildlife, such as ducks, cannot have it both ways. Without wetlands protection, there will be fewer wetlands and fewer ducks. In this climate of austerity, the farming community also cannot expect to receive public money as a subsidy to work against the public interest. There may have to be restructuring of those wetland provisions, but wildlife interests must take on this issue positively, constructively and now.

Voluntary protections are equally at risk. Some are willing to trade thousands of acres under permanent easement in the Wetland Reserve for millions of acres of farmed wetlands under shorter term protection in the Conservation Reserve. We should retain both mechanisms or we slip back significantly from attaining wetland goals under the North American Waterfowl Management Plan.

Congress cannot have it both ways either. Many self-proclaimed champions of fishing, hunting and the interests of sportsmen and women are supporting the most damaging legislation. Too many organizations representing these sportsmen and women are joining the anti-regulation, anti-government clamor without looking at the consequences. These groups must carry the truth to specific members of Congress—that many proposed actions will hurt the interests of constituents back home who value fish and wildlife. Among many bad ideas deserving challenge are: setting aside laws and regulations to facilitate huge timber cuts in the West; returning public lands to state and private ownership; giving national wildlife refuges to individual states; and making the Federal Aid in Fish and Wildlife Restoration Program into block grants. Wildlife and fish and their habitats would be the losers. If change and reappraisal of these issues are appropriate, let us do it right and with full appraisal of the consequences.

Since 1916, the Migratory Bird Treaty between Canada and the United States has linked the two countries in some of the most productive long-term wildlife conservation activity anywhere in the world. Waterfowl programs are developed most fully because they involved hunted wildlife, and regulation and management are consistent needs. In recent years, partly because of highly visible declining species, science and management energies have been targeted increasingly at songbirds, wading birds and raptors, also covered under the Treaty. The addition of Mexico to that Treaty, and later Japan and Russia, has enlarged its scope. It is implemented by the Migratory Bird Treaty Act enacted by Congress, and by regulations that provide utilization of some species and protection of others.

The Migratory Bird Treaty is significantly linked to the National Wildlife Refuge System, to provide reserve lands for migratory flocks as the United States' agricultural development progressed. The North American Waterfowl Management Plan—involving Canada, Mexico and the U.S.—has initiated landscape-scale habitat management programs designed to reverse the downward trend of waterfowl populations so visible in the 1980s. The recent resurgence of waterfowl after the return of favorable water years has depended significantly upon the habitat base provided through joint actions by governments, organizations and private landowners.

The Migratory Bird Convention with Canada is arguably the longest running and most successful international agreement both to provide human use of resources and preserve biological diversity. Because of changes in Canadian law and the needs of Alaskan native peoples, negotiations are pending to amend the basic treaty. For thousands of years before the 1916 Treaty and ever since, native peoples in both Alaska and Canada have taken migratory birds and their eggs for food and other cultural purposes. Such take has been particularly necessary in spring, because the first fresh meat available in remote areas after the long winter is migratory birds. The treaty never fully recognized the need for regular subsistence take by native peoples in North America.

Native people rightly wish to have legal access to this resource. Other North Americans have access to the resource through carefully designed hunting seasons, under the umbrella of the treaty. Treaty amendment is being approached with the fundamental premise to provide for legitimate uses by all parties, yet assure long-term conservation.

Many questions have arisen in the past about the impact of changing the law. Some argue that the treaty has been so successful it should not be risked by proposing change. However, the Canadian Constitution of 1982, as now interpreted, provides for subsistence take as a right of Canadian aboriginal peoples, which must be addressed in the treaty for it to be effectively implemented. Further, the traditional needs of native peoples in Alaska, under provisions of U.S. law, which are different than those in Canada, also must be provided for.

Fundamental principles in these negotiations center around both countries wishing to recognize the legitimacy of subsistence activity, yet not significantly increasing subsistence harvest. This is a move to amend the treaty to recognize harvest that has been carried out for centuries. Questions about monitoring, how conservation actions will be taken by governments and how native peoples will be directly involved in management processes will be addressed either in the treaty or implementation language which will be crafted by an international negotiating team. These matters have been announced publicly by the U.S. Fish and Wildlife Service and discussed in migratory bird management forums during the past several years. Formal negotiations are scheduled to begin at the end of next month, leading to language that would have to be ratified by the U.S. Senate and approved by the President.

Many of the questions raised during more than two decades of debate about this possible amendment have been answered in the form of working documents available through either the Canadian Wildlife Service or U.S. Fish and Wildlife Service. These include an environmental assessment on the proposed changes for Alaska and a white paper developed during 1994 by the International Association of Fish and Wildlife Agencies. Answers now are available to questions such as who will take birds, how many will be taken and where. The conservation community must take this treaty amendment seriously, for successful renegotiation will provide a framework for continuing international protection, management and public uses of migratory birds and their habitats.

Progress has been made in moving toward using an adaptive management process in developing waterfowl hunting regulations. Full implementation is a year or so away, but a more orderly process to make regulatory decisions based on clear strategies to meet specific population goals is a likely outcome. This is an exciting evolution in the use of science to facilitate practical resource management decisions—and it deserves attention and support.

At the last several North Americans, we have focused on various aspects of the Endangered Species Act. At this Conference, the uncomfortable question of triage is on the program. Many newly elected members of Congress have identified the Endangered Species Act as a symbol of everything that is wrong with government. It doesn't matter that most of the outcry is based more on paranoia and fear of regulation than real inhibition of individual freedoms, because perception is what is driving the zealous attempts at changing the Act. The original intent of the Endangered Species Act was to be a safety valve, developing directly out of Fish and Wildlife Service research on declining species such as whooping cranes, Everglade kites, Puerto Rican parrots, bald eagles, peregrine falcons, black-footed ferrets and others. This was an act passed to protect species under real threat of extinction. It never was intended to be the only land-management policy on public and private lands in America.

The crisis we face is not because of a lack of science nor, as Secretary Babbitt suggested, because science was connected to management agencies, but because about

25 to 30 other federal laws, ranging from the Migratory Bird Treaty to the National Forest Management Act, have been insufficient to provide direction that the U.S. would follow. Our crisis is manifest in relying on the Endangered Species Act to do what has not worked under all these other laws.

The Fish and Wildlife Service recently published a series of draft guidelines for administering the Endangered Species Act, dealing with identifying distinct vertebrate populations, petition management, candidate species, Section 7 consultation, habitat conservation planning and incidental take permits. The guidelines were developed to promote uniform application of the ESA throughout the Service's geographic regions by establishing unambiguous procedures, timetables, and definitions of responsibility and authority.

A few weeks ago, the Secretaries of the Interior and Commerce released "Ten Principles for Federal Endangered Species Act Policy," and suggested a number of reforms to the Act for Congress to consider. In addition to faster response and uniform application, some of the positive results of these changes would include: minimizing social and economic impacts; providing landowners with certainty for the future; and exemptions from incidental take provisions for small landowners. Opportunity would be provided for state and local governments and other stakeholders to take the lead in developing conservation plans, participate in recovery planning and designating critical habitats, and identify specific areas and activities to be exempt from Section 9 "take" provisions. These measures recognize that federal, top-down regulation cannot handle all that must be done under ESA. Congress should assure appropriate federal oversight, while passing the opportunity and responsibility for threatened and endangered species conservation planning to the states within guidelines.

Practically, this may lead to accepting greater risks to individual species or populations in exchange for greater assurances of habitat restoration and enhancement. These administrative changes and suggested reforms can provide a framework for significantly reducing conflicts and regenerating widespread public support for ESA, while still providing protection to imperiled species. They deserve strong consideration in any dialogue about the future of ESA.

Ding Darling, in his speech at the 1936 Conference, spoke about the need to preserve habitats and fix the landscape of America as a foundation for wildlife. We speak of ecosystem management, and know biologically that large landscapes and broad habitats can conserve many species at once and probably are a better economic focus. We also should know, however painful it may be to acknowledge, that we are going to lose some species because of increasingly intense human uses of resources. It is impractical and merely academic to argue whether human influence is an unnatural phenomenon. It makes more sense to deal with it and work with it. Perhaps we should just get on with the job of habitat protection under the many laws we have on the books and not dig in so strongly over one law that can't possibly do it all.

The transfer of endangered species responsibilities to the states cannot be allowed to become a classic, unfunded mandate. We can switch the emphasis to forestalling future listings under ESA by addressing the conservation needs of all wildlife species on a landscape scale. Focus on individual species still will be needed. All this will cost money—money the federal government is not likely to have in the foreseeable future. How, then, do we accomplish this important shift—beyond changes in federal programs?

In the midst of all the proposed change and uncertainty about traditional wildlife programs, one new opportunity bears special mention. Pay close attention to David Waller's next presentation on the Wildlife Diversity Funding Initiative. The opportunity to extend the user-pay principle to finance comprehensive wildlife management programs in America is one of the most important opportunities to have arisen since the first North American Wildlife Conference in 1936. This is an opportunity to invest in a wide array of new programs and information that can work at the landscape level, but targeted within state jurisdictions where the actual legal authorities reside. It is a way to build on existing Federal Aid in Fish and Wildlife Restoration processes for distribution of funds and for accountability of programs without excessive new overhead costs. It is a way to bridge the gap perceived by some to exist between hunting- and fishing-related programs and other groups of wildlife in the public interest. The Wildlife Diversity Initiative builds on the success of the past 60 years and offers a solid framework for the future of wildlife management. This is a landmark proposal that deserves your widespread support and attention.

The Wildlife Funding Initiative

David Waller
Georgia Department of Natural Resources
Atlanta

Good morning. It is a pleasure to be here with you all to talk about the Wildlife Funding Initiative. As wildlife and fisheries agencies, we are approaching a crossroads in wildlife management. Or perhaps, I could say more accurately that we are reaching the end of a road and must decide which way to turn. The road to which I am referring is traditional wildlife management. For most of our careers, we have been catering to hunters and anglers, or to a ''hook and bullet'' audience, as we say in Georgia. We like this group, and we are comfortable working with them. But now the face of the wildlife user is changing. How and if we respond to this change likely will determine the fate of fish and wildlife agencies and fish and wildlife management as we know it.

The facts are these—the numbers of hunters and anglers is declining and the numbers of non-hunters and non-anglers who enjoy the outdoors is expanding rapidly. We can no longer assume that hunters and anglers can or will continue to foot the bill for the wide array of wildlife conservation, recreation and education programs being demanded by the public. If we do not bring some new wildlife supporters into the fold, it is very likely that state wildlife and fisheries agencies will be obsolete in the not too distant future.

The decline in the number of traditional wildlife and fisheries supporters can be illustrated dramatically by examining national hunting and fishing license sales (Figure 1). From a strictly numerical standpoint, the number of licenses sold has remained fairly steady over the past few decades. However, this is a deceiving picture. When you look at the number of licenses sold compared with population growth, you will see a drastic decline in the percentage of hunters and anglers in the U.S.

My home state, Georgia, is treading the same path as the rest of the nation (Figure 2). From the standpoint of number of licenses sold, it appears that Georgia's license sales are increasing or at least remaining stable. But, when you look at population growth in our state versus growth of license sales, you'll see the real picture. In 1960, 16.3 percent of Georgia's 3.75 million residents purchased hunting or fishing licenses. Between 1960 and 1994, Georgia's population has doubled. However, the number of licenses sold remained constant. In 1994, only 12.3 percent of the 7 million people in Georgia purchased licenses. In other words, Georgia's population has doubled in the past 24 years, but the constituent based as a percentage of the population has declined by 25 percent.

In contrast, the number of Americans participating in ''non-consumptive'' types of wildlife recreation, including backpacking, bird watching, wildlife photography, mountain biking and other activities, is growing rapidly. More than 100 million Americans indicated that they enjoy participating in non-consumptive wildlife activities (Figure 3), yet, most of them have had little or no contact with their state fish and wildlife agencies.

In 1990, 37.5 million people took trips specifically to view wildlife, up from only

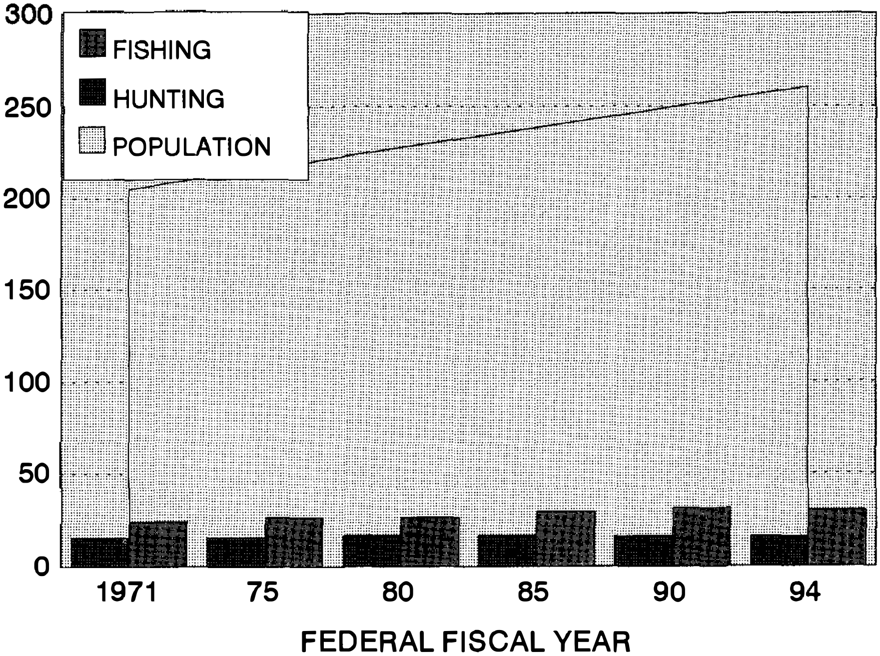


Figure 1. Hunting and fishing license holders compared with the total U.S. population, 1971–1994.

23 million in 1980 (Figure 4). Obviously, this audience represents a new and growing group of wildlife users.

And, with this new constituent base comes a new list of demands. Demands for lands on which to enjoy these different activities, demands for facilities on these lands and demands for a variety of wildlife to view. Unlike the demands of the hunters and anglers, however, the demands of non-consumptive users are not backed with funding.

We're all familiar with the overwhelming success of the Pittman-Robertson and Wallop-Breaux Programs. These two programs provided $411 million nationally in 1994 for wildlife and sport fish conservation and management. This user-pay, user-benefit program has had tremendous successes with restoring species such as wild turkey, white-tailed deer, wood ducks and many others to their native habitats. The money is dedicated to game and sport fish conservation, and this program is strongly supported by the hunters and anglers that fund it.

In Georgia, and in each of your states, we're facing a dilemma. We know that we need to "dance with the one that brought us," which is the hunters and anglers who have been supporting our programs for decades, but we have this large, growing group of non-consumptive users who also are making demands, albeit unfunded demands, for more non-consumptive use opportunities and for information on nongame species. Let me make it clear here that we are not seeking to abandon the hunters and fishermen. They are the backbone of our agencies. What we are struggling with is how to fulfill the needs of our traditional supporters while reaching out to these new users and providing for some of their needs. If we

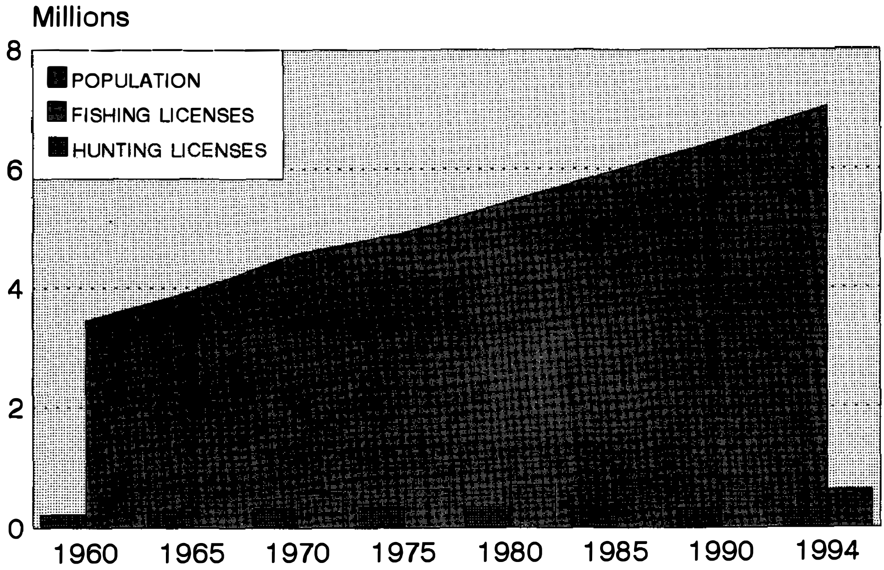


Figure 2. Hunting and fishing license sales in Georgia compared with the state's populations, 1960–1994.

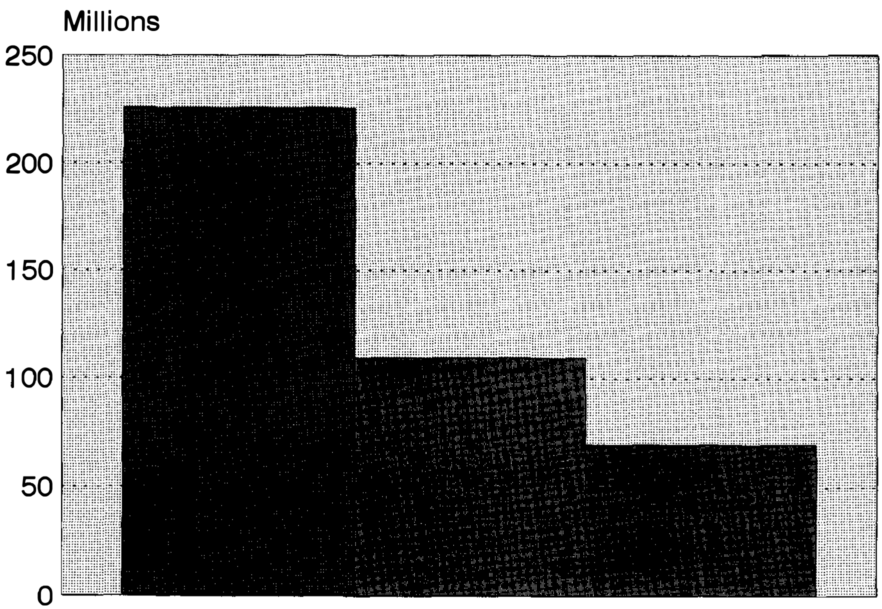


Figure 3. Numbers of nonconsumptive wildlife users, sportsmen (anglers and hunters) and total population in the U.S., 1990.

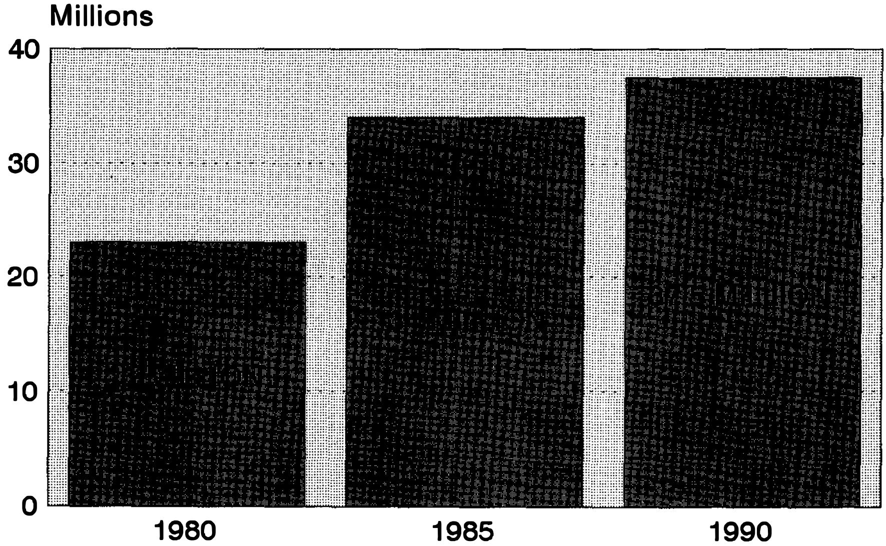


Figure 4. Numbers of Americans who took trips to view wildlife in 1980, 1985 and 1990.

manage to do this, we will create a much broader constituent base for all wildlife conservation programs.

While the Georgia Wildlife Resources Division would like to do more for nongame wildlife, we have very limited funds available for the task (Figure 5). Sixty-one percent of the Division's operating budget is funded by hunters, anglers and boaters through license fees and boat registrations. An additional 21 percent comes from the same group of individuals through surcharges on rods, reels, guns, ammunition and other equipment. And, unlike some other states, we are fortunate to receive some state funds from the General Assembly. Still, only 2 percent of the Division's budget comes from donations to the Nongame Program.

Division expenditures reflect this as well, with only 3 percent of the Division's $36.7 million budget being spent on the Nongame Program (Figure 6).

As in many other states, Georgia's Nongame and Endangered Wildlife Program is funded primarily by voluntary donations (Figure 7). For a few years, a state income tax checkoff resulted in an average of $500,000 annually for the nongame program. Last year, however, a competing tax checkoff was added to the state income tax form resulting in a 40 percent decline in donations. Georgia's Nongame Program will not exist for much longer if reliable funding is not established. The message is clear—if we are adequately going to address the conservation needs of nongame wildlife and provide enhanced recreational opportunities for non-consumptive users, then we need to establish a reliable source of funding specifically for this program.

With the introduction of the Wildlife Funding Initiative by the International Association of Fish and Wildlife Agencies, we have been given the avenue for doing just this. It is the solution to our problems.

The approach used in the Wildlife Funding Initiative is not a new one. It simply is an expansion of programs that started in the 1930s with the Pittman-Robertson

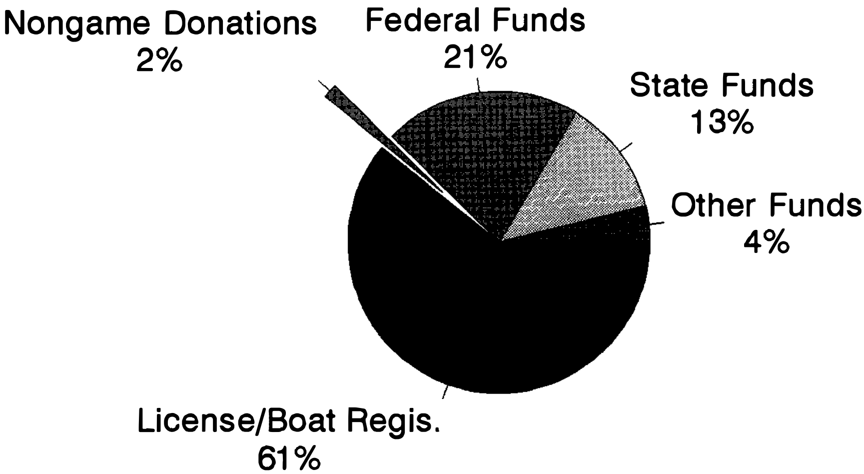


Figure 5. Sources of funding for the Georgia Wildlife Resources Division in fiscal year 1994.

Act, expanded in the late 1940s to the Dingell-Johnson Act, then into the Wallop-Breaux Act. Now we need to expand it once again to encompass nongame species.

The goal of the Wildlife Funding Initiative is to secure adequate and reliable funding for state nongame programs for the conservation, management and enjoyment of the diverse array of fish and wildlife species in the nation and to increase opportunities for people to observe and appreciate fish, wildlife and their habitats. The objective is to raise $350 million to be distributed in all 50 states.

Funds generated through the Wildlife Funding Initiative will be directed in three key areas—conservation, recreation and education. The money would be raised through a modest surcharge on a spectrum of outdoor products, including binoculars, hiking boots, backpacks, sleeping bags, field guides, birdseed, birdfeeders, tents, film, cameras and other equipment. In essence, it's a wildlife user-fee, paid for by those

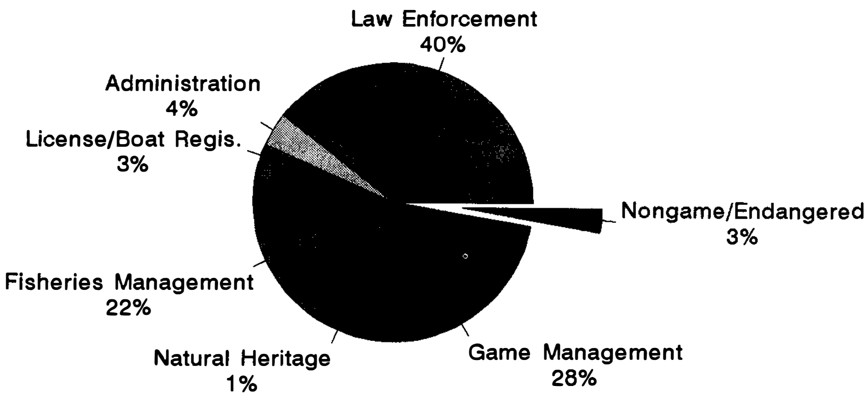


Figure 6. Georgia Wildlife Resources Division budget.

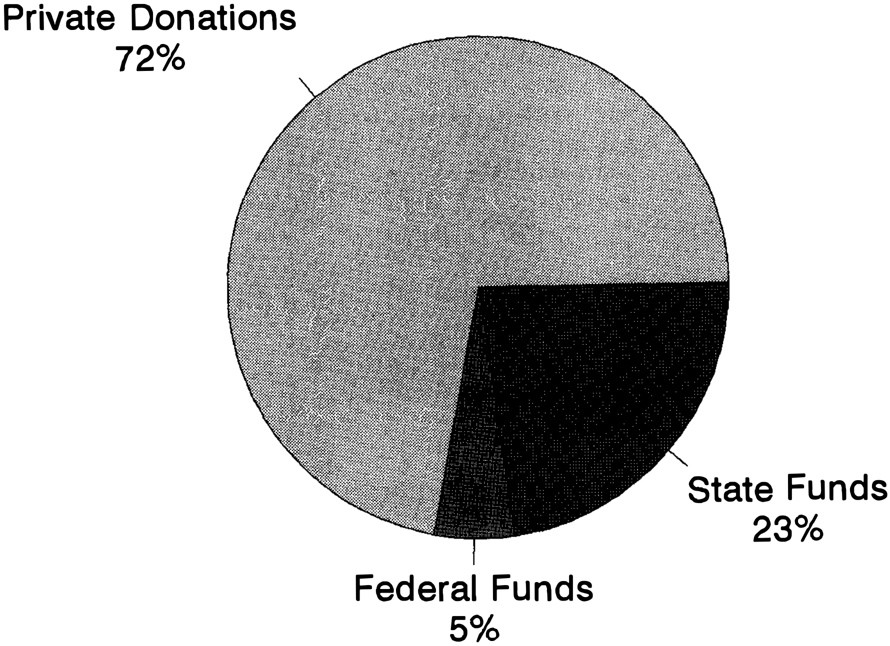


Figure 7. Sources for funding of Georgia's Nongame/Endangered Wildlife Program.

who benefit from and enjoy wildlife. The surcharge would never exceed 5 percent and it would be levied at the manufacturers' level. Studies show that Americans spend approximately $18 billion annually on wildlife-associated recreation and this number is increasing, not decreasing.

The question everyone is asking is, "how much is this going to cost me?" In Georgia, we are estimating the average wildlife enthusiast will spend about $5 per person. Nationally, it has been estimated that people will spend less than $10 per year. Still, this is less than the cost of two movie tickets and less than the cost of a family dinner at McDonalds.

The benefits would be great. In Georgia, we would use this money to build nature trails, hiking trails and canoe trails on state wildlife management areas, public fishing areas and parks. We also could build new facilities, such as picnic areas, restrooms, parking areas, campsites and other resources for wildlife enthusiasts.

From an education standpoint, we would develop wildlife management areas and public fishing areas as outdoor classrooms for use by schools, scouts and other groups. We also could use this money to further develop our recently purchased Charlie Elliott Wildlife Education Center where we plan to educate Georgia's youth about wildlife conservation and management and teach them how to be responsible environmental stewards.

From a program standpoint, Wildlife Funding Initiative monies could be used to purchase critical nongame habitats, to fund research and surveys on various nongame species, and to develop management plans for these species. Nongame species management will be blended into existing management programs that presently target game species on state lands.

Besides benefitting non-consumptive users, the Wildlife Funding Initiative will benefit sportsmen and women in several ways. First, by supporting the Initiative, hunters and anglers again will be taking a lead role in wildlife conservation. In addition, working with other wildlife enthusiasts will create a broader coalition and build additional political support and influence on critical conservation issues.

The Wildlife Funding Initiative also should be well-received by hunters and anglers since, for the first time ever, hikers, campers and other wildlife enthusiasts will be helping foot the bill for protecting and acquiring wildlife habitat to benefit both game and nongame species. Anytime you do good things for habitat, all wildlife benefits. In the same manner, all groups will benefit from the public-use facilities that will be developed on lands purchased with monies from this Initiative. The Funding Initiative also would provide much needed money for wildlife education programs which hunters and anglers have been supporting for years. In other words, the Wildlife Funding Initiative is a great opportunity for all wildlife enthusiasts to work hand-in-hand for wildlife conservation.

In order for the Wildlife Funding Initiative to pass, it must be supported by state fish and wildlife agencies, as well as a wide range of organizations and individuals. Already, IAFWA has signed on a long list of national supporters, including the National Audubon Society, BASS Anglers Sportsmen's Society, the National Wildlife Federation, The Wildlife Society, the American Fisheries Society, the Wildlife Management Institute and others.

Georgia has been working hard to gain support for this Initiative. In November, we held a coalition meeting for a variety of wildlife conservation and outdoor recreation organizations. It was a very successful meeting and also was the first contact the Wildlife Resources Division had ever had with hiking clubs, hang gliders, cavers and other non-consumptive use groups. We also have had good support from the outdoor press. Presently, we are developing a steering committee that will be responsible for overseeing the state-wide efforts to pass the Funding Initiative. In the meantime, we have developed a slide show which has been distributed to staff for presentation to all different types of wildlife and outdoor groups.

Another critical area on which we have been focusing is gaining congressional support. When the Republicans swept into office during last November's elections, many of us were gravely concerned that any chance of passing the Wildlife Funding Initiative was dead. I am pleased to report that this is not the case. While the Republicans say they are against any new "taxes," they do not see the Wildlife Funding Initiative as a tax. Instead, they say they can support the Funding Initiative's "user-pay, user-benefit" concept and are especially fond of the idea that the money will be returned to state and wildlife programs.

Another positive component of this Initiative to Congress concerns endangered species. Congressional leadership is not very sympathetic toward our present endangered species laws and the manner in which they have been enforced. Offering the Wildlife Funding Initiative as a means of keeping wildlife species from becoming endangered is particularly appealing to this Congress.

I met with the Speaker of the House, Newt Gingrich, and explained the importance of passing the Wildlife Funding Initiative. He said the Republicans could support this concept. Others also have been in contact with congressional representatives and have received favorable responses.

If your state or organization has not already signed on to the Funding Initiative, I encourage you to do so immediately. This has to be a grassroots effort involving all of the users. It is critical that you create a base of support within your agency and encourage your agency to take a national role in this conservation effort. If you have not already done so, you need to be forming state coalitions made up of conservation organizations and obtaining support of your congressional delegation. You also should be encouraging any industries in your state that would be affected by this Initiative to support this wildlife conservation effort. Naomi Edelson or I will be happy to provide any information you need to get up and running on this program. There are a lot of materials out there that can be adapted easily for use in your home state.

This is not a ''flash-in-the-pan'' project. We have been working on this since the 1980 passage of the Fish and Wildlife Conservation Act and have yet to secure a nongame funding source. The Initiative is the answer to the nongame funding dilemma. The time to get this Act passed is now, and I am confident that it can happen in this Congress. But in order for this to happen, each and every one of us, plus many others, must commit to the Initiative and work for its passage. It is critical that we get individuals, organizations and manufacturers signed on to press for passage of this important legislation. The Wildlife Funding Initiative well could be the most important piece of wildlife conservation legislation that many of us will see in our lifetimes. It is potentially the most important project that I, and many of you, will work on in our careers. Today, I am asking each of you to get involved, take a leadership role and ensure that you are a key player in passing this important conservation legislation.

Reinvention at BLM

Mike Dombeck
Bureau of Land Management
Washington, D.C.

I'd like to thank the Wildlife Management Institute for inviting me to speak with you today. During the past 14 months, while serving as the Acting Director of the Bureau of Land Management (BLM), I've come to appreciate the old Chinese curse, "may you live in interesting times." I'm pleased to be here to talk with you about where we are headed at BLM.

My crusade in the BLM is to improve the health of the land and the way we do business, to cut processes, keep things as simple as possible, and deliver scarce resources where they are needed most—on the ground.

In keeping with that, I'd like to take this opportunity to talk about three things: (1) BLM's mission and commitment to ecosystem management; (2) the effects of our reorganization on management of wildlife and fisheries resources; (3) how we will remain accountable to you, Congress and the American people.

About BLM

The United States have passed through three distinct eras in land and resource management. I'll call the first the "Dominion Stage." Lasting from the late 18th to the late 19th century, the Dominion Stage was characterized by an all-out effort by the government and its citizens to settle and tame the nearly 1.8 billion acres of original public domain.

Between 1789 and 1834, Congress accepted its public land responsibilities with zeal—passing more than 375 laws that adjusted the size of public land lots for sale, payment rates and schedules. Laws such as the Homestead Act contributed to the scattered and checkerboard ownership pattern of the public lands today. In 1812, the General Land Office was formed to process land patents and expedite settlement of the West.

Settlers moved West and used the land as they wished. Entire forests were harvested for fuel and farmland. Rivers and streams were dredged in the search for gold and other precious metals. Trespass on the public domain was common. By the 1870s, the federal rangelands were overstocked. Vicious grazing wars among cattlemen and sheep herders broke out. Miles of illegal fence were strung and water was at a premium.

The presidency of Theodore Roosevelt signaled a change in resource management—a period I'll call the "Conservation Era." Roosevelt expanded the forest reserve system and created the U.S. Forest Service to manage them. Other public lands were withdrawn from settlement and established as national parks, wildlife refuges and military bases.

Congress enacted a number of laws early in the 20th century that expanded federal control over use of the public lands and resources. The Taylor Grazing Act of 1935 created the Grazing Service to administer public rangelands. The General Land Office and the Grazing Service were merged to form BLM in 1946.

The Conservation Era was characterized by Gifford Pinchot's belief that federal lands should "provide the greatest good, for the greatest number, for the longest time." This belief inspired the philosophy of "sustained yield."

Rachel Carson's publication of *Silent Spring* in 1962 increased America's awareness of the importance of maintaining the land's health. Passage of the National Environmental Policy Act (NEPA) required federal agencies to document environmental effects of proposed development and harkened the third era of resource management in the U.S.—an era I'll call the "Multiple-use Era."

The Multiple-use Era expanded public involvement in land-management planning and decisionmaking. Passage of the Endangered Species Act, the Clean Water Act and other environmental legislation reflected the country's resolve to protect noncommodity resources, such as wildlife and fisheries, clean water, recreation, and aesthetic and spiritual values.

Multiple use was codified as BLM's mandate by passage of the Federal Land Policy and Management Act (FLPMA) in 1976. Through FLPMA, Congress recognized the value of the public domain to the American people and declared that these lands would remain in public ownership.

Through the 1980s, the Multiple-use Era was marked by costly lawsuits and contentious disagreements. These lawsuits and logjams have had a detrimental effect on natural resources and on our relationships with the local communities that depend on them.

Today, BLM administers 270 million acres of public land—more land than any other federal or state agency. The lands we manage range from fragile Arctic tundra to sun-drenched Southwest deserts. We are responsible for:

- 50 million acres of forests;
- more than 23 million acres of wetlands;
- nearly 169,000 miles of fishable streams;
- 4 million acres of lakes and reservoirs;
- 1.6 million acres of designated wilderness;
- about 170 million acres of public rangelands; and
- habitat for more than 3,000 wildlife species, including many that are threatened or endangered.

We maintain and administer thousands of recreational areas that are used for popular activities such as fishing, hunting, camping, hiking, boating, mountain biking, canoeing, climbing and even hang gliding. BLM lands are places of solitude and spiritual renewal for thousands of Americans. They also contain:

- 12.5 trillion cubic feet of proven natural gas reserves;
- about 1.4 billion barrels of proven oil reserves;
- about 80 percent of the nation's oil shale; and
- nearly one-third of the nation's coal supply.

Ecosystem Management

The western states are growing faster than any other part of the country. People are moving to previously undeveloped areas; expecting more from the government and more from the land. Demand is shifting and society's needs are shifting.

Nowhere in government is that change more evident and challenging than at BLM. Our constituents are as diverse as the American people. Miners, fishermen, ranchers, environmentalists, recreation users, timber companies, Native Americans, oil and gas developers, hunters, and so on. It is safe to say that we manage a more diverse set of resources, interests and values than any other agency in the federal government.

But, for too long, management of the public lands has been contentious and controversial. BLM and other federal land-management agencies too often have served as foils for interest group disagreements and lightning rods for litigation.

If we have learned anything from the past, it's that natural resources are better served when agency money is spent on the ground and not in court. We have many challenges:

- the exponential spread of noxious weeds threatens productivity of public and private lands;
- the number of threatened and endangered species continues to increase;
- stream courses and riparian areas are in desperate need of repair; and
- poor forest health and degraded water quality compromise the land's health.

Our challenge is to break the gridlock and restore the land's health. We must fundamentally change the way we look at and care for the land.

The first step I took as BLM's Director was to simplify the long and confusing mission statement. Today, all BLM employees have a single charge: to sustain the health, diversity, and productivity of the public lands for the use and enjoyment of present and future generations. This recalls the old proverb: "We have not inherited the land from our forefathers; we have borrowed it from our children."

I have given two very basic instructions to my line managers and all BLM employees: (1) maintain and restore the health of the land; and (2) improve the way we do business. These strategic goals are spelled out in BLM's *Blueprint for the Future.*

Although our objectives differ slightly, we all would agree that we must protect the natural diversity, productivity and integrity of the land; and never compromise the ability of future generations to draw social, economic, aesthetic and spiritual benefits from the land. These are our guiding principles—the most basic distillation of ecosystem management that I know.

Reorganization

I want to thank the many people and organizations in this room who have gone to bat before Congress for BLM's wildlife and fisheries program. In fact, Lonnie Williamson helped to establish on BLM lands the first federal wildlife challenge cost-share program in the country. Thanks to your support, this year, BLM will parlay a \$6-million challenge cost-share appropriation into \$16 million of habitat improvements. Our wildlife and fisheries habitat budget has grown from approximately \$17 million in 1987 to \$48 million in 1994.

The BLM is a more effective resource management agency due to your efforts. In fact, our new mission statement reflects your hard work. Yet, many here have expressed concerns, often very loudly, about how BLM will remain accountable to Congress and the American people as we reorganize, blur program lines and allocate more control to field managers.

I appreciate your concerns. I've worked for federal land-management agencies for

17 years, including a stint as the Forest Service's Fisheries Program Manager. There were few people more functional or "tunnel visioned" than I. I know that change is not easy. Our goal is not to dismiss programs such as fish and wildlife, range or recreation, but to integrate their goals in an interdisciplinary manner across every watershed that BLM manages.

For too long, we have used the program structure to respond to the *effects* of resource degradation rather than addressing the root *causes*. In the past, we waited until a species reached the brink of extinction before invoking the Endangered Species Act to "recover" them. It is a thankless and nearly impossible task. Although the ESA must remain a critical tool to prevent extinction, managing ecological systems in their entirety, rather than focussing on their parts, is the essence of good stewardship. As John Muir said, "whenever we try to pick something out of the universe, we find it hitched to something else."

In 1987, BLM developed *Fish and Wildlife 2000*, soon after, several programs—forestry, range, and wildlife and fisheries—individually developed initiatives that addressed riparian area protection: *Our Growing Legacy, Range of Our Vision* and the *Riparian Wetland Initiative for the 90s*. These initiatives are the building blocks of BLM's approach to ecosystem management.

But we must move forward into the next generation of land and resource stewardship. Whether we call it ecosystem management, watershed approaches or holistic resource management is unimportant. The important thing is that efforts such as PACFISH, the President's Forest Plan for the Pacific Northwest and our efforts to improve rangeland health are unprecedented opportunities to protect and conserve watershed function and health. For example, implementation of the new grazing rule will help us to:

- restore the health of 100,000 acres of riparian areas;
- bring 20 million acres of upland habitat into properly functioning condition;
- improve water quality and watershed health by reducing erosion, increasing water quality, ground water recharge and streamflow;
- benefit most plant, animal and fish species; and
- enhance recreational opportunities such as fishing, hunting, hiking, tourism and wildlife viewing.

We will replace rancher dominated grazing advisory boards with diverse resource advisory councils to help us develop state or regional standards and guidelines that protect the *physical function and biological health* of the land.

Our focus and responsibility must be to work together to ensure that future generations enjoy the benefits of healthy, diverse and productive public lands. This will require us to work more closely than ever before with other federal and state fish and wildlife agencies.

We must share scarce skills, work across agency lines and exchange resource information. In short, we must work with local communities and the American people to develop a common vision for maintaining the health of the land.

Accountability

The emphasis is shifting from program structure to ecosystem integrity and should be applauded and supported by biologists.

Consistent with our mission, we will measure our effectiveness—evaluate our performance—by the condition and health of the land. Don't look for our performance measures in some dusty, unused manual. They must be visible across the landscape, in ways that resource professionals and taxpayers alike support, appreciate and understand. Let us not choke the system with technical data, rather, we should emphasize tangible benefits such as:

- greener riparian areas that buffer floods;
- more song birds;
- stable streambanks that prevent erosion;
- replenished ground-water reserves;
- better hunting and fishing;
- more wildlife viewing opportunities;
- increased flow in ephemeral streams;
- high-quality domestic water supplies;
- a resilient mix of native grasses;
- better grazing; and
- healthy, disease-free forests.

Help us to identify these indicators of ecosystem health. Contact our Washington office and become involved in developing Bureau-wide performance measures, indicators that measure the physical function and biological health of the land.

My promise to you is that if threshold levels of these indicators are exceeded, BLM managers will modify resource use levels and management direction. If we fail to maintain the health, diversity and productivity of the land, we have essentially abrogated our trust to the American people.

If we do our job right, local communities will be with us. The days of command and control approaches to resource management are over. People must recognize and appreciate the social and economic benefits of maintaining healthy and diverse ecological systems. I'm asking for your help. We need your active participation. We must know the condition of our lands and work together to achieve their health.

Challenge us to lead by example. Don't look to Washington, D.C. for a prophet to guide you. We, in this room, are the catalysts of change. Help us to think in new ways and be innovative. Challenge us to err on the side of maintaining the land's health. This is our charge from the American public and your challenge as natural resource professionals. Never forget that the actions we take today shape the future of tomorrow's children.

Responsibilities of the National Biological Service

H. Ronald Pulliam
National Biological Service
Washington, D.C.

The nation's biological resources are the basis of much of our current prosperity and an essential part of the wealth that we will pass on to future generations. Our very existence is dependent on the plant and animal products that provide us food, fuel, fiber, shelter and pharmaceuticals. Thousands of other biological products, although less essential, greatly enhance the quality of our lives and directly contribute to the vitality of our economy. However, these are not merely standing resources of finite size and value, they are living systems that, if conserved, will continue to produce wealth for future generations. In addition to the biological products that enter our market economy, biological diversity plays an essential, yet, largely unappreciated role in maintaining critical ecosystem services such as clean air, clean water and fertile soil.

If biological resources are an essential part of our nation's wealth, then, like other forms of wealth, biological diversity constitutes a resource that should be managed wisely so that it continues to produce the stream of goods and services that underlie our health and economic well being. Proper management of any resource requires (1) inventorying the resource and monitoring its condition over time, (2) understanding the factors determining its supply and demand, and (3) analyzing options for current and future uses of the resource. I will outline what I see as the proper role of the National Biological Service (NBS) in meeting these needs and thereby fulfilling its responsibility to provide the scientific support necessary for the wise management of the nation's biological resources.

Tactical and Strategic Approaches to Research

Inasmuch as an understanding of how natural systems work is an essential step in the proper management of natural resources, all environmental studies can be considered to be applied research. For this reason, when discussing biological research within NBS, it is more instructive to distinguish between tactical and strategic research, as opposed to the usual dichotomy of applied versus basic research.

Tactical research consists of those studies addressing the immediate information and technology needs of managers, regulators and policy makers. Tactical research is focused on issues already identified as serious problems, requiring immediate attention. In a very real sense, tactical information is needed "yesterday," because the lack of adequate information already is impeding the ability to act quickly. As a result, tactical studies almost always are hurried, information is preliminary and results often are incorporated into decision making without the benefit of serious peer review.

Strategic research, on the other hand, is aimed at addressing emerging and future problems. Resource managers, policy makers and practicing scientists all have unique and valuable perspectives on what environmental problems will emerge in the future, so all have a legitimate role in the setting of priorities for strategic research. Because the applications are not so imminent, strategic studies, unlike tactical studies, usually are competitively awarded and fully peer reviewed at both the pre-award and publication stages.

One of the most pressing challenges facing the National Biological Service is devising an approach to science that integrates tactical and strategic research. Of course, these two types of biological research need not, and should not, be completely separated. The division can spawn an unhealthy split between scientists who stress responsiveness and the immediate practicality of their research, and those who pursue more thorough, long-term work aimed at advancing general scientific understanding. NBS will have to do both of these things, and meeting our broad and ambitious mandate will require that each NBS scientist embrace both perspectives and seek creative approaches to linking tactical and strategic approaches.

This is a challenge that NBS is prepared to carry out. NBS scientists have a history of meeting management needs while advancing our understanding of environmental biology. For example, scientists now working for NBS helped discover that environmental contaminants were the cause of declines in the populations of bald eagles and other birds of prey. This tactical research led to the policies that have brought back the eagles, and it also contributed greatly to the strategic goal of understanding the potential impacts of contaminants on fish and wildlife. By linking tactical and strategic research, these scientists helped save our national bird, and they built a body of knowledge that has made lasting contributions to environmental quality.

This is just one example of how the tactical and strategic missions of the NBS must be integrated. We must learn how to do more than one thing with each research dollar. NBS must look for synergies in its research efforts by pulling together researchers with different skills and perspectives so that they may more effectively collaborate and link the immediate information needs of managers with the broader scientific goals. This integration of tactical and strategic approaches will help solve today's problems while we avoid tomorrow's, and it should enhance the cohesive and creative culture of NBS science.

The National Biological Service

The mission of the National Biological Service is to work with others to provide the information and technologies needed to manage and conserve the nation's biological resources. We must integrate tactical and strategic approaches in order to manage and conserve our biological resources. Also clear is the need to work with others in order to achieve a goal as large as providing the information needed to manage and conserve the nation's biological resources.

As the biological sciences arm of the Department of Interior (DOI), NBS has as its primary focus serving the biological science needs of other DOI bureaus. The DOI has management and oversight responsibilities for more than 20 percent of the nation's land, plus responsibility for Interior "trust" species, such as migratory birds, anadromous fishes and endangered species. NBS also has the broader role of working with others in a "National Partnership" to ensure that a more comprehensive and holistic approach is taken to providing information about the nation's biological resources. Let me first discuss the NBS responsibility to other DOI bureaus.

The NBS was created by merging the biological research, inventory, monitoring and information technology capabilities of seven Department of Interior bureaus, namely the U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, Minerals Management Service, Office of Surface Mining, Bureau of Reclamation, and Geological Survey. Collectively, these bureaus have immense management and regulatory responsibilities, and NBS has inherited the task of providing them with the biological information and technologies needed to carry out their responsibilities.

Let me illustrate the kinds of research performed by NBS in support of other DOI bureaus with a few examples:

Migratory waterfowl research. NBS devotes substantial resources to waterfowl research. Some of this research is tactical in that it addresses immediate management and regulatory needs, but much of it is strategic in as much as it attempts to understand the basic biology and ecology of waterfowl species in order to anticipate and better deal with future waterfowl issues.

Great Lakes fisheries. NBS monitors fish populations in the Great Lakes and provides scientific information to support improved management of recreational and commercial fisheries. Science units now in NBS conducted the original research that led to the control of sea lampreys in the Great Lakes and allowed the recovery of a viable fisheries industry there.

Contaminants and wildlife health and disease. As mentioned above, bald eagles have increased in abundance over much of the country, but there are continued threats. Last December, I received a call from the Director of the Arkansas Game and Fish Commission asking NBS's help in determining the cause of the deaths of 25 bald eagles on one lake in that state. NBS has unique, world-class expertise in contaminants, and in fish and wildlife health and disease, and we are committed to maintaining that expertise.

Non-indigenous species. The Government Accounting Office estimates that the cumulative impact of non-indigenous species to be on the order of $100 billion. The Department of Agriculture has the primary lead in the control of agricultural pests, but NBS has major responsibility for programs designed to understand and control non-agricultural pest species, such as the brown tree snake in the Pacific, invasive weeds on western range lands, and zebra mussel in the entire mid-continent region. The success of tactical efforts to develop and apply appropriate control methods and technologies is underlain by a strategic research program in NBS on the biology of invasive species and specific pests.

Research in parks. NBS now is home to a number of former Park Service Cooperative Units based at universities across the country, as well as scientists stationed in national parks. These NBS scientists have a long-term commitment to understanding the ecology of our national parks and providing quality information to park managers. This type of "site-based" research serves as a useful model for how NBS can provide timely information to other DOI land-management bureaus.

Support of states. In addition to supporting the research needs of DOI bureaus, NBS provides essential services to states than cannot be efficiently performed by the states themselves. In addition to supporting work in fish and wildlife health and disease, NBS provides states with essential information on species that cross state boundaries, such as migratory waterfowl and anadromous fish.

NBS also is the home of the Fish and Wildlife Cooperative Units, which are perhaps the most successful joint venture ever between states and federal government in support of fish and wildlife research and conservation. When NBS was formed, Congress provided an additional $3.6 million in support of the Coop program that has allowed us to fill 19 vacancies in the past 12 months. Our 1996 budget request to Congress requests funding to expand the Coop system into additional states.

Partnerships with the private sector. Although NBS research focuses on public lands and Interior trust species, we do have a growing number of research partnerships with private industry. For example, International Paper has invited NBS to inventory and study rare wetland plant species that occur on their properties. This research is leading to a better understanding of the habitat requirements of these plants and likely will result in revised management plans which allow for conservation of the plants without interfering with timber management and harvest practices. This is but one example of a win-win situation where solutions are found outside the regulatory context, benefiting both business and the environment.

National Partnership for Biological Survey

The 1993 report of the National Research Council (NRC) entitled, ''A Biological Survey for the Nation,'' called for the establishment of a National Partnership for Biological Survey ''to collect, house, assess, and provide access to the scientific information needed to understand the current state of the nation's biological resources (status), how that status is changing (trends), and the causes of the changes.'' As envisioned by the NRC, the new Partnership would be a ''new national, multisector, cooperative program of federal, state, and local agencies; museums; academic institutions; and private organizations.''

The NRC report clearly recognized that NBS has much broader responsibilities than ''the inventory and mapping functions that the use of the word survey might imply.'' In fact, inventory and monitoring account for only 13 percent of the NBS budget and is focused mostly on federal lands and on Interior trust species. These inventory and monitoring studies address both tactical needs, such as the need to set hunting and fishing regulations, and strategic needs, such as anticipating future population declines so that potential problems can be headed off before they occur.

NBS has been mischaracterized by some as a ''giant survey of all flora and fauna.'' This has led to an unfortunate image of NBS as a threat to private land rights because of the assumption that NBS would need unrestricted access to private property, as well as public lands, in order to survey all species. NBS recognizes the need for more statistically reliable monitoring and inventory information, but NBS is not a giant survey of all species. NBS can help to provide better information, not by conducting a giant survey but, rather, as suggested by the National Research Council, by encouraging the development of a partnership between federal, state and private organizations to ensure the availability of more reliable information.

Working through such a National Partnership, NBS can play an important role in ensuring that there is more and better information on the status and trends of the nation's biological resources. First, we can work with the Interior land-management agencies to ensure that there is adequate inventory and monitoring of the biological trends on Interior lands and adequate information about Interior trust species. Second, we can work with other federal agencies, states and the private sector to ensure that more rigorous standards and protocols are developed for monitoring biological populations. In this role, the major NBS role would not be to conduct new surveys, but rather, to help provide a common "architecture" that ensures the reliability of the information collected by others. Third, NBS can play a critical role in making certain that both existing and new information are fully available to decision makers, both within and outside government.

The National Partnership for Biological Survey is the key to providing the nation with more reliable information on the status and trends of biological resources, and NBS can play a key role in establishing and fostering this partnership. Among the ongoing and planned activities of NBS that relate directly to the establishment of the Partnership are the following:

National Biological Information Infrastructure. The National Biological Information Infrastructure (NBII) is an integrated effort on the part of NBS to improve electronic access to existing and new information about the nation's biological resources. The goal of NBII is to create partnerships with government agencies, states, universities, museums and the private sector for sharing biological and ecological data, and to make certain that good information is available to other scientists, decision makers and the general public. The NBII will help us make better use of the data that we already have.

State Partnership Program. Interior agencies have responsibility for the management of relatively few species (e.g., migratory birds, anadromous fishes and endangered species); states have the trust responsibilities for the vast majority of species. The NBS State Partnership program is our way of working with state agencies to improve existing data and develop common protocols and approaches to collecting new information. To date, NBS has funded pilot programs in five states; we currently are accepting applications for new State Partnerships and we have requested funds to expand the State Partnership program in 1996.

Taxonomic Authority System. Correct taxonomic identification and classification of species is an underpinning of all biological research. NBS is working with the systematics and museum community to develop a directory of systematics expertise, and to improve the availability and accessibility of biological information in museum collections. This information will directly support NBS inventory and monitoring activities and will provide a focal point for museum activities in the National Partnership.

Developing an Integrated Ecosystem Approach

Ecological "train wrecks" come from focusing too narrowly and not seeing other trains on the same track, from taking a single-resource or a single-species approach when there are many competing interests, and from focusing on current needs and not looking ahead. The first and most important step in avoiding these crises will come from molding previously unrelated research efforts into a unified attempt to understand whole ecosystems. This goal reaches beyond the integration of tactical and strategic approaches and will require NBS to link its research to other programmatic areas.

Two major efforts are underway now:

1. Inventory and monitoring programs, which establish the status and trends, are being linked to research on the driving forces that cause the trends. Obvious driving forces are contaminants, exotic species, climate change, and land-use and management practices. Monitoring both trends and driving forces at varying spatial scales can help establish testable hypotheses to guide research activities and adaptive management efforts.

2. NBS activities are being coordinated with management and other research activities. Most regional natural resource issues involve numerous parties from both government and private sectors. Each will have expertise and information relevant to a specific aspect of the issue or region. Only through close integration can a coherent understanding emerge regarding what questions must be addressed and what information and expertise are available.

Better Information for Better Decisions

Regulatory agencies are mandated by Congress to make decisions on the basis of the best available information. Unfortunately, the best available information often is incomplete or inadequate. Nevertheless, management decisions still must be made. The basic problem is the lack of solid, reliable scientific information, and this is a problem that NBS and the National Partnership can help to fix.

I believe there are good reasons why biological science in the Department of Interior should be done by an independent, non-advocacy science agency, rather than by a regulatory agency. Research in a regulatory agency is, by necessity, often focused on the immediate crises faced by the agency. For example, I believe that past biological research in the Department of Interior has focused too much on saving already endangered species and not enough on preventing species from becoming endangered. In essence, there has been an overemphasis on tactical research that addresses immediate needs at the expense of strategic research aimed at preventing future problems.

Furthermore, the information collected by regulatory agencies too often is kept internal to the organization, not fully peer reviewed and not readily available to all concerned. Regulatory agencies, by their very nature, have an agenda, and scientists in a regulatory agency are there to serve the mission of that agency. Some of the most productive and accomplished scientists in the world work for government agencies. The real issue is not how competent or well-trained the scientists are, but, rather, whether government scientists work in an atmosphere that promotes good science and the open review and exchange of ideas and information, even when that information may not fit with prevailing opinions.

NBS is an independent, non-regulatory, non-advocacy science bureau dedicated not only to improving the quality of research through peer review and competitive funding, but also to making the results of our research available to all parties involved.

We believe that better access to information will result in greater scrutiny of that information and an even playing field for all parties. Sometimes the information provided by NBS will lead to greater protection of species and their habitats and sometimes the information will lead to less regulation. NBS has the obligation to provide better, more reliable information without regard to whose agenda is served by that information.

In the final analysis, NBS is an organization founded on the proposition that better scientific information and increased access to information will result in better and fairer decisions.

Forest Health: What It Is, What We're Doing About It

Jack Ward Thomas
USDA Forest Service
Washington, D.C.

Introduction

When I became Chief of the USDA Forest Service, I could not have imagined that, in less than a year, I would be facing the friends and families of fallen wildland firefighters, trying to make some sense of our tragic loss. I could not have envisioned the loss of property, the damage to plant and animal resources, and the pain of human suffering that would be the fire season of 1994. As the old cowhand said, ''There were a few things they didn't tell me when I signed on for this job.'' Dealing with the deaths of 28 young people we sent into harm's way certainly was one of those things they didn't tell me would be part of my job. While the concept and the debates surrounding ''forest health'' are not new, the wildfires of the summer of 1994 galvanized the attention of the public and their elected representatives on this subject.

As Chief of the Forest Service, this is the first time I've had the opportunity to address the North American Wildlife and Natural Resource Conference. In talks elsewhere, however, I've discussed the challenges facing the Forest Service and shared some of our plans for reinforcing our role as a conservation leader. Today, I speak specifically about the challenge of dealing with forest health—what it is, what we are doing and will do about it, and how all of this relates to ecosystem management. If we, as a community, are to be ranked among the conservation leaders of the world, we must successfully respond to this challenge. This is a calling far beyond simple preservation of species and it is a calling to the highest professional levels of management actions.

What It Is

Background

Although not all of America's forests are unhealthy, many of our forested lands today are in a state which threatens the capability of these lands to produce timber, maintain desired habitats, protect soils and provide desired aesthetic values. The greatest immediate concern is for systems where altered ecological conditions have increased susceptibility of forests to drought, pest epidemics, and extensive and unusually hot wildfires.

A desired state of forest health is a condition where biotic and abiotic influences do not threaten resource management objectives now or in the future. Forest health is about the growing awareness that human activities over the past century have had some undesirable effects, and these effects now are becoming apparent.

Across the country, timber cutting, introduction of domestic livestock (cattle and sheep), elimination of burning by Native Americans and increased effectiveness of fire suppression efforts have radically altered the composition and structure of forests. For example, Douglas fir and white fir now dominate many ponderosa pine stands, making them more susceptible to insect epidemics (Mutch 1992). Western spruce budworm, Douglas fir tussock moth and mountain pine beetle kill and defoliate trees.

The problem culminates when stands with heavy fuel loadings resulting from extensive tree mortality burn at high temperatures over large areas. Such high-energy fires are apt to be much more damaging than past forest, because dense ''ladder'' fuels allow forest to move into tree crowns.

These ''crown'' fires produce higher intensity, rapidly spreading fires, often producing their own wind, that are difficult or impossible to control. In some cases, such forest can heat soils so excessively that, for some years afterwards, nutrient levels are drastically lowered and soils actually repel water, causing watershed and water-quality impacts. Following such forest, it may take years to restore forest ecosystems to some semblance of their former state.

One of the greatest areas of concern often is referred to as the wildland/urban interface. Here, forest health problems that lead to intensive and inordinately hot wildfires are dramatically magnified as more and more people build homes in natural settings where fires historically burned every 5 to 30 years. Until we find ways to reduce wildfire risks in these areas, we will increasingly find ourselves deploying our fire suppression resources in ways that dramatically diminish our capacity to protect natural resource values. This is an issue that cries out for careful evaluation. The problem is worsening at an increasing rate. Who protects these homes and who pays? Also of critical concern are areas where the risk of losing key habitats for threatened, endangered and sensitive species is greatest.

Forest Health and Ecosystem Management

What is the relationship between forest health and ecosystem management? First, let me give my definition of ecosystem management. Ecosystem management is a concept of natural resources management wherein national forest activities are considered within the context of economic, ecological and social interactions within a defined area or region over both short and long term.

A few months ago, the Forest Service published a document outlining our agency ethics and course to the future (USDA Forest Service 1994a). This document makes it clear that we draw passion and commitment to our mission from our land and service ethics. Very simply, our land ethic is ''Management of the National Forest so as to meet human needs while maintaining the health, diversity, and productivity of ecosystems.'' Planning is conducted using regional or area assessment of economic and social effects to enhance management decisions for the affected national forests. Information developed is made available to other interested parties.

By sustaining healthy ecosystems, present and future generations will be able to reap the benefits that healthy, diverse and productive ecosystems provide. Our ethic is one that includes the active use of ecosystems, ranging from extensive to intensive management, to gain these benefits—so long as use does not unduly impact ecosystem sustainability. And these resources of wood, water, recreation, fish and wildlife, and forage can be subject to management actions to increase yields.

In other words, our first priority is ensuring ecosystem health in order to provide the foundation for all life. Our concept of ecosystem health builds on Leopold's definition of land health as a vigorous state of self-renewal (Leopold 1949). We believe that ecosystem health must incorporate resiliency and diversity of composition, structure and function, including the variety of genes, species, plant and animal communities, and the processes that connect them through time. As our understanding grows, we will collaborate with others to refine, as appropriate and timely, definitions of ecosystem health.

So, for the Forest Service, the concept of forest health is rooted in the concept of healthy forested ecosystems and reflects a condition where "biotic and abiotic influences do not threaten resource management objectives now or in the future" (USDA Forest Service 1993).

The concept also recognizes that a healthy forest is one that "is a fully functioning community of plants and animals and their physical environment" (Monning and Byler 1992). It is clearly much more than the concept of "tree health" or even of "stand health," and recognizes that fire, insects and disease, at appropriate levels, are essential components of healthy forests. These appropriate levels will be influenced by the objectives of managers and by the cost/benefit ratio of management actions.

The concept of forest health must always include the answer to the question—"healthy enough for what?" This implies that there is a purpose to management and "health enough" is part of reaching the management goal. The answer would be very different for a wilderness area and an intensively managed plantation.

The philosophy of ecosystem management embodies many of the principles and practices that we will employ to reach our goal of healthy and sustainable systems.

These principles include comparing patterns and rates of change with historical conditions as criteria for measuring forest health, with a recognition that ecosystems are dynamic, complex and often unpredictable. They include a recognition that ecosystems occur at multiple scales which cross a variety of human boundaries. These principles recognize that people are part of ecosystems and consider our past influences, present values and future desires for ecosystems. In fact, as many have said, ecosystem management is more about people than anything else. (H. Salwasser personal communication: 1994).

To sum ecosystem management up in one word, I would choose the word "scale." By this, I mean an increased scale in terms of time—considering the effects of our actions in terms of long-term sustainability, scale in space—considering the effects of our actions in the context of larger landscapes, ecosystems and the world, and a scale of factors included—considering a broader array of attributes, including human effects and effects on humans.

What We're Doing About It

Specific Actions

In moving to address the long-term forest health problem, no single approach or action will fully suffice. Successful activities will require matching up management practices to achieve the desired future condition for each site and, in turn, the overall forest mosaic. The best foundation for determining this desired future condition is a comprehensive assessment of the processes that maintained a given ecosystem over time. There are several such studies underway.

One is the Forest Service and Bureau of Land Management's Eastside Ecosystem Assessment Project for the Columbia Basin. Such ecosystem assessments and the forest plans that will be based on these efforts should significantly increase the likelihood that long-term actions taken to resolve current forest health problems will be successful. We can't wait for the completion of all needed assessments, however, before beginning action.

We have a reasonable idea of what might be done to alter these conditions. Strategies for accomplishing this and other findings are outlined in the report called the *Western Forest Health Initiative*, compiled by a special Forest Service team in late 1994 (USDA Forest Service 1994b). Recommendations include identifying landscapes that currently are most susceptible to catastrophic wildfire and targeting them for treatment using prescribed fire, thinning, timber harvest or mechanical reduction of fuel loading to produce conditions closer to the normal range of variation for the ecosystems involved. The team recommended placing special emphasis on urban/wildland interface areas that are most at risk.

Priorities concerning areas to be treated should be set on the basis of protecting human life and property, protecting key ecosystem resources such as critical endangered species habitat, economic efficiency, environmental effects, resources available, insect and disease risk, and capacity of industry for processing woody material removed from treated sites. Obviously, some areas might best be left alone.

Areas in which intense and debilitating controversy is certain likely will be bypassed initially. But let me make one thing very clear—in order to address forest health problems, to salvage some of the trees killed by last year's fires and to help meet people's need for wood fiber, we *will* pursue an active and aggressive salvage program. To do otherwise is to shy away from our responsibility to care for the land and serve people.

There are people in these places and communities who depend on us to be good stewards of resources. Such stewardship includes using those resources to benefit people by providing timber to the mills, wood products for the American people and jobs for our citizens. We must not exploit natural resources to sustain our economy. That is certain. What never is certain is what will occur in a sustainable system of management. Such is our challenge and goal.

As Chief of the Forest Service, I can no longer abide the agency being mired in a quagmire of controversy and suffering a paralysis born out of a fear of this controversy and the threat of challenge to every action. I was taught, long ago and far away, that conservation was wise use and that conservationists were leaders. We intend to be conservation leaders.

Conservation leaders must take the nation out of the present state of incessant and exacerbating wrangling. If conservation leaders of every stripe do not lead in addressing the issues of forest health, we will follow where circumstances of the political surges lead. I can tell you from my recent prolonged experience on the battlefield of the Potomac that we are at a crossroad. We have, as the "pros" say, a situation on our hands that simply is not tolerable—either in terms of responsible management or in terms of the developing political situation. There will be change. Have no doubt about that. We can lead—but time is short. Or, we simply can be irrelevant.

Conclusions

Innovative and extraordinary measures are needed to restore forest health in stressed forests. Although not all forests are unhealthy, restoration of forest health is a nationwide problem and a national priority for the Forest Service. The dynamic nature of forested ecosystems, combined with human interactions, provides a vast array of challenges to our goal of maintaining healthy forested ecosystems. In treating the symptoms of forest health problems, it is well to apply a rule from medicine for its practitioners—"First, do no harm." Such should and will be in our minds.

Of most immediate concern are the forest health and wildfire problems in ecosystems with historic 5- to 30-year fire return interval, particularly those in the intermountain West. The question is not whether these areas will burn, but when and how. The human and monetary costs of continued management inaction in these areas will continue to mount for forest resources and private property in the adjacent wildland/urban interface. I do not believe we simply can step back and wait for "nature" to take its course.

In 1994, 40,000 fires burned more than approximately 1 million acres (405,000 ha) of state and private lands, and 12,000 fires on National Forest lands burned more than about 1.2 million acres (486,000 ha). Total costs on National Forest System lands exceeded $700 million and more than 28,000 firefighters were in action at the peak season. Twenty-eight of those special people died in the effort.

Many of these were high-intensity forest, indicating ecosystems dramatically outside of their normal range of conditions.

They were the kind of fires that indicate a forest health problem that will not go away at the end of a severe fire season with the arrival of winter snows and spring rain.

The same problems will be with us next summer and many summers in the future unless we recognize that actions are necessary to return the vital process of fire to environments that have evolved and adapted in its presence. I do not believe that what has happened this past fire season as a regular phenomenon will prove acceptable to the American people as a solution to the problem.

I do not believe that failure to salvage, with appropriate care, some significant portions of the billions of board feet of dead and dying timber while there are willing workers without work, a demand for the wood and increasing social stress in the timber regions is either good leadership or good management. Nor do I believe that failure to act is technically or politically acceptable.

Ultimately, forest managers must understand what healthy forests and ecosystems—including healthy human communities—can be, as well as what the public envisions them to be. Resource management objectives that are based on a full array of human needs and values—including those set forth in law and regulation—must be considered in this process.

And so, the debate is joined and is beginning to intensify over how to address the related questions of forest health and salvage of dead and dying trees. That debate surely will intensify. On one side are those who will maintain that making any attempt to deal with forest health and with salvage is unjustified. On the other side are warnings from a respected ecologist that say:

"In many cases the natural functioning of these ecosystems has been severely impaired . . ., While some might quibble over the exact magnitude of change, the general trajectory seems unequivocal . . . We anticipate increased fuel accumulations, lengthened fire seasons, and intensified burning conditions, all contributing to large and catastrophic wildfires. A fairly narrow window of opportunity—perhaps 15- to 30-years—exists for land managers to implement ecosystem management treatments to restore more nearly natural and robust ecosystem structure and processes. . . ."

We have learned much about fire science and forest health during the last 50 years. We have begun to learn what the principles of ecosystem management mean for forest managers. It is time we apply what we have learned with a new vision of what we want from our forests and our forest managers. We can lead or we can follow where others lead or pressure us to go. The Forest Service intends to lead. And we are looking for support and for partners.

References

Arno, S. F. 1985. Ecological effects and management implications of Indian fires. In Proceedings: Symposium and workshop on wilderness fire. November 15–18, 1983, Missoula, MT. Intermountain Forest and Range Experiment Station. Gen. Tech. Rept. INT–182. Ogden, UT.

Leopold, A. 1949. A Sand County almanac and sketches here and there. Oxford Univ. Press, New York, NY. 226 pp.

Monnig, E., and J. Byler. 1992. Forest health and ecological integrity in the Northern Rockies. FPM Rept. 92–7, R1–92–32. USDA For. Serv., North. Reg., Missoula, MT. 18 pp.

Mutch, R. W. 1992. Sustaining forest health to benefit people, property, and natural resources. Paper presented at the Fire Working Group Tech. Sess. Soc. Amer. Forest. Nat. Con., October 25–28, 1992.

Nettleton, W. A. 1988. Southern pine beetle. Pages D1–D20 *in* Forest health through silviculture and integrated pest management: Supporting appendices. USDA For. Serv., Washington, D.C.

Pyne, S. J. 1982. Fire in America: A Cultural history of wildland and rural fire. Princeton Univ. Press, NJ.

Thomas, J. W. 1994. Statement of Jack Ward Thomas before the Subcommittee on Agricultural Research, Conservation, Forestry, and General Legislation, Committee on Agriculture, United States Senate, August 29, 1994 Concerning the Health and Productivity of Fire-adapted Forests of the Western United States. 16 pp.

USDA Forest Service. 1993. Healthy forests for America's future. Publ. MP–1513. Washington, D.C. 58 pp.

———. USDA 1994a. The Forest Service ethics and course to the future. FS 567, USDA For. Serv., Washington, D.C., 9 pp.

———. 1994b. Western forest health initiative. State and Private Forestry. Washington, D.C. 67 pp.

4-H Wildlife and Fisheries Recognition Awards, 1994

Allen Fannin, *Westdale, New York*

Allen Fannin owns his own business, but, for the past four and a half years, has devoted much of his time, resources and expertise to the New York 4-H Sport-fishing and Aquatic Resources Education Program (SAREP).

Dean Rose, *Pocatello, Idaho*

Dean Rose is a Regional Habitat Biologist for the Idaho Department of Fish and Game who has served for the past four years as a 4-H volunteer leader. Dean initiated the development of Idaho's 4-H Wildlife Habitat Evaluation Program and its team's participation in The National 4-H Invitational Wildlife Habitat Evaluation Contest for the past two years.

Ellen D. Goethel, *Hampton, New Hampshire*

Ellen Goethel is a marine biologist and educator who has been a volunteer 4-H leader for the past six years. Her 4-Hers are kept busy with a variety of projects ranging from growing and seeding clams to community action on environmental ordinances and beach cleanup.

Patricia A. Dobes, *Elizabethton, Tennessee*

Patricia Dobes is a homemaker who has served for the past three and a half years as a 4-H volunteer leader. She leads a group of 4-Hers in hands-on projects such as building and maintaining wood duck boxes, doing salamander counts with TWRA biologists, conducting wildlife interpretative programs, cleaning up streams and repairing public boat ramps.

Donnielle Slanina, *Cleveland, Utah*

Donnielle Slanina is a fiber artist who has served as a volunteer 4-H leader for seven years. Her 4-H members have developed 40-acre tracts of wildlife habitat, competed in shooting sports programs and 4-H habitat evaluation contests at state and national events. She also is an NRA shooting instructor for rifle and a coach for the 4-H Habitat Evaluation state and national teams.

Russell G. (Buzz) Meyer, *Odenton, Maryland*

Russell Meyer has been a volunteer 4-H leader for 28 years and also is Executive Director of "Meyer Station" Nature Center, which he and his 4-Hers developed on 135 acres of his farm, that includes a rifle range and four miles of nature hiking trails featuring management for diverse habitats for wildlife, including wood duck and blue bird boxes, wildflowers, and beaver swamps. Many groups in the community travel to Meyer Station each year for outdoor educational programs.

The 1995 Guy Bradley Award

Whitney Tilt
National Fish and Wildlife Foundation
Washington, D.C.

When wildlife managers are asked to recite the ingredients of successful wildlife conservation, too often, law enforcement is left out. But law enforcement is part of the formula that includes biologists, habitat managers, and a host of other state and federal land-management professions. Collectively, they are the ''thin green line'' dedicated to conserving this nation's fish, wildlife and plant resources for future generations. In recognition of law enforcement's role, the National Fish and Wildlife Foundation presents the Guy Bradley Award.

The Guy Bradley Award was established by the Foundation in 1988 to recognize the contribution of the law enforcement community to conservation. The award is given annually to that person, or persons, whose dedication and service to the protection of the country's natural resources provides outstanding leadership, extended excellence and lifetime commitment to the field of wildlife law enforcement, and whose actions advance the cause of wildlife conservation. The award is given in the spirit of Guy Bradley, an Audubon game warden killed in the line of duty in July 1905, while preserving a Florida rookery from plume hunters. Guy Bradley is believed to have been the first warden to give his life in the line of wildlife law enforcement.

In the past, the Foundation has recognized state and federal law conservation officers, and the Department of Justice. This year, the Foundation is pleased to recognize one individual and one corporation.

John Cooper, U.S. Fish and Wildlife Service

John Cooper serves as Senior Resident Agent with the U.S. Fish and Wildlife Service (Service) in Pierre, South Dakota. He has worked with the Service for more than 20 years to protect wetlands, waterfowl, migratory birds and other wildlife. In addition he has been at the forefront of tribal land protection in the Dakotas and is a nationally recognized Indian law expert.

As a direct result of his near-perfect prosecution record, Agent Cooper has dramatically reduced the number of wetland drainage violations in the Dakotas, from a high in 1974 of more than 1,200 serious violations to fewer than 100 minor violations annually today. Agent Cooper has achieved similarly dramatic reductions in illegal grazing and haying on Service lands, a practice that once took a heavy toll on spring migrating waterfowl. To protect migratory birds, Agent Cooper has worked to get at the roots of problems ranging from electrocution to illegal trapping. For example, in one state alone, he negotiated with 43 power companies to reconfigure 11,000 miles of power lines, reducing migratory bird deaths by 98 percent. To protect wildlife from airborne hunting in violation of the Airborne Hunting Act, Agent Cooper implemented an aggressive airplane seizure and forfeiture program that outpaced even that in Alaska.

As a self-taught expert in Indian law, Agent Cooper has brought tribal land managers together with their state and federal counterparts to work on collaborative conservation strategies. He established the first Indian conservation officer training program, now taught annually at the National Law Enforcement Training Center, and put in place numerous Indian game codes on reservations so that the Lacey Act could be used to support Tribal wildlife initiatives.

It is for these and many other creative, collaborative and aggressive law enforcement achievements over the last twenty years that we are proud to honor Special Agent John Cooper with the 1995 Guy Bradley Award.

PacifiCorp

It is with great pleasure that the National Fish and Wildlife Foundation presents the first Corporate Guy Bradley Award today to PacifiCorp, in recognition of their significant contribution to wildlife protection. PacifiCorp is represented here today by Monte Garrett, Senior Wildlife Biologist.

PacifiCorp is a diversified electric utility company that provides service to more than 1 million customers in seven states in the Pacific Northwest. In 1978, PacifiCorp initiated a program to address the problem of eagle mortality as a result of interaction with overhead powerlines. PacifiCorp started the program in Wyoming, with a reporting program to gather data on eagle electrocutions. As a result of the reporting program, PacifiCorp was able to target modifications to poles to prevent future eagle mortality. PacifiCorp then expanded the program to service areas in Oregon and northern California to help protect one of the largest wintering populations of bald eagles in the lower 48 states. By 1988, the program involved: (1) standard operating procedures distributed to each district within the company; (2) formal training presentations, including a video reviewing the issue and outlining policies and procedures for all employees in the company; and (3) training sessions for bird identification. Strong employee support for the program resulted in efforts to protect other raptors, including the installation of nesting platforms for osprey and hawks in Oregon, Idaho and Montana. PacifiCorp now has a Memoranda of Understanding with the U.S. Fish and Wildlife Service for each of the seven states in which they operate. This MOU outlines specific steps for action regarding active and inactive nests on power poles, reporting and disposal procedures for bird mortalities, and preparation of annual reports summarizing mortalities and nest-management actions.

Since 1988, PacifiCorp has spent close to $3 million on their bird/powerline management program. In recognition of this extraordinary commitment to wildlife protection, we are proud to present to PacifiCorp the first corporate Guy Bradley Award.

The Award

In recognition of John and PacifiCorp's efforts on behalf of wildlife conservation, the National Fish and Wildlife Foundation is pleased to present them each with the Foundation's 1995 Conservation Print and commemorative plaque, together with a check for $1,000.

The Foundation recognizes that John and PacifiCorp are only two of the many dedicated individuals and corporations who deserve recognition. We look forward to recognizing many others in the years to come. The Foundation would like to thank

John Doggett, Terry Crawforth, Jim Timmerman, Ken Goddard, Terry Grosz, Rollie Sparrowe and Max Peterson for their willingness to serve as Guy Bradley Award Judges. Finally, our thanks to the Wildlife Management Institute for its help in this presentation.

Special Session 1. *Perspectives on the Takings Issue*

Chair
KEITH A. ARGOW
National Woodland Owners Association
Vienna, Virginia

Cochair
MICHAEL J. BEAN
Environmental Defense Fund
Washington, D.C.

Introductory Comments: Perspectives on the Takings Issue

Keith A. Argow
National Woodland Owners Association
Vienna, Virginia

"Rosemary's Baby . . . What Have We Created Together?"

I have been looking forward to this moment together for years! Looking around at the number of you here today, I am not disappointed. Your attendance this afternoon attests to the importance of resolving the takings issue fairly. For too long, wildlife professionals and the environmental community have been slow to recognize the perceived and actual consequences of the Endangered Species Act and the Clean Water Act. As a working landowner myself—and a representative of 39,000 other private woodland owners—I am here to tell you we want to resolve the takings issue soon. Our anxiety is far greater than many of you realize.

For nearly 20 years, it has been my privilege to serve on the Planning Committee of this annual Conference. First, as the Executive Director of Trout Unlimited (predecessor to our colleague Bob Herbst—well known to many of you here in his home state of Minnesota), and for a decade as President of the National Woodland Owners Association. For the past several years, we have considered ways to examine this powerful issue and search for areas of agreement, and this panel is the result of our effort. With the political events of recent months, our review today is timely indeed.

Originally, these introductory comments were titled: "Gut Shooting the Endangered Species Act." But that is *not* the tone I want to set. Our organization always has supported good stewardship—including clean water and wildlife diversity—and we still do! The fact is, we got into this mess together, with the best of intentions, and have created an evil child . . . "Rosemary's Baby" . . . the unintended consequences of a good time!

The private property rights movement has been growing for years, but only recently have there been signs of a positive resolution . . . a light at the end of a very dark tunnel. For the National Woodland Owners Association and our 38 affiliated state woodland owner associations, private property rights is a prime issue.

Rather than react, we have led with a positive thrust: the Private Property Responsibility Initiative. It is our association's *Signature Statement* and nobody has anything quite like it. Our position is that ''We earn our property rights with good stewardship every day. . .and we are not going to give them up willingly.'' Copies of this statement are outside and on tables around this room, and I hope you will take one with you and help us spread the ''Stewardship Ethic.''

The concept of enhancing the *public good* in a contract with consenting adult private landowners has deep roots in America. Public incentives to encourage private investments are well-established in farm policy and to some extent in industrial policy. Landowners have been more than willing to participate in programs that led to improved management of wetlands and woodlands for owls, woodpeckers, lizards and butterflies, as well as for timber.

In hindsight, we were seduced by helpful wildlife professionals . . . and the lure of easy money (cost sharing) to do what we believed to be the right thing. When we accepted those federal dollars (e.g., SIP payments), we probably lost any hope of mounting the defense of *non-consent* to the action in which we participated.

How could something that seemed so right go wrong? What we thought to be *wildlife aid* is beginning to look a lot like a bad case of *wildlife AIDS,* with all the fearful implications. True, very little lasting damage to private property rights has been documented *yet*, but the *fear of the unknown* is very real.

When we turned to our wildlife partners for answers, you fell strangely silent. I suspect, like us, you didn't know much about the Endangered Species Act—and the wetland provisions of the Clean Water Act—and how they would eventually play out. We—the landowners—have suffered through the first term of this pregnancy largely alone, with all its nausea and anxiety.

There have been cases of denial, statements made claiming that wildlife aid and wetlands regulation have nothing to do with endangered species and property rights. More and more of us signed up for what appeared to be reasonable wetland easements, until the President of the National Association of State Foresters came in and turned on the lights! A *perpetual easement* is *forever*, and a cooling-off period is in order to ensure informed consent.

On November 8, 1994—a day that will live in history—citizen concern burst forward at the ballot box. The 104th Congress was sent to Washington, D.C. with an agenda—some say a mandate—of regulatory relief and the empowerment of private initiative known as the ''Contract With America.''

Our issues are in there, but so is everything else! Both the Endangered Species Act and the Clean Water Act are up for reauthorization. I heard on Minnesota public radio yesterday that the latter is likely to be taken up first, stripped down and re-enacted as the ''Water Act.'' Why would this law move ahead of the others? Everyone in the Congress knows how to pass water! Newt Gingrich is no doubt overjoyed at the joviality—and real concerns—expressed on federally funded National Public Radio!

As with Rosemary's Baby, we may not like what we have produced together, but the issue is both of ours. Now the 104th Congressional Crusades have been launched. Is that a *white knight* or a *dark knight* riding to our rescue? Maybe we will find out this afternoon!

When given this assignment a year ago, I turned to the best source I knew to be co-chair, and, happily, he accepted. Michael Bean is well-known to most of you. According to the March, 1995 newsletter of Montana's Political Economy Research Center, he is "the Environmental Defense Fund attorney often credited with writing the Endangered Species Act." Notwithstanding that Michael still was in law school when the law was passed, he is well-recognized by friend and foe alike as an expert on endangered species law.

In quick succession, Dr. Jerry Anderson, Associate Professor of Law at Drake University in Des Moines, Iowa will present an overview of what is really involved in the takings issue. No two overviews of this issue are quite alike, and he has some interesting insights. He will be followed by two well-known litigants on opposite sides. Perry Pendley is Chief Legal Officer of the Mountain States Legal Foundation in Denver, Colorado, a position once held by former Interior Secretary James Watt. He will speak—quite eloquently, I am sure—of landowner's concerns with takings. Perry will be followed by Glen Sugameli, a lead attorney with the National Wildlife Federation who is equally eloquent and knowledgeable from the wildlife or public trust perspective.

Following their presentations, we will have time for brief questions and discussion before moving to the second half of the panel on the "Ramifications of the Takings Issue."

An Overview of the Takings Issue

Jerry L. Anderson
Drake University Law School
Des Moines, Iowa

Introduction: Debate Over Property Rights Heat Up

Over the past quarter century, environmental regulation has literally exploded, presenting an increasing intrusion on the land-use desires of the average citizen. In the last decade alone, for example, the number of species protected by the Endangered Species Act has grown from 220 to 660, increasing the chances that private development will impact critical habitat, or that protected species will damage crops or herds. Ranchers complain that wild horses protected by the Wild Horses and Burros Act destroy the forage needed for their sheep and cattle. An endangered wolf may kill sheep with impunity because the rancher is unable to take action that would harm the predator. Wetlands restrictions imposed under the Clean Water Act also are a focal point for the debate. Permit denials have prevented developers and farmers from making full use of their land.

In a speech last year, American Farm Bureau Federation President Dean Kleckner passionately summed up the complaints of the regulated landowners, arguing that "rats and bats, bugs and weeds [are] claiming title to our lands." He vigorously objected to "attempts by elitists and their bureaucratic accomplices to dictate how land will be used."

Of course, private property rights have never been absolute. We have always recognized that the public also has a strong interest in how private property is used—and, for that reason, nuisance laws, zoning regulations and subdivision ordinances have long been upheld as reasonable constraints on the landowner's use of property. The balance between these public and private interests in land use can be traced back to the founders: James Madison, a strong advocate of private property rights, was the main proponent of the explicit Constitutional protection of property in the Fifth Amendment. Thomas Jefferson and Benjamin Franklin, on the other hand, while recognizing that private property interests must be respected to a certain degree, believed that those interests must yield at times to the greater needs of society.

Thus, the question is how to balance the interests of private property owners against those of the public concerning how land is used. As dwindling species habitat faces increasing pressure from human activity, this type of conflict promises to become even more frequent.

Constitutional Limits on Government Regulation: The Takings Clause

The traditional fulcrum on which private property rights are balanced against the public interest is the takings clause of the U.S. Constitution's Fifth Amendment. The Fifth Amendment provides: "nor shall private property be taken for public use without just compensation." The provision is supposed to prevent the government from enriching the public at the expense of the individual. The restriction applies not only to the federal government, but also to the states through the Fourteenth Amendment's due process clause. Because local governments are subdivisions of the state, city and county regulations such as zoning or growth controls also are limited by the takings clause.

Historically, the takings clause applied only to actual, physical appropriations of property by the government. For example, in the late nineteenth century when Kansas prohibited a citizen named Mugler from operating his brewery, he claimed that his property had been "taken" without compensation. But the Supreme Court held that as long as the state's regulation furthered the health, safety or welfare of the community, it was permissible, despite the fact that it greatly diminished the value of his property (*Mugler v. Kansas*, 123 U.S. 623, 1887).

In 1922, however, the Supreme Court held that even regulations that further the public interest can "go too far" in burdening private property and require compensation. In *Pennsylvania Coal versus Mahon*, 260 U.S. 393 (1922), the Court found that burdensome regulations, even though they do not physically confiscate property, can effectively "take" the property by destroying its value. Justice Oliver Wendell Holmes, writing the majority opinion, noted that "a strong public desire to improve the public condition is not enough to warrant achieving the desire by a shorter cut than the constitutional way of paying for the change." The Supreme Court recognized, of course, that the government could not pay for every burden its regulations placed on private property. But, the Court ruled, when regulation diminishes the value of property too much, the government must compensate the landowner to sustain the law.

The Regulatory Takings Test

Since *Pennsylvania Coal*, the Supreme Court and lower courts have struggled to determine when government regulation has "gone too far" and become a regulatory taking that requires compensation. The Court generally has used an ad hoc, case-by-case approach that balances governmental interest against the amount of harm caused to the property owner. Among the factors considered by the Court:

- **Diminution in Property Value:** how much has the landowner been adversely affected by this regulation? Here, the court focuses on the degree to which the regulation interferes with the landowner's reasonable, investment-backed expectations as to the use of the property. For that reason, the timing of the restrictions is important: if the landowner bought the property after the restrictions were in place, he or she would not have a legitimate expectation of being able to use it in a manner contrary to the regulations. Generally, courts focus on whether the restrictions are so severe that they prevent the landowner from realizing a reasonable return on his or her investment.
- ***Open issue: The size of the parcel:*** The Court has waffled a little on how the regulation's impact should be measured. Should a court look at the entire parcel the property owner has or just the part affected by the regulation? In a wetlands case, for example, the denial of a permit to fill 10 acres of a 100-acre tract could be seen as a total destruction in value of 10 acres or just a 10-percent reduction in value of the entire parcel.
- **Character of the Regulation:** is the government preventing the landowner from

harming the public or attempting to create a public benefit on the backs of individual landowners? The distinction is not always easy to draw, but the idea is that government should not have to pay a landowner when it is merely preventing nuisance-like behavior that is harmful to the community.

Courts are supposed to balance these factors and decide whether a regulation creates a burden that in fairness should be born by the community rather than the individual landowner.

Recent Applications of the Takings Test

Supreme Court Cases

The conservative shift in the Supreme Court is in evidence in several recent cases that tip the takings test toward property owners.

Lucas versus South Carolina Coastal Commission, 112 S.Ct. 2886 (1992). Lucas owned two lots on the South Carolina coast. In an effort to protect its fragile coastline area, the state passed the Beachfront Management Act, which basically prevented Lucas from developing his property. The Court ruled that where regulation totally destroys property value, it amounts to a "categorical taking" that does not need to go through the normal balancing test. Lucas proved that his property was essentially worthless and eventually was awarded $1.2 million. Thus, even when the state's interest is admittedly extremely important (i.e., the protection of a sensitive area from destruction by development), the state must compensate landowners if it completely restricts the owners' ability to make economic use of the land.

Nevertheless, the Court left open the possibility that even a 100-percent diminution in value might not be a taking if the government was merely acting to abate a nuisance under traditional state law. In that case, of course, the property owner would not have had a legitimate expectation of using the property in a harmful manner. How broad this "nuisance exception" is remains to be seen. According to the Court, "normal development" would not fit in the nuisance category.

Dolan versus City of Tigard, 114 S.Ct. 2309 (1994). The Dolans wanted to expand their hardware store and sought a permit from the city. The city would grant the permit only on the condition that the Dolans donate part of the parcel for a bike trail and for improvement of a storm drainage system along an adjacent creek. The Supreme Court held that the conditions amounted to a taking of property without compensation because they were not closely related to the harms the new development would cause. Development exactions such as these must bear a "rough proportionality" to the impact of the proposed development, the Court held. The case requires the government to be more careful regarding what it asks for in return for granting permits.

Recent Environmental Takings Cases

Formanek versus United States, 26 Cl.Ct. 332 (1992). The Claims Court found that the denial of a wetland permit was a taking. The Army Corps of Engineers was trying to protect a calcareous Fen, which it considered very valuable. The Court found that denial of the permit resulted in a reduction in value of the parcel from $1 million to about $112,000, and awarded more than $900,000 in damages for a taking.

Whitney Benefits versus U.S., 18 Cl. Ct. 394 (1989), *aff'd,* 926 F.2d 1169 (Fed. Cir. 1991). The federal Court awarded the plaintiff $60 million when mining regulations decreased the value of the company's coal reserves.

Loveladies Harbor versus U.S., 21 Cl. Ct. 153 (1990), *aff'd,* 28 F.3d 1171 (1994). Army Corps of Engineers denied permission to fill about 12 acres of wetlands. The court found that the regulation was a taking and awarded the landowner more than $2.6 million.

Property Rights Legislation

Some landowners have not been satisfied with the Constitutional remedy for regulatory takings and have been pushing for legislation to make it easier to recover when government action results in loss of property value. "Property rights" bills have been introduced in Congress and in almost every state legislature.

The bills fall into two categories: study and compensation. The study bills require government agencies to assess the impact of their actions on property rights. Essentially, the bills seek to ensure that impacts on property value are taken into account in the same way environmental concerns have been highlighted by the Environmental Impact Statement. Federal agencies have been subject to an executive order since the Bush Administration requiring the same sort of study, although implementation of the requirement has been lax.

The second type of bill requires compensation for government actions that diminish property values by a certain percentage, usually 25 to 50 percent. The legislation presumably would require compensation in many more cases than the Constitutional takings test, by eliminating any sort of consideration of the government's interest and by setting a lower level of impact that will trigger compensation. The potential impact of such legislation has been widely debated and may depend on how the diminution in property value is measured in individual cases. In addition, many of the bills contain exemptions for many types of regulations, such as local zoning laws.

As of January 1995, eight states had passed some kind of study-type legislation. No state had passed a compensation-type bill, although several states have it under serious consideration. At the federal level, Congress is debating property rights legislation under the "Contract with America."

Taking Advantage: The Response to the Public Use of Private Property for Threatened and Endangered Species and Wildlife[1]

William Perry Pendley
Mountain States Legal Foundation
Denver, Colorado

Horror Stories—Mankind and Beasts

Item 1: One very dark, snowy night in 1989, John Shuler of Dupuyer, Montana, heard the unmistakable sounds of grizzly bears dining upon his sheep. He dashed from his house, clad only in his shorts and socks, grabbing his rifle as he went. Seeing three bears near his sheep pen, he fired several shots into the air. The bears disappeared into the night. Thinking the danger was over, Shuler turned to go back into his house.

Suddenly he was confronted by the mother of all bears, or at least, the mother of the other three. It rose up before him, spreading its powerful paws, and looked down upon him. Thinking that it was about to attack and fearing for his life, Shuler killed the bear.

In response to the fine the U.S. Fish and Wildlife Service sought to assess, Shuler claimed self defense. In considering the self defense claim, the Administrative Law Judge (ALJ) held that he had to rule as if Shuler had killed another human being. Thus, while the ALJ declared that Shuler feared for his life, Shuler could not claim self defense since he had introduced himself into the "zone of imminent danger"—his own yard. (Under this ruling, if you are asleep in your bedroom and hear a noise down in the kitchen, don't go downstairs. That would be the "zone of imminent danger.")

Item 2: In 1978, the California Department of Fish and Game (DF&G) relocated 40 to 60 tule elk to Pillsbury Lake in Mendocino County, fully aware of the fact that roughly 90 percent of the property in what it called the Mendocino County Elk Management Unit was privately owned, and that the elk would compete with private livestock for food and drink.

When, in 1988, those elk—now numbering nearly 100—began to invade Robin Moerman's 200-acre sheep and cattle ranch, consuming grasses and destroying property in the process, Moerman complained to the DF&G. The DF&G not only refused to alleviate the situation, it denied all responsibility, asserting that the elk were neither instruments of nor controlled by the state.

Item 3: When the U.S. Fish and Wildlife Service was preparing to locate wolves throughout Wyoming, Idaho and Montana in what it euphemistically, and erroneously, calls the "central Idaho and Yellowstone areas," it was confronted by the fact that wolves already were there. Since such commingling of indigenous and imported Endangered Species Act creatures is prohibited, Fish and Wildlife Service officials sought a basis for declaring that the locals weren't really a "population." Advised

[1]Copyright Pendley 1995. Portions of these remarks are excerpted from Mr. Pendley's book, *War on the West* (Regnery Publishing, Inc.) to be released September 1995.

one biologist: ''[p]ick or create the 'legal' definition [you believe] favors the interests of the wolf.''

Similarly, when a hearing was conducted on efforts by local ranchers to obtain a preliminary injunction barring release of the wolves until a ruling on the ranchers' lawsuit, Fish and Wildlife Service experts testified that wolves prefer to eat wildlife rather than livestock. After one of the imported wolves killed and began to eat a newborn calf, the Service ignored the results of a necropsy and asserted that the calf had died of natural causes.

Lessons Learned

These items illustrate three widely held perceptions of the views of the Endangered Species Act and wildlife advocates regarding wildlife and its relationship to human beings. First, people are less important than animals. Second, people's property may be used or, as the Constitution puts it, ''taken,'' with utter abandon and without compensation, for the needs of animals. Third, the scientific basis for much of what is being done is founded upon either weird or political science. These perceptions are the reason why there is a growing backlash in this country against environmental overkill in general, and against the Endangered Species Act in particular.

One political truism is that once an individual or an issue becomes the subject of jokes on the nightly talk shows, it is very difficult, if not impossible, to regain credibility. The descent from serious and even sacrosanct to irreverent and even irrelevant begins with Jay Leno and David Letterman. Thus, it is not just funny but illustrative that the former declared, on learning of the proposed listing of the Dehli sands flower loving fruit fly, that all Denny's restaurants in southern California would have to be closed as ''critical habitat.'' Yet, Leno's ability to tell that joke and have it considered impish and not impertinent rests upon the existence of a public attitude. That foundation has been laid over the years by news story after news story.

When the Fish and Wildlife Service swoops down upon a newly minted U.S. citizen as if he had killed a playground full of school children for plowing over what the government thinks may be a kangaroo rat; when environmentalists say, as they did when a mountain lion killed a jogger, that we can always get more people but we can't replace mountain lions; when the Fish and Wildlife Service tells Libby, Montana parents that to protect children from the grizzly bears brought into the area their children should wear bells: then the public rightfully concludes that the Endangered Species Act and wildlife advocates value creatures more than humans.

When the Fish and Wildlife Service declares that it needs 3.8 million acres of public and private land—an area the size of Connecticut and Rhode Island combined—to protect the California gnatcatcher; when wildlife agencies rake in hundreds of millions of dollars a year selling licenses to kill wildlife, but then deny any responsibility for the damage they do; when the Fish and Wildlife Service tells a property owner in Utah that the presence of snails on his land means that, while he must pay taxes on the land, he no longer controls it: then the public rightfully concludes that the Endangered Species Act and wildlife advocates view private property with a covetous and even larcenous eye.

When the Chief of the U.S. forest Service—a biologist—declares that there isn't ''a [scientifically based] magic number'' of northern spotted owls and that his determinations are simply ''moral decisions''; when a high-ranking Fish and Wildlife

Service official admits that what he does has little to do with biological science, but really is the "balancing of competing demands"; when an alleged expert regarding a particular species drops his or her role as the disinterested, objective scientist and becomes the plaintiff in a lawsuit demanding the listing of that species—from which a substantial amount of federal grant money and consulting fees will flow: then the public rightfully concludes that the Endangered Species Act and wildlife advocates are not scientists, with expertise that society can use in making informed decisions, but just one more special interest group with a financial or political axe to grind.

The danger here involves more than just the public policies that such advocates favor. The risk is, as well, to their credibility and their standing as scientists and professionals. For, unless there is a realization of what is happening outside this hall within the body politic and a concerted effort to address these very real public perceptions, experts in this field run the risk that, all too soon, they will be held in the same high regard as lawyers.

A New Day in America

If it weren't clear that there is a new day in America regarding the Endangered Species Act and wildlife issues on November 8, 1994, it became very clear on March 3, 1995, when the U.S. House of Representatives passed the Private Property Protection Act. There are three important reasons for this newly emerging consensus.

First, the sky-is-falling rhetoric of the last two decades, like the young boy crying "wolf," now is falling on deaf ears. Even liberal, *Washington Post* editor Meg Greenfield decried the "melodramatic, wildly overstated end-of-the-world bulletins [issued] every hour on the hour for the last 20 years." Many Americans feel that they have been deceived, with good reason, as the following statement from one of Vice President Al Gore's advisors demonstrates: "We [scientists] have to offer up scary scenarios, make simplified, dramatic statements, and make little mention of any doubts we may have. Each of us has to decide what the right balance is between being effective and being honest."

Second and third, environmental policy, which, at one time, was both feel-good and free, now is neither. It is not feel-good because people have heard too many horror stories and not just from me. They also have heard evidence of it from prime-time television. For example, Barbara Walters' expose on how the Endangered Species Act caused the fiery destruction of homes in Winchester, California led her to question whether the Act goes "too far."

In addition, environmental policy is on longer free. For years, environmental policy was like federal tax policy, as described by former U.S. Senator Russell Long of Louisiana: "Don't tax me. Don't tax thee. Let's tax the fellow behind the tree." The burden for achieving environmental objectives was not shared by the people who enjoyed the benefits—supposedly the American people. Instead, it was imposed on a handful of Americans.

Thus, when the Fish and Wildlife Service decided that the kanab ambersnail of Kane County, Utah had to be "saved," only the property owner where the snail was found bore the burden of the ostensible public benefit. When the Fish and Wildlife Service decided that the red-cockaded woodpecker had to be "saved," the owners of private woodlands throughout the South lost the value of their land. When the

Fish and Wildlife Service decided the golden-cheeked warbler needed all or portions of 33 counties around Austin, Texas as "critical habitat," it was the private property owners alone who paid the price.

Of course, such a policy is in direct conflict with the Takings Clause of the Fifth Amendment which bars, in the words of the U.S. Supreme Court, "Government from forcing some people to bear public burdens alone which, in all fairness and justice, should be borne by the public as a whole."[1] Although it had fallen into disuse over the decades, the Takings Clause and the protection it provides to property owners today is very much alive as a result of several recent decisions. Thus, environmental policy is no longer free.

Paying for the Change

Of all the words in the United States Constitution, perhaps the clearest are those found in the "Takings Clause" of the Fifth Amendment. In straightforward and simple fashion, the founding fathers stated, "nor shall *private property* be taken for *public use*, without *just compensation*" (emphasis added). They could not have chosen more basic words, nor put them together in plainer fashion. However, for the first 131 years of the Republic, the Supreme Court held that the Takings Clause applied only to the "direct appropriation" of property, or the functional equivalent of a "practical ouster of the owner's possession."[2] In 1922, all that changed.

In what scholars regard as one of the most important takings cases in the Supreme Court, *Pennsylvania Coal Company v. Mahon*, the Court found that the state of Pennsylvania effected a "taking" when it applied a statute that prohibited coal mining on private property. Justice Oliver Wendell Holmes, writing for the Court, held that the Pennsylvania statute constituted a "taking." "While property may be regulated to a certain extent," Holmes wrote, "if regulation goes too far it will be recognized as a taking . . . [Otherwise] the natural tendency of human nature [would be] to extend the qualification more and more until at last private property disappear[ed]."[3] Justice Holmes' most enduring statement, one that resonates with meaning even more powerfully today than when it was first written, was that "a strong public desire to improve the public condition is not enough to warrant achieving the desire by a shorter cut than the constitutional way of paying for the change."[4]

Some 70 years after the Supreme Court's landmark decision in *Pennsylvania Coal*, the Court was asked to rule in *Lucas v. South Carolina Coastal Council.* There, the State of South Carolina had decided to save the beach, starting with David Lucas' two lots. After the Supreme Court ruled in Lucas' favor, South Carolina was compelled to purchase the property from him, at which point, it sold the property to the highest bidder for development purposes. Said South Carolina's attorney, supposedly with a straight face, "[W]ith a house to either side and in between the lots, it is reasonable and prudent to allow houses to be built."[5]

While the Court may find it difficult to discern what is going "too far," there is one area in which it sees the "takings" issue clearly. The physical invasion of property is a "taking" per se—that is, on its face. It was on this basis—physical invasion—that the Court ruled in favor of property owners in *Nollan v. California Coastal Commission.*[6] The Court had taken the same position five years earlier in *Loretto v. Teleprompter Manhattan CATV Corp.*: "A permanent physical occupation [is] a taking to the extent of the occupation, without regard to whether the action achieves an important public benefit or has only minimal economic impact on the owner.''[7] In addition, the Court found such a ''permanent physical occupation'' even though the item in question was a mere 1.5 cubic feet in size.[8]

In *Nollan*, Justice Scalia, writing for the Court, found a ''taking.'' Scalia held that an impermissible permanent physical occupation, and hence ''taking,'' occurs ''where individuals are given a permanent and continuous right to pass to and fro, so that the real property may continuously be traversed, even though no particular individual is permitted to station himself permanently upon the premises.[9]

Over the years, the Supreme Court—seen in particular in Justice Scalia's opinion in *Nollan*—has appeared to transition from determining whether the use denied the private property owner is a ''nuisance'' to determine whether the regulation substantially advances a legitimate state interest. This was the approach the Court used in *Dolan v. City of Tigard.*[10]

In *Dolan*, the City of Tigard denied the property owner use of her property unless she gave 10 percent of her land to the city and built a bicycle path for bikers to cross her property. In that case, the Audubon Society filed a brief in support of the City of Tigard and asserted that a ruling for Mrs. Dolan would ''frustrate the efforts of democratically elected officials to cope with serious environmental . . . problems.''[11] Furthermore, Audubon suggested, ''while the Court has recognized that the Constitution protects 'property rights' . . . the Court has never recognized a general 'right to use property.' ''[12]

In *Dolan*, the Clinton administration weighed in on behalf of the city of Tigard, advocating that the only time a property owner should win a ''takings'' action is when he or she can demonstrate that the regulatory body's action is merely a ''pretext'' to achieve control over the land.[13] Responded Justice Scalia, ''that's an awful burden to put on the small individual property owner. . . .''[14]

These two viewpoints, taken during the U.S. Supreme Court's most recent decision on the Fifth Amendment, by environmental organizations and the Clinton Administration, demonstrate the degree to which both are out of step with the views of the American people. The idea that people have the right to own—and pay taxes on—property, but no right to use it, is not only bad public policy, it is contrary to numerous holdings of the U.S. Supreme Court. The idea that property owners of modest means may prevail in challenging government control of their land by going up against the biggest law firm in the world (the U.S. government) and proving officials are lying about why they want to restrict the use of the landowner's property strikes the overwhelming majority of the American people as outrageous in the extreme.

On June 24, 1994, the Supreme Court, in a five-to-four opinion by Chief Justice Rehnquist, held that the demands by the City of Tigard constituted an uncompensated taking of the widow Dolan's property.[15] To those who asserted that property rights are inferior to other rights, Chief Justice Rehnquist answered: ''We see no reason why the Takings Clause of the Fifth Amendment, as much a part of the Bill of Rights as the First Amendment, or Fourth Amendment, should be relevated to the status of a poor relation in these comparable circumstances.''[16] To those who argued that application of the Takings Clause would impose new costs on local government, the Court quoted its earlier holding in *Pennsylvania Coal*: ''A strong public desire to improve the public condition [will not] warrant achieving the desire by a shorter cut than the constitutional way of paying for the change.''[17]

While no U.S. Supreme Court decisions have addressed the issue of the ''taking'' of property through the Endangered Species Act and wildlife restrictions, a powerful dissent—like many such dissents before it—may serve as the basis for a majority opinion in the near future: "There can be little doubt that if a federal statute authorized park rangers to come around at night and take petitioner's livestock to feed the bears, such a governmental action would constitute a 'taking'. . . . Thus, if the Government decided (in lieu of the food stamp program) to enact a law barring grocery store owners from 'harassing, harming, or pursuing' people who wish to take food off grocery shelves without paying for it, such a law might well be suspect under the Fifth Amendment. The public should be willing and able to allocate public resources to the preservation of endangered species, either by funding wildlife preserves or by compensating private landowners who feed the animals.[18]

Restrictions on the use of private land are increasing and becoming increasingly controversial. The years ahead will see more lawsuits over the issue and, in time, a decision by the U.S. Supreme Court. Already, the Court has agreed to hear one narrow issue regarding the regulation of private land under the Endangered Species Act, albeit one regarding the federal statute and not the Constitution.

One final cautionary note, the Endangered Species Act and wildlife advocates have chosen to portray the current "Takings Clause" debate as a concern of "powerful special interests" and "rich corporations." It is not. David Lucas, the landowner who prevailed before the U.S. Supreme Court in 1992, relates that following his victory he did not receive a single call from corporate C.E.O.s or lawyers for big corporations. Instead, he received hundreds of telephone calls from ordinary Americans who feared they would lose their tiny piece of the American dream.

When I began this afternoon, I told the story of John Shuler, attacked one snowy night by a grizzly bear. The U.S. Fish and Wildlife Service told Shuler, after the fact, that when the grizzly rose up before him, it was not the sign of an imminent attack and was the worst time to shoot. Moreover, said the Fish and Wildlife Service, when the grizzly got down on all fours and came at Shuler, that, too, was the worst time to shoot, since it might be a false charge.

I don't know about you. But if I had been John Shuler, standing toe to toe with that grizzly on a dark and stormy night, I don't think I would have taken the advice of the Fish and Wildlife Service. Obviously, too much was at stake.

I also would suggest that you professionals have too much to lose to rely on those who suggest that the public's concern with the taking of private property is just a passing fad; that it is an issue being manipulated by special interests; and that the continuing barrage of beggar thy neighbor, ad hominem attacks will lead you to victory. You ignore this very troubling concern of the American people and the three perceptions that have caused it only at the peril of the issues to which you have dedicated your life. For, like the night John Shuler faced down the grizzly, it is growing darker. The snow has begun to fall even more heavily and the way to safety now is obscure.

Endnotes

[1]*Armstrong v. United States*, 364 U.S. 40, 49 (1960).

[2]*Northern Transportation Co. v. Chicago*, 99 U.S. 269 (1879).

[3]Ibid., p. 415.

[4]Ibid., p. 416.

[5]Bachman S. Smith, III, attorney for the South Carolina Coastal Council, quoted in *The Washington Post*, "Accord Ends Fight Over Use of Land," July 17, 1993, El. Also reported in "That's Outrageous!" *Reader's Digest*, August 1994, pp. 97–98.

[6]483 U.S. 825 (1987).

[7]458 U.S. 419, 434–435 (1982).

[8]"In any event these facts are not critical: whether the installation is a taking does not depend on whether the volume of space it occupies is bigger than a breadbox." *Ibid.*, p. 438, fn 16.

[9]483 U.S. 825, 832 (1987).

[10]512 U.S. ___, 129 L Ed 2d 304, 305, 114 S Ct ___ (1994).

[11]*Dolan v. City of Tigard*, Brief for the National Audubon Society as *Amicus-Curiae* Supporting Respondent, U.S. Supreme Court, October 1993, No. 93–518, p. 3.

[12]Ibid., p. 8.

[13]*Dolan v. City of Tigard*, Brief for the United States as Amicus Curiae Supporting Respondent, U.S. Sup. Ct., October 1993, No. 93–518.

[14]*Dolan v. the City of Tigard*, Official Transcript Proceedings Before the Supreme Court of the United States, D.C.: Aldersen Reporting Company, March 23, 1994, pp. 46, 48, 50.

[15]*Dolan v. City of Tigard*, 512 U.S. ____, 129 L Ed 2d 304, 305, 114 S Ct ____ (1994).

[16]*Ibid.*, p. 321.

[17]*Ibid.*, at 323, quoting Pennsylvania Coal, 260 U.S. at 416.

[18]*Christy v. Hodel*, 857 F.2d 1324 (9th Cir. 1989), *cert. denied*, 490 U.S. 1114 (1989).

Species Protection and Fifth Amendment Takings of Private Property

Glenn P. Sugameli
National Wildlife Federation
Washington, D.C.

Introduction

To what extent do species protection laws implicate the Constitution's Fifth Amendment provision, ''. . . nor shall private property be taken for public use, without just compensation''? Despite a great deal of sound and fury surrounding this issue, takings claims under these laws have been rejected by federal and state courts in the overwhelming majority of cases. For example, in the more than 20-year history of the Endangered Species Act (ESA), (16 U.S.C. §§ 1531–1544 [1988]), courts have only decided two Fifth Amendment taking cases, both of which have found that the ESA did *not* take private property (*Christy v. Hodel*, 857 F.2d 1324, 1335 [9th Cir. 1988] [rancher fined for killing grizzly bears that were eating sheep], *cert. denied*, 490 U.S. 1114 [1989]; *United States v. Kepler*, 531 F.2d 796, 797 [6th Cir. 1976] [ban on interstate or foreign transport of endangered species as applied to species lawfully possessed before passage of the ESA]).

Federal and state courts have recognized several reasons why protection of species will rarely, if ever, take private property. These include threshold principles that: (1) takings are limited to actions that eliminate property rights, as defined by wildlife, wetlands, public trust, federal land law and other ''background principles of property and nuisance law''; and (2) takings only can result from authorized government actions, not, for example, cases where protected animals destroy property.

Even if species protections passed this initial threshold, a taking is unlikely. First, it is not a taking to regulate only part of the ''parcel as a whole,'' in terms of acreage or time. Second, prohibiting only particular uses of land does not cause a taking. Third, limits on commercial uses of personal property (as opposed to real property), are almost certainly not a taking. Fourth, there may be no taking because species protection laws generally are not directed at land. Finally, variances, ''incidental take'' permits and other administrative remedies can preclude takings.

The Fifth Amendment Takings Clause requires that just compensation be available through the courts where private property is taken for public use. ''[S]o long as compensation is available for those whose property is in fact taken, the government action is not unconstitutional'' (*United States v. Riverside Bayview Homes, Inc.*, 474 U.S. 121, 128 [1985]). The Fifth Amendment applies to the federal government; state and federal court takings claims against state and local governments can be brought under state constitutional provisions and under the Fourteenth Amendment.

Species protection takings claims have not been, and are unlikely to be, successful. Radical attempts to rewrite the constitutional standard through state and federal takings bills, however, could severely undermine laws that protect species and the private property, health and safety of average Americans. Justice Holmes, in the opinion that created the concept of a regulatory taking, warned that ''[g]overnment could hardly go on if to some extent values incident to property could not be diminished without paying for every such change in the general law. . . . [S]ome values are enjoyed under an implied limitation and must yield to the police power'' (*Pennsylvania Coal Co. v. Mahon*, 260 U.S. 393, 413 [1922]; see Sugameli 1993, *Takings issues in light of Lucas v. South Carolina Coastal Council: A decision full of sound and fury signifying nothing*, 12 Va. Envtl. L.J. 440 [discussing administrative, legislative, and judicial aspects of the takings issue]).

Threshold Questions

Is There A Protected Property Interest?

Species protection laws cannot take away claimed property ''rights'' that never existed, such as the ''right'' to create a nuisance that harms neighboring property or the public. It is not a taking to forbid uses which are barred by ''background principles'' of property and nuisance law, because such forbidden uses were not part of the owner's title to the property to begin with (*Lucas v. South Carolina Coastal Council*, 112 S. Ct. 2886, 2899–900 [1992]; see McElfish 1994, *Property rights, property roots: Rediscovering the basis for legal protection of the environment*, 24 Envtl. L. Rep. 10,231).

Background Principles of Property and Nuisance Law

Laws that repeat limitations inherent in the title to property, as defined by state and federal property and nuisance law, *never* cause a taking (*Lucas*, 112 S. Ct. at 2899–900).

Fish and wildlife laws. Thus, it often (and perhaps always) is not a taking to protect wildlife because, under traditional state property law, landowners, users of public land, commercial fishermen and others never had the right to immunity from regulations to protect species.

The Tenth Circuit essentially anticipated *Lucas'* background principles of both property and nuisance law. First, court-ordered removal of a 28-mile fence on private land, which prevented pronghorn from reaching critical winter range on public domain, abated a nuisance proscribed by federal law (*United States ex rel. Bergen v. Lawrence*, 848 F.2d 1502, 1507 [10th Cir.], *cert. denied*, 488 U.S. 980 [1988]). Second, ''All that [the plaintiff] lost is the right to exclude others, including wildlife, from the public domain—a right he never had'' (*Id.* at 1508; see also *Fallini v. United States*, 31 Fed. Cl. 53, 59 [1994], *appeal docketed*, No. 94–5110 [Fed. Cir. Mar. 11, 1994] [no compensable expectancy to exclusive use of federal grazing allotment; wild horses did not take permittees' water rights]; *Organized Fishermen of Florida v. Watt*, 590 F. Supp. 805, 815 [S.D. Fla. 1984] [commercial fishing ''permit is a privilege granted by the Park Service and is, therefore, by its very nature, revocable''], *aff'd on other grounds*, 775 F.2d 1544, 1550 n.5 [11th Cir. 1985], *cert. denied*, 476 U.S. 1169 [1986]; *Farris v. Arkansas State Game and Fish Commission*, 310 S.W.2d 231, 237 [Ark. 1958] [''only a qualified ownership'' in privately raised fish subject to ban on sale]).

Laws protecting and regulating wildlife are a traditional, common component of state property law and state police powers. Wyoming's allocation of hunting licenses on private property was not a taking because "the state possesses the right to regulate wildlife within its borders in the exercise of its police powers" (*Clajon Production Corp. v. Petera*, 854 F. Supp. 843, 852 [D. Wyo. 1994], *appeal docketed*, No. 94–8071 [10th Cir. July 15, 1994]). State courts also have long recognized that all property is held subject to the government's police power to regulate wildlife (*E.g., Platt v. Philbrick*, 47 P.2d 302, 304 [Cal. App. 1 Dist. 1935]).

Thus, if species protection laws ban activities that are not part of title to property under "background principles of property and nuisance law," there is no taking, regardless of the claimed impact on value (*Lucas*, 112 S. Ct. at 2900–01).

Wetland laws. Forty-three percent of threatened and endangered species rely on wetlands for their habitat (National Wildlife Federation, *Endangered species, endangered wetlands: Life of the edge* 7 [1992]). Thus, wetland preservation often will be closely related to endangered species protection (See *Good v. United States*, No. 94–442L [Fed. Cl. filed July 11, 1994] [alleged taking from action under ESA and wetlands laws]).

It is not a taking to protect critical wetland habitat if background principles regarding *either* wetlands *or* endangered species apply. *Lucas* defined nuisances as harms "to public lands and resources, or adjacent private property, posed by the claimant's proposed activities" (112 S. Ct. at 2901). One *Lucas* "background principle" clearly refers to certain denials of permits to dredge and fill lake beds and other wetlands: "[T]he owner of a lake bed . . . would not be entitled to compensation when he is denied the requisite permit to engage in a landfilling operation that would have the effect of flooding others' land. . . . Such regulatory action may well have the effect of eliminating the land's only economically productive use, but it does not proscribe a productive use that was previously permissible under relevant property and nuisance principles" (*Id.* at 2900–01).

Background principles also should include the state law principle that protection of wetlands is not a taking because "[a]n owner of land has no absolute and unlimited right to change the essential natural character of his land so as to use it for a purpose for which it was unsuited in its natural state and which injures the rights of others" (*Just v. Marinette County*, 201 N.W.2d 761, 768 [Wis. 1972] [denying a wetlands takings claim]; see also, *e.g., Rowe v. Town of North Hampton*, 553 A.2d 1331, 1335 [N.H. 1989]; *Graham v. Estuary Properties, Inc.*, 399 So. 2d 1374, 1382 [Fla.], *cert. denied*, 454 U.S. 1083 [1981]).

Public trust doctrine. Background principles should preclude species protection takings claims for denials of land uses that are incompatible with the public trust doctrine, which protects the public's right of access to certain natural resources, particularly those associated with navigable waters (see *Kreiter v. Chiles*, 595 So. 2d 111, 112 [Fla. Dist. Ct. App. 3d Dist. 1992] [public trust doctrine defeats claim that denial of permit to build a dock on submerged land is a taking], *review denied*, 601 So. 2d 552 [Fla. 1992], *cert. denied*, 113 S. Ct. 325 [Oct. 13, 1992]).

Public trust principles could insulate certain actions to preserve endangered species from takings claims in two ways. First, traditional water-related applications of the public trust doctrine may defeat private property claims to uses of certain critical habitat. Second, courts could extend the public trust doctrine to wildlife (see *In re Steuart Transportation Co.*, 495 F. Supp. 38, 40 [E.D. Va. 1980] ["[u]nder the public trust doctrine, the State . . . and the United States have the right and the duty to protect and preserve the public's interest in natural wildlife resources'']; Meyers 1989, *Variation on a theme: Expanding the public trust doctrine to include protection of wildlife*, 19 Envtl. L. 723).

Evolving Nuisance Law

Courts should define nuisances to include newly perceived environmental dangers: ''Changed circumstances or new knowledge may make what was previously permissible no longer so'' (*Lucas*, 112 S. Ct. at 2901). Thus, the evolution of nuisance law can negate compensation where new regulations prohibit uses that were not barred by ''background principles'' at the time a parcel was purchased (*Id.* at 2900).

Nuisance law may grow to encompass acts which now are not considered nuisances, such as destruction of a species that is found to harbor a life-saving drug. ''New appreciation of the significance of endangered species . . . shapes our evolving understandings of property rights'' (*Id.* at 2921–22 [Stevens, J., dissenting]). Because each state can define what is a nuisance, takings law will vary from state to state.

Federal and State Limitations

Limits on state-created property rights may originate in either federal or state law. *Preseault v. United States* held that ''*Lucas* acknowledged only limitations that inhere in one's title, be they state or federal . . .'' (27 Fed. Cl. 69, 89 [1992], *appeal docketed*, No. 93–5067 [Fed. Cir. Jan. 28, 1993]) (citing *Lucas* 112 S. Ct. at 2900) accord *M & J Coal Co. v. United States*, 47 F.3d 1148, 1153 [Fed. Cir. 1995]).

Background Principles of Property Law

Under *Lucas*, limitations on title that preclude a taking include those that have nothing to do with nuisances (see *Stevens v. City of Cannon Beach*, 854 P.2d 449, 456 [Or. 1993] [denying permits for seawall to allow motel development was not a taking, because seawall would block public's right to use the dry sand area under the ''doctrine of custom'' background principle], *cert. denied*, 114 S. Ct. 1332 [1994]). Thus, species protection laws that track property or nuisance law background principles cannot be a taking.

Is There Government Action?

Takings must be the direct consequence of authorized government action (*Tabb Lakes, Ltd. v. United States*, 10 F.3d 796, 802–03 [Fed. Cir. 1993]). Unauthorized actions may be enjoined, but cannot cause a taking.

Where protected animals destroy property, most courts have found no governmental action. Federal courts have unanimously rejected such takings claims (see *Christy*, 857 F.2d at 1334–35 [rancher fined for killing a grizzly bear]; *Mountain States Legal Foundation v. Hodel*, 799 F.2d 1423, 1429–31 [10th Cir. 1986] [damage caused by protected wild horses], *cert. denied*, 480 U.S. 951 [1987]; *Clajon*, 854 F. Supp. at 852–53 [state regulation of wildlife on private lands]). However, two state cases found that crop damage caused by hunting bans on private land caused a taking. A Wisconsin case found that a permanent prohibition on hunting of migratory wildfowl on a ''closed area'' essentially had created a wildlife refuge on private property (*State* *v. Herwig*, 117 N.W.2d 335, 340 [Wis. 1962] [''unnaturally concentrated foraging upon the defendant's land by wildfowl'']). An Arkansas case held that a specific ban on hunting on private lands surrounded by a state wildlife refuge ''damaged'' private property for public use without just compensation under the state Constitution (*Shellnut v. Arkansas State Game and Fish Commission*, 258 S.W.2d 570, 573–74 [Ark. 1953]).

Both the Ninth and Tenth Circuits have specifically rejected *Herwig* and *Shellnut.* In *Christy*, the Ninth Circuit stated that: ''Of the courts that have considered whether damage to private property by protected wildlife constitutes a 'taking,' a clear majority have held that it does not. . .'' (857 F.2d at 1334, quoting *Mountain States Legal Foundation*, 799 F.2d at 1428). Some of the cases cited by the Ninth and Tenth Circuits include *Bishop v. United States*, 126 F. Supp. 449 (Ct. Cl. 1954) (crop damage caused by protected geese), *cert. denied*, 349 U.S. 995 (1955); *Jordan v. State*, 681 P.2d 346 (Alaska App. 1984) (criminal prohibition on killing bear which attacked defendant's moose carcass); *Collopy v. Wildlife Comm'n*, 625 P.2d 994 (Colo. 1981) (hunting ban inflated goose population, causing crop losses); *Maitland v. People*, 23 P.2d 116 (Colo. 1933) (protected deer increased in number, causing crop damage); *Barrett v. State*, 116 N.E. 99 (N.Y. 1917) (reintroduction of beavers which destroyed hundreds of trees); *Cook v. State*, 74 P.2d 199 (Wash. 1937) (beaver trapping ban resulted in damage to private lake used as commercial skating rink).

Neither *Herwig* nor *Shellnut* discussed any of the prior contrary federal or state decisions that were cited by the Ninth and Tenth Circuits. The *Herwig* court tried to distinguish one case which found no taking from a hunting ban on private land near a wildlife refuge (117 N.W.2d at 340 [reasoning that in *Bailey v. Holland*, 126 F.2d 317, 324 [4th Cir. 1942], a state which created an actual game refuge may protect it]). *Herwig* and *Shellnut* were rejected in *Green Acres Land and Cattle Co. v. State* (766 S.W.2d 649, 652 [Mo. App. 1988] [preserve on state land did not take crops damaged by increase in wild birds]).

Court rejections of takings claims include cases where the government relocates animals that eat private forage (see *Moerman v. California*, 21 Cal. Rptr. 2d 329, 332–34 [Cal. App. 1 Dist. 1993] [tule elk are ''wild animals who roam across private and public property,'' not ''instrumentalities of the state''], *cert. denied*, 114 S. Ct. 1539 [1994]).

Personal Property

The Supreme Court's only wildlife protection takings case held that a ban on the sale of eagle feathers which were lawfully acquired before the prohibition was enacted was not a taking. Although the ban foreclosed the most profitable use of the property, it did not deprive the owner of all value (*Andrus v. Allard*, 444 U.S. 51, 67–68 [1979]). *Lucas* cited *Andrus* in fundamentally distinguishing between real and personal property: ''[I]n the case of personal property, by reason of the State's traditionally high degree of control over commercial dealings, [the owner] ought to be aware of the possibility that new regulation might even render his property economically worthless (at least if the property's only economically productive use is sale or manufacture for sale)'' (112 S. Ct. at 2899–900; see also *Kepler*, 531 F.2d at 797 [no taking from ESA's ban on interstate or foreign transport of an endangered species that was held lawfully when ESA was enacted]; *Burns Harbor Fish Co. v. Ralston*, 800 F. Supp. 722, 726 [S.D. Ind. 1992] [state ban on gill nets in Indiana waters of Lake Michigan did not take fishing licenses]).

Real Property

Subject to major exceptions, two categories generally are compensable: physical invasions of property and actions which "den[y] all economically beneficial or productive use of land" (*Lucas*, 112 S. Ct. 2893).

Considering the Entire Parcel as a Whole

Courts must consider the entire parcel, not merely the affected portion. Thus, species protections usually do not cause takings because such laws do not impact non-critical habitat portions of the parcel as a whole. " 'Taking' jurisprudence does not divide a single parcel into discrete segments and attempt to determine whether rights in a particular segment have been entirely abrogated" (*Penn Central Transp. Co. v. New York City*, 438 U.S. 104, 130 [1978]; accord *Concrete Pipe and Prods., Inc. v. Construction Laborers Pension Trust*, 113 S. Ct. 2264, 2290 [1993]; see *Tabb Lakes*, 10 F.3d at 802 ["[c]learly, the quantum of land to be considered is not each individual lot containing wetlands or even the combined area of wetlands"]; *Florida Game and Fresh Water Fish Comm'n v. Flotilla*, 636 So. 2d 761, 765 [Fla. App. 2 Dist. 1994] [protection of bald eagle nesting site did not deny use of entire property]; *Fallini v. United States*, 31 Fed. Cl. at 59 [water from which federally protected wild horses drank was not taken in its entirety]).

Thus, takings analysis must examine all rights in the property as a whole in terms of value and spatial measurement. This includes both "vertically," *e.g.*, the air rights and surface support rights in a particular acre of land, *Penn Central*; and "horizontally," all acreage in a particular parcel, *Tabb Lakes*.

There is one murky Federal Circuit "property as a whole" decision which found a taking from denial of a permit to fill 11.5 acres that originally were part of a 250-acre parcel the developer had purchased (*Loveladies Harbor, Inc. v. United States*, 28 F.3d 1171 [Fed. Cir. 1994]). The court did not consider 199 acres that had been filled and developed prior to the wetlands regulations and 38.5 acres that were protected in exchange for the state's agreement to permit development of the remainder (*Id.* at 1181).

The appellate Court of Claims has denied other wetland takings claims by analyzing returns from sales and development of the property as a whole prior to the permit denial (*Deltona Corp. v. United States*, 657 F.2d 1184, 1192 [Ct. Cl. 1981] [values and use of 10,000-acre parcel, including developed areas, areas approved for development and uplands], *cert. denied*, 455 U.S. 1017 [1982]; and *Jentgen v. United States*, 657 F.2d 1210, 1213 [Ct. Cl. 1981] [plaintiff was offered, but refused, permits to develop more than 20 acres of wetlands and the tract contained 20 acres of developable uplands], *cert. denied*, 455 U.S. 1017 [1982]). These decisions, along with *Penn Central, Concrete Pipe* and *Tabb Lakes*, are the federal law on the "property as a whole."

Temporally Limited Prohibitions

The property as a whole principle has been applied in a temporal sense: a moratorium's denial of all economically viable use was not a taking because it was qualified by its two-year defined duration. Thus, a "temporary taking" means "regulatory takings which are ultimately invalidated by the courts," not regulations that are designed to be temporary (*Woodbury Place Partners v. City of Woodbury*, 492 N.W.2d 258, 262 [Minn. Ct. App. 1992], *cert. denied*, 113 S. Ct. 2929 [1993]).

Species Protections Are Unlikely to Deprive All Economic Use

Supreme Court "cases have long established that mere diminution in the value of property, however serious, is insufficient to demonstrate a taking" (*Concrete Pipe*, 113 S. Ct. at 2290). The Supreme Court also has held that the: "requirement that a person obtain a permit before engaging in a certain use of his or her property does not itself "take" the property in any sense: after all, the very existence of a permit system implies that permission may be granted. . . . even if the permit is denied, there may be other viable uses. . ." (*Riverside Bayview Homes*, 474 U.S. at 126–27).

Even land under a "permanent" limitation can have market value to buyers who bet that it "would some day be lifted" (*Florida Rock Indus. v. United States*, 791 F.2d 893, 902–03 [Fed. Cir. 1986], *cert. denied*, 479 U.S. 1053 [1987]). Courts must consider value of property to long-term investors who are not dissuaded by temporary or indefinite development controls: "[T]he precise content of regulations at any given time may not be particularly important to those active in the market" (*Florida Rock Indus. v. United States*, 18 F.3d 1560, 1566 [Fed. Cir. 1994], *cert. denied*, 115 S. Ct. 898 [1995]). Thus, ESA restrictions might be lifted because of recovery and delisting, natural or artificial relocation of the protected species, a Habitat Conservation Plan or incidental take permit, and even extinction of the species.

Species protections typically include case-by-case flexibility, including variances, approvals of less ambitious development projects or permits authorizing "incidental takes" of species as part of otherwise lawful activities. Those who obtain such remedies have not been deprived of all value.

Alleged Non-categorical Takings

Non-categorical takings claims involve: (1) the character of the governmental action, (2) the economic impact of the regulation and (3) interference with reasonable investment-backed expectations (see *Penn Central*, 438 U.S. at 124). "Those who do business in the regulated field cannot object if the legislative scheme is buttressed by subsequent amendments to achieve the legislative end" (*Concrete Pipe*, 113 S. Ct. at 2291). This may diminish investment-backed expectations and, thus, defeat species takings claims in two ways. First, there is a long history of state regulation of fish and wildlife, especially hunting and fishing licenses, and prohibitions to protect species. Second, species laws may affect dams, power plants or factories that traditionally have been regulated intensively.

Courts often reject takings claims involving land that was acquired with knowledge of existing or pending regulatory limitations (*e.g., M & J Coal Co.*, 47 F.3d at 1154 [existing federal statute prohibited mining that endangered public health or safety]; *Maine Land Use Regulation Comm'n v. White*, 521 A.2d 710 [Me. 1987] [notice of undevelopable deer yard]; *Claridge v. New Hampshire Wetlands Board*, 485 A.2d 287, 292 [N.H. 1984] [notice that "property was subject to state wetlands statutes"]).

Species laws do not prohibit all use of parcels of property. For example, hunting and fishing for animals *other* than the protected species is not automatically prohibited; the right to possess, the right to exclude others—including, to a limited extent, the species in question—and the right to sell or devise the land to others should preclude deprivation of all value. Where less than the entire parcel is critical habitat, a taking is even more remote.

Whether the Regulation is Directed at Land

Regardless of alleged impacts on land value, courts may find no taking because species protection laws are not directed at land. *Lucas* stated that "perhaps" a law "that destroys the value of land without being aimed at land . . . —the generally applicable criminal prohibition on the manufacturing of alcoholic beverages challenged in the *Mugler* case comes to mind—cannot constitute a compensable taking" (112 S. Ct. at 2899 n.14).

Generally, civil and criminal laws to protect species are not "aimed at land," but prohibit killing of protected species and other activities that could occur in the air from planes, in the water from boats and by trespassers regardless of any claimed property rights in land. This is a clearer example than the statute in *Mugler v. Kansas* (123 U.S. 623, 668–70 [1887]), which prohibited the manufacture of alcoholic beverages, an activity necessarily involving real property (see Robert Meltz, *Where the wild things are: The Endangered Species Act and private property*, 24 Envtl. L. 369, 404 [1994] ["many ESA limitations on private defensive measures, not being "aimed at land," may be constitutionally noncompensable with respect to their regulatory impact on real estate value."]).

Procedural Issues

Courts will not hear anticipatory takings challenges nor claimants that have not exhausted all other possible state and administrative remedies. "[T]akings decisions must await as-applied challenges and are not usually ripe until the permit stage" (*Sierra Club v. California Coastal Comm'n*, 15 Cal. Rptr. 2d 779, 789 [Cal. App. 1st Dist. 1993]).

Takings claims first may have to be pursued through state administrative processes and in state courts, rather than in federal courts. For example, a takings challenge to state protection of endangered species was dismissed because the claimants first must pursue state court challenges to "a complex state regulatory scheme concerning important matters of state policy" (*Meredith v. Talbot County, Md.*, 828 F.2d 228, 231–32 [4th Cir. 1987]). Second, there were "unsettled questions of state law that may dispose of the case and avoid the need for deciding the constitutional question" (*Id.* at 230; see also *Southwest Diversified, Inc. v. Brisbane*, 652 F. Supp. 788, 791–98 [N.D. Cal. 1986] [state court must first clarify whether "Habitat Conservation Plan" created "vested" property rights]).

Alleged Physical Occupations

Compelled physical occupations of private property are far more likely to take property than limits or conditions on uses. Mandated transfer of ownership of private property to protect a species would be a taking unless the agency could demonstrate: (1) an "essential nexus" between the public purposes served by the transfer and the conditions imposed on the land; and (2) a "roughly proportional" relationship between the transfer and the nature and extent of the potential impacts from development (*Dolan v. City of Tigard*, 114 S. Ct. 2309, 2317–20 [1994]).

Species protections do not physically take property; such cases are analyzed as potential regulatory takings claims (see *Christy*, 857 F.2d at 1335 [rejecting argument of government occupation based on the degree of management or protection of grizzly bears]; *Mountain States Legal Foundation*, 799 F.2d at 1428 [Wild Free-Roaming Horses and Burros Act is "nothing more than a land-use regulation"]; *Moerman*, 21 Cal. Rptr. 2d at 334 [state relocated tule elk were not "instrumentalities of the state"]; *Clajon*, 854 F. Supp. at 853 ["wild animals are owned . . . by no one, including the state"]; *Southview Associates, Ltd. v. Bongartz*, 980 F.2d 84, 106–07 [2d Cir. 1992] [no physical taking; developer still possessed deeryard and retained substantial power to control use or to sell it], *cert. denied*, 113 S. Ct. 1586 [1993]; *Flotilla*, 636 So. 2d at 764 [no physical occupation from bald eagle nest buffer zone; developer "lost neither the right to possess nor convey the affected areas, and further retained the right to use the property in any way that would not disturb the eagles' habitat"]; see also *State v. Lake Lawrence Pub. Lands Protection Ass'n*, 601 P.2d 494, 500–01 [Wash. 1979] [en banc] [no physical or regulatory taking from denial of plat to protect eagle perching and feeding area], *appeal dismissed and cert. denied*, 449 U.S. 830 [1980]).

Thus, species protection laws are very unlikely to take property for all of the reasons discussed above.

Regulatory Takings After *Lucas v. South Carolina Coastal Council:* To What Extent Do Wildlife Regulations Impact a Property Owner's Reasonable Investment-Backed Expectation?

Jerome M. Organ
University of Missouri—Columbia School of Law
Columbia

Sara Parker
Missouri Department of Conservation
Jefferson City

Introduction

The Fifth Amendment to the Constitution provides that "private property [shall not] be taken for public use, without just compensation." When the government physically takes someone's property for a road, school, park or other public purpose, the Fifth Amendment clearly requires that the state compensate the property owner for the value of the property taken, even if the state takes only a portion of the property owner's parcel. When the government does not physically take someone's property, but merely regulates the ways in which the owner can use the property, it is much less clear whether the Fifth Amendment requires that the state compensate the property owner for the "value" of the property "taken" as a result of the regulation.

For many years, the U.S. Supreme Court has struggled to define the point at which government regulations "go too far,"[1] when they so restrict the rights of private property owners as to constitute a "taking" requiring compensation under the Fifth Amendment (Anderson 1989, Michelman 1987, Nolon 1992). In determining whether a regulation results in a taking, the Supreme Court generally has focused its attention on whether the regulation serves a legitimate state interest or whether it interferes with a property owner's reasonable expectations regarding the lawful uses of the property.[2] Accordingly, the Supreme Court has held that regulations that preclude a noxious use, which could have been prohibited under common law nuisance, do not result in a taking.[3] The Supreme Court also has suggested that regulations that generally restrict use of land for the general benefit of the public, with all affected

[1]In *Pennsylvania Coal Company v. Mahon*, 260 U.S. 393, 415, 43 S.Ct. 158, 160 (1922), Justice Holmes noted that "while property may be regulated to a certain extent, if regulation goes too far it will be recognized as a taking."
[2]Agins v. Tiburon, 447 U.S. 255, 260, 100 S.Ct. 2138, 2141 (1980).
[3]Goldblatt v. Hampstead, 369 U.S. 590, 82 S.Ct. 987 (1962) (prohibiting excavation in residential area); Hadacheck v. Sebastian, 239 U.S. 394, 36 S.Ct. 143 (1915) (prohibiting brick manufacturing in residential area).

property owners enjoying an "average reciprocity of advantage," do not result in a taking because they do not interfere with a property owner's reasonable expectations.[4]

The *Lucas* Decision

The Supreme Court's most recent effort to define when a regulation results in a taking came with its decision in *Lucas v. South Carolina Coastal Council.*[5] *Lucas* concerned a challenge to South Carolina's Beachfront Management Act ("the Act"), which prevented Lucas from constructing any permanent habitable structures on his property. The trial court in South Carolina concluded that because the Act deprived Lucas of "any reasonable economic use of the property" and rendered Lucas's property valueless, a taking had occurred requiring the state to compensate Lucas. On appeal, the South Carolina Supreme Court reversed the trial court's decision. Applying what it understood to be the applicable law with respect to regulatory takings, the South Carolina Supreme Court held that because Lucas conceded that the Act constituted a lawful exercise of the state's police power, designed "to prevent serious public harm," the state need not compensate Lucas, regardless of the Act's impact on the value of Lucas' property.

On appeal, the U.S. Supreme Court reversed the holding of the South Carolina Supreme Court, rejecting the argument that a regulation will not trigger the need for compensation whenever the legislature has determined that the regulation serves a valid public purpose. Rather, the Court held that a regulation that prohibits all economically beneficial use of land will require compensation unless the "background principles of the State's law of property and nuisance already" constrain the rights attendant to land ownership, such that the property owner had no reasonable expectation to use the property in the manner constrained by the regulation.[6]

The Impact of *Lucas* on Wildlife Regulations

Many states, such as Missouri, have had specific regulations regarding wildlife management, i.e., bag limits or hunting seasons, for many years (Bean 1983, Missouri Department of Conservation 1976). Over the last several years, however, in response to a better understanding of the ways in which human development impacts the ecosystems around us, the federal and state governments have developed a broader array of "wildlife regulations"—land-use restrictions designed to protect wildlife or preserve threatened ecosystems by limiting the extent to which private property owners may alter the "natural" state of their property. These include prohibitions on the destruction of critical habitat for an endangered or threatened species, prohibitions on disturbing wetlands or shorelands and prohibitions on developing areas

---

[4]Keystone Bituminous Coal Association v. DeBenedictis, 480, U.S. 470, 492, 107 S.Ct. 1232, 1245 (1987); Agins v. Tiburon, 447 U.S. 255, 261, 100 S.Ct. 2138, 2141 (1980).

[5]112 S.Ct. 2886 (1992).

[6]*Lucas*, 112 S.Ct. 2886, 2900. The Supreme Court remanded the case to allow the South Carolina Supreme Court to determine whether the Act's restrictions were inherent in Lucas's title by virtue of background principles of South Carolina's law of property and nuisance. The South Carolina Supreme Court concluded that the Act resulted in a taking because the constraints on land use encompassed in the Act were not grounded in background principles of South Carolina's property and nuisance law. Lucas v. South Carolina Coastal Council, No. 91–453 (S.C. Nov. 20, 1992).

designated as "green space." With increasing frequency, however, property owners have challenged "wildlife regulations" on the ground that they constitute a "taking" that requires compensation under the Fifth Amendment (Lazarus 1993). Although many expected that the *Lucas* decision would provide the Supreme Court with an opportunity to answer some questions regarding when such "wildlife regulations" would constitute a "taking," the Supreme Court's *Lucas* decision raises far more questions than it answers (Funk 1993).

Unanswered Questions from *Lucas*

Many scholars have analyzed the *Lucas* decision seeking to identify questions that the decision either raises or fails to answer in an effort to predict *Lucas's* impact on future regulatory takings cases (Epstein 1993, Fisher 1993, Funk 1993, Humbach 1993a). The answers to these questions will determine *Lucas'* likely impact on wildlife regulations.

How Does the Court Define the Affected Property?

Several scholars have noted that *Lucas* raises a question regarding the definition of the property affected by a regulation (Fisher 1993, Funk 1993, Humbach 1993a, 1993b). These scholars note that prior to *Lucas*, the Court traditionally viewed the entire parcel as the denominator in evaluating whether a regulation resulted in a taking by depriving the owner of reasonable investment-backed expectations[7] (Humbach 1993b). Because *Lucas* involved the somewhat unique factual situation in which the Act was held to render all of Lucas' property completely valueless, the *Lucas* decision did not provide the Court with a significant opportunity to stray from this traditional approach. To some extent, therefore, *Lucas* may not provide a meaningful basis to challenge many wildlife regulations, as most wildlife regulations do not destroy all economically beneficial use of all of someone's contiguous property[8] (Lazarus 1993).

Nonetheless, these scholars have highlighted Justice Scalia's statement in *Lucas* that the " 'deprivation of all economically feasible use' rule does not make clear the 'property interest' against which the loss of value is to be measured"[9] (Fisher 1993, Funk 1993, Humbach 1993a). Were the Supreme Court to hold at some future point that courts must evaluate whether a regulation completely destroys the economically beneficial use of property by looking only at that portion of a parcel affected by the regulation, the universe of possible takings claims in the context of wildlife regulations would increase significantly.[10]

---

[7]See, e.g., Keystone Bituminous Coal Association v. DeBenedictis, 480 U.S. 470, 497–502, 107 S.Ct. 1232, 1248–1251 (1987).

[8]Traditional wildlife management regulations, i.e., bag limits and hunting seasons, almost certainly will not require compensation under the *Lucas* formula because they will not negate all economically beneficial use of property. Even more modern "wildlife regulations," which take the form of land-use restrictions, rarely will result in the complete elimination of all economically beneficial use because (1) they may not impact all of a parcel, and (2) they generally allow some use which has some economic value.

[9]Lucas v. South Carolina Coastal Council, 112 S.Ct. 2886, 2893 n.7 (1992).

[10]The more modern "wildlife regulations" that significantly restrict land use would be most at risk if the Supreme Court were to change the definition of the "affected parcel."

Does the Logic of Lucas *Apply Only to Complete Loss of Value Cases?*

Even if the Court does not alter its approach to defining the "affected parcel," Justice Scalia's reasoning in *Lucas* could support a taking claim even when a regulation does not result in the loss of all economically beneficial use of property, but only diminishes the value of the property. The Supreme Court held in *Lucas* that even when a regulation precludes all economically beneficial use, compensation may not be required if the constraint on property use contained in a challenged regulation is encompassed within "background principles of the State's law of property and nuisance."[11] The "background principles" exception is premised on the notion that a regulation that restricts certain uses of property cannot result in a taking if it merely precludes uses of the property that the property owner could not reasonably expect to enjoy under "background principles of the State's law of property and nuisance."[12] The "background principles" concept could be turned around just as easily such that any time a regulation constrains property use in a manner not encompassed within "background principles of the State's law of property and nuisance," a court could view the regulation as a taking of some portion of the owner's "bundle of rights" and could require compensation, even though the regulation does not destroy all economically beneficial use of the property (Epstein 1993).

How Does the Background Principles Concept Get Applied to State and Federal Wildlife Regulations?

The extent to which this expanded application of the "background principles" concept would result in an increase in the number of takings claims associated with "wildlife regulations" depends significantly on the answer to a couple of other questions which scholars have identified in their analyses of *Lucas*. First, with respect to state wildlife regulations, what is included within "background principles of the State's law of property and nuisance?" Second, how does the "background principles of the State's law of property and nuisance" concept get applied with respect to federal wildlife regulations?

What should be included within the "background principles" concept? The "background principles" concept, according to Justice Scalia, finds its roots in the traditional notion of takings jurisprudence that property owners reasonably should expect that the state may impose some limitation on the " 'bundle of rights' that they acquire when they obtain title to property."[13] Some scholars suggest that the "background principles" concept encompasses the common law of property and nuisance, taken together with statutes, regulations and ordinances that constrain land use, since all these things impose inherent limits on a property owner's reasonable expectations regarding their "bundle of rights" (Chinn et al. 1994, Funk 1993, Humbach 1993a). These scholars take the view that a property owner should not "reasonably expect" to make use of her property in a manner prohibited by nuisance law, or by statutes, regulations and ordinances in existence when she receives her property (Funk 1993, Humbach 1993a). This understanding of the "background principles" that limit a

[11] *Lucas*, 112 S.Ct. 2886, 2900.
[12] *Id.*
[13] *Lucas*, 112 S.Ct. 2886, 2898.

property owner's ''bundle of rights'' suggests that a regulation will result in a taking only if (1) it is enacted after someone acquires title, and (2) it impairs the economic value of the property by imposing restrictions on land use that did not inhere in the property owner's title at the time she received the property in question by virtue of the common law of property and nuisance and existing statutes, regulations and ordinances.

These same scholars and others have noted, however, that the language the Court used in defining the ''background principles'' concept suggests that the Court may view the inherent limits on a property owner's ''bundle of rights'' more narrowly, focusing solely on the extent to which the common law of nuisance restricts the ''bundle of rights'' (Chinn et al. 1994, Epstein 1993, Fisher 1993, Funk 1993, Humbach 1993a). This narrower interpretation of the ''background principles'' concept finds its roots both in Justice Scalia's specific reference to ''background principles of the State's law of *property and nuisance*,'' and, in his distrust of state legislatures, which he assumes will identify some public purpose to justify any regulation[14] (Blumm 1993, Fisher 1993, Funk 1993, Humbach 1993a). More importantly, because this narrower interpretation of the ''background principles'' concept focuses solely on judicial interpretations of what constitutes a nuisance, legislative efforts to ''correct'' or ''supplement'' the common law of nuisance through statutes, regulations and ordinances may not be protected under the ''background principles'' concept (Humbach 1993a). This narrower understanding of the ''background principles'' concept, therefore, suggests that a regulation will result in a taking whenever it imposes restrictions on land use that 1) impair the value of property and 2) do not inhere in the property owner's title at the time she received the property in question by virtue of the common law of nuisance.

Some scholars have noted, however, that even the narrower interpretation of the ''background principles'' concept may be broader than the above discussion suggests because common law public nuisance claims include claims arising when a property owner's conduct violates a statute or ordinance enacted pursuant to a state's police powers (Funk 1993, Humbach 1993a). Moreover, the ''background principles'' of property law may include the public trust doctrine, which may place inherent limits on a property owner's ''bundle of rights'' such that a challenged regulation that merely expands on restrictions imposed under the public trust doctrine would not result in a taking (Sarahan 1994). Accordingly, even under the narrower interpretation of the ''background principles'' concept, ''wildlife regulations'' might be included within the inherent limits on a property owner's ''bundle of rights'' such that the ''wildlife regulations'' do not result in a taking.

Impact of the ''background principles'' concept on existing and newly-enacted ''wildlife regulations.'' Notably, how the ''background principles'' concept gets interpreted will have a significant impact with respect to existing wildlife regulations, as well as newly enacted wildlife regulations. The broader interpretation of the ''background principles'' concept would provide states some comfort that their existing ''wildlife regulations'' will not trigger an obligation to compensate for a taking. Because many states, such as Missouri, have had ''wildlife regulations'' on the books

[14]Lucas, 112 S.Ct. 2886, 2898, n.12.

for 20 or 30 years or more (Bean 1983, Missouri Department of Conservation 1976), under the broader interpretation of the ''background principles'' concept few people would be in a position to claim that the ''bundle of rights'' they acquired when they received their property should not be limited by such regulations. The broader interpretation of the ''background principles'' concept similarly would provide states some comfort that enacting new wildlife regulations will not trigger an obligation to compensate for a taking. Because the broader interpretation contemplates that existing wildlife regulations inherently and justifiably limit a property owner's reasonable expectations regarding the ''bundle of rights'' acquired when receiving property, new land-use regulations designed to protect wildlife arguably would not result in a taking because they would constitute mere extensions of the limitations that inhere in the property owner's ''bundle of rights'' by virtue of the existing wildlife regulations.

By contrast, the narrower interpretation of the ''background principles'' concept would present states with a much greater likelihood of having to compensate for a taking with respect to existing wildlife regulations and new wildlife regulations alike. Under the narrower interpretation, the mere fact that a wildlife regulation existed when someone purchased property would not protect a state from having to compensate for a taking resulting from such regulation because the regulation may not impose restrictions that inhere in the property owner's title. Any effort to enact new wildlife regulations likely would face a similar taking challenge on the ground that the regulations do not impose restrictions that already inhere in the property owner's title as a result of ''background principles.'' Wildlife regulations would be exposed to taking challenges under the narrower interpretation of the ''background principles'' concept because common law nuisance generally only prohibits conduct that results in a concrete harm to neighboring property, as opposed to prohibiting conduct that negates a generalized benefit to the public (which is a fair characterization of most wildlife regulations). Phrased differently, under the narrower interpretation, most courts likely would conclude that land-use regulations designed to protect wildlife or promote ecosystem preservation result in a taking whenever they diminish property values because they do not fit within the traditional common law nuisance idea of negating a concrete economic harm; rather, they fit a more modern legislative trend toward providing a generalized benefit to the public (wildlife preservation) at dramatic cost to a handful of property owners (Sax 1993).

Interestingly, because the ''background principles'' concept depends on *state* property and nuisance law, the ''background principles'' concept could mean that each of the states could reach different answers to the question of whether a given regulation results in an unconstitutional taking under the Fifth Amendment (Fisher 1993, Funk 1993).

How does the ''background principles'' concept apply to federal wildlife regulations? Some scholars also have noted that *Lucas* offers little insight into how its ''background principles'' concept should be applied to federal wildlife regulations (Funk 1993). Because *Lucas* concerned a state wildlife regulation, the Court's discussion of the ''background principles'' concept has a *state* law focus. In the context of federal wildlife regulations, the ''background principles'' concept could get implemented in at least two different ways. First, it could mean that the federal regulations get evaluated against ''background principles'' of federal law. This would present similar issues regarding whether the ''background principles'' concept gets interpreted broadly, to encompass both the federal common law of nuisance and statutes and regulations that restrict land use, or narrowly, to encompass only the federal common law of nuisance. Second, it could mean that federal regulations get evaluated against state property and nuisance law, raising both the question of the broad or narrow interpretation and the possibility that federal wildlife regulation could result in a taking in one state but not in another.

The Irony of Judicial and Legislative Responses to Lucas

Justice Scalia's opinion in *Lucas* empowers courts to be more assertive in second guessing whether legislatures have chosen an appropriate means of providing a public benefit when they enact a regulation that restricts land use without compensation. Justice Scalia shifted this decision-making authority to the judiciary because he does not trust legislatures to compensate a handful of affected property owners when legislatures require that property owners leave their land in its natural state to provide a public benefit.

Ironically, in the aftermath of *Lucas*, the courts have been much less friendly to property owners than Justice Scalia probably would prefer. Conversely, the legislatures have been much more solicitous of assuring compensation of affected property owners than Justice Scalia probably would have expected. As Professor Lazarus predicted, in the vast majority of state court regulatory takings cases decided since *Lucas*, courts have taken *Lucas* at face value and concluded that absent the complete destruction of all economically beneficial use, no taking has occurred[15] (Lazarus). The vast majority of state courts have disregarded completely the question of whether a regulation requires compensation on the ground that it imposes a restriction that did not inhere in the property owner's title. At the same time, a number of legislatures at the state and federal level have enacted or are considering legislation that either requires agencies to assess whether a regulation would result in a taking or defines specifically the point at which a regulation so impacts the value of property as to require compensation (Freilich et al. 1994, Martinez 1993).

Conclusion

For those concerned about the future of wildlife regulations, therefore, the battles on the legislative front probably have taken priority over the battles on the judicial front. While those involved in wildlife management certainly should continue to track relevant cases at the state and federal level to assure themselves the best opportunity of making their case against an expansion of the regulatory takings concept through "friend of the court" briefs, it is all the more important that they become involved in the legislative debates at the state and federal levels on "property rights" legislation that seeks to define the point at which regulations will require compensation.

References

Anderson, J. L. 1989. Takings and expectations: Toward a 'broader vision' of property rights, 37 U. KAN. L. REV. 529.

Bean, Michael J. 1983. The evolution of national wildlife law.

Blumm, Michael C. 1993. Property myths, judicial activism and the Lucas case. 23 ENVTL. L. 907.

[15]See, e.g., Cannone v. Noey, 867 P.2d 797 (Alaska 1994); Mock v. Dept. of Environmental Resources, 623 A.2d 940 (Commonwealth Ct. of Penn. 1993).

Chinn, Stephen P. and Shortlidge, Neil R. 1994. Regulatory takings after Lucas: The Missouri nuisance exception. 50 J. Mo. Bar 213: July–August.

Epstein, Richard A. 1993. Lucas v. South Carolina Coastal Council: A tangled web of expectations. 45 Stan. L. Rev. 1369.

Fisher, William W., III. 1993. The trouble with Lucas. 45 Stan. L. Rev. 1393.

Freilich, Robert H. and Doyle, RoxAnne. 1994. Takings legislation: Misguided and dangerous. 46 Land Use Law 3; October.

Funk, William. 1993. Revolution or restatement? Awaiting answers to Lucas' unanswered questions. 23 Envtl. L. 891.

Humbach, John A. 1993a. Evolving thresholds of nuisance and the takings clause. 18 Colum. J. Envtl. L. 1.

Humbach, John A. 1993b. "Taking" the imperial judiciary seriously: Segmenting property interests and judicial revision of legislative judgments. 42 Cath. U. L. Rev. 771.

Lazarus, Richard J. 1993. Putting the correct "spin" on Lucas. 45 Stan. L. Rev. 1411.

Martinez, John. 1994. Statutes enacting takings law: Flying in the face of uncertainty. 26 Urb. Law. 327.

Michelman, Frank. 1988. Takings, 1987. 88 Colum. L. Rev. 1600.

Missouri Department of Conservation. 1976. Missouri Conservationist: Missouri's wildlife trail 1700–1976, July.

Nolon, John R. 1992. Footprints in the shifting sands of the Isle of Palms: A practical analysis of regulatory takings cases, 8 J. Land Use & Envtl. L. 1.

Sarahan, Paul. 1994. Wetlands protection post-Lucas: Implications of the public trust doctrine on takings analysis. 13 Va. Envtl. L. J. 537.

Sax, Joseph L. 1993. Property rights and the economy of nature: Understanding Lucas v. South Carolina Coastal Council. 45 Stan. L. Rev. 1433.

Re-engineering Private Lands Stewardship

Carlton N. Owen
Champion International Corporation
Greenville, South Carolina

Introduction

Polluted rivers, smog-filled cities and rapidly diminishing forests were readily visible examples of environmental threats to our natural estate in Aldo Leopold's day. Even in the face of rapidly expanding human populations, we have made enormous progress in reversing and improving many past environmental problems. Yet, there are many environmental challenges remaining. I say "challenges," because today's environmental threats are more complex and often less visible.

However, while environmental issues have grown in complexity and the environmental movement has matured, many preservationists have been reluctant to change their approach to solutions. Many simply continue to vilify the private sector (especially big business), demand more and more land set-asides and lobby for ever stiffer laws and regulations.

What is lacking in this approach? I believe that in their rush to embrace and support new scientific theories that lend credence to their agendas, there is one science lesson that many preservationists seem to have missed. It is an application of Isaac Newton's third law of motion which states that for every action there is an equal and opposite reaction. As environmental interest demands grow ever more threatening and burdensome (the action) to private landowners (the majority of landowners in the U.S.), we should not be surprised to see the birth and proliferation of "wise-use" groups and activist private rights coalitions (the reaction). It is the inability of environmentalists to change and promote a more balanced, solution-oriented approach to issues that has provided the energy of motion fueling these new interest groups.

Poll after poll shows the American public remains committed to a quality environment. However, the desire is for a more pragmatic view—one where conservation, itself defined as wise use, is preferred three to one over preservation (Roper 1993), one where government isn't looked to as the source of all solutions. If the 1994 elections did not teach us anything else, it should be clear that the public is frustrated by government inefficiency and many are feeling overburdened by government intervention in their lives. Since private landowners represent a critical constituency for the natural resources professions, we cannot afford for them to feel so overburdened that they adopt an "anti-wildlife" philosophy in reaction to regulatory pressures.

It really doesn't matter whether your sympathies are with the environmental movement or whether you believe the wise-use, less-government approach is better. I assume many of us share some mix of values and concerns with both camps. Nevertheless, the bottom line is that arguments over private property rights and the regulatory takings issues are increasingly the cause of consternation and conflict. These issues are so emotionally charged that they threaten a grassroots revolt which could lead to the rollback of many environmental laws. If these radical events do unfold, much of the blame must rest on the shoulders of those who were unwilling to find and promote less burdensome options to environmental regulation.

In his book *Broken Trust, Broken Land*, Dr. Robert Lee reminds us that "threats to property rights, or uncertainty about their future security, has throughout history resulted in the abandonment of long-standing commitments to resource conservation" (Lee 1994). Thus, landowner concerns and fears in the face of growing regulatory burdens should not surprise us. I fear that we in the wildlife profession have been taken in by the environmentalist versus landowner paradigm and that we too may have lost sight of the bigger picture. If we are in for an ultimate "winner-take-all" showdown, wildlife will most surely be the loser.

Too much is at risk for us to let things stay on the current course. Since Aldo Leopold articulated a vision for wildlife management in the U.S. in the late 1920s (Leopold 1930), there has never been a more pivotal time that demands the vision and leadership of natural resources professionals.

Just as in Leopold's time, to be successful, we must articulate a vision that is inclusive, a vision that does not unfairly burden one segment of society and one where private property owners are full partners in efforts to protect and manage wildlife habitat. Thus, my goal today is to convince you that as natural resource managers we only will be successful to the extent that private landowners are willing to do their part voluntarily for wildlife management. And further, to suggest that we must craft positive mechanisms that enlist them in that endeavor. It truly is time that we re-engineer our approach to private lands stewardship.

The Current State—Private Property Owners In The Middle

Private landowners control about 60 percent of the 2.3 billion acres in the U.S. (U.S. Government Accounting Office 1979) and more than 55 percent of all forests (American Forest Council 1991). These ownerships are highly segregated—high public ownership in the western states and high private holdings in the eastern states. Maine, with high private ownership, and Nevada, with high public ownership, are examples of the extremes.

If we could turn back the clock and resettle the country today, perhaps we could spread government ownership across all ecosystems and habitat types such that a portion of all habitats would be in relatively undisturbed public ownership, yielding something akin to Mac Hunter's triad of habitats (Seymour 1992)—some intensively managed for commodity values, some extensively managed for multiple values and still others retained in their natural conditions. If, as one can do with computer games, SimCity or SimLife, we could achieve this allocation, perhaps many of our current debates over endangered species or land uses would not exist. As the promotional material states, with SimLife you can "build your own ecosystem from the ground up and give life to creatures . . . test their adaptive abilities by turning their environment into either a paradise where life is easy or a wasteland . . . play with genetics, food webs, mutations, extinction, or natural disasters."

No, we can't build our own ecosystems. Our environment is not a computer game, nor can we turn back the clock. But my suspicions about human nature are that even if we could, we would still be having the same arguments. The debates still would erupt over how much of the public lands should be set-aside and how much burden private property owners should be expected to bear to protect public resources. Thus, even a more balanced past would not guarantee wiser decisions nor better cooperation today.

We can't start over. Lands already are "allocated." Many have been put into uses to meet society's needs with little thought of protection for noncommodity public resources. And yet, it seems that those owners who have retained their lands in a relatively natural condition now are being asked to make up for all past land conversions. Let me relate a situation that I believe depicts this clearly.

When working for another private property owner a number of years ago, I came upon two men illegally cutting firewood from my employer's forest. When I engaged the fellows in a conversation, they told me how they had cleared their adjoining lands for soybean production and how they depended on my employer's lands for firewood and hunting opportunity. Rather than acknowledge that they had made decisions to meet their own objectives, they began to deride my company for having the gall to harvest trees on its own land! Many today hold to this same double standard. We expect and ask more of those landowners who have retained their lands in more natural conditions than we do of those who have more drastically altered their holdings.

Lest you fail to see the connection, let me give you examples of how the preservationist community, and even we in this profession, sometimes mirror these attitudes. A couple of years back, Washington State's Lands Commissioner established a Sustainable Forestry Roundtable to address the management of forests in the state. Parties to the discussions included the forest industry, federal resource agencies, county governments, tribal owners and the environmental community. After agreeing on a number of proposed regulatory changes, including reduced harvest unit size, wider streamside zones, and the retention of green trees and snags, the environmental community proposed that every private property owner should set-aside from all management the oldest 25 percent of their holdings for wildlife habitats. This in a state with huge public forest ownerships. Surprisingly, after lengthy negotiations, the private lands representatives did agree to a provision that would have allocated 10 percent of each ownership to such protection areas. With these gains on the table, the environmental interests refused to support the final package, because, in the words of one spokesman, "we got 80 to 90 percent of what we wanted, but that wasn't enough."

Let me give you one more example of unrealistic expectations or, at the very least, what I have come to call the "piling on" mentality. Again, with another private property owner, I and others convinced the company to consider placing a conservation easement on 60,000 acres of prime bottomland hardwoods. When the representatives from the federal government came to discuss the proposal that was offered by the company, rather than responding to the company's proposed precedent-setting action with open arms, the offer was met with skepticism. The discussions quickly broke down, when the government representatives (all wildlife biologists) said they could only support the easement if it contained severe constraints on harvesting, and only if the company agreed to complex formulas to favor "mast producing" hardwoods. These proposed restrictions were far more stringent than those required on the adjoining lands that were operated as part of the National Wildlife Refuge System. Is it any wonder that my employer dropped its consideration of conservation easements? Another case of voluntary stewardship thwarted by burdensome additional demands—piling on.

I can understand how we all can become jaundiced as we see acre after acre of wildlife habitat converted to non-wildlife uses. But again, we are letting ourselves get diverted by skirmishes without keeping an eye on the larger objective. We must look at ways to establish new processes that will add additional gains for wildlife. Each gain may be small, but, when taken over millions of acres and over decades, the cumulative gains will be great. It is time to meet private landowners more than halfway.

What I'm advocating is nothing new. As a matter of fact, Aldo Leopold, speaking to this same Conference 65 years ago, suggested that we must recognize the private landowner as custodian of [wildlife] on private lands and protect and compensate him accordingly. Many parts of his vision for American game policy have been fully endorsed and implemented. We have extended public land ownership for wildlife. We have made wildlife management a profession. We have brought the non-hunter into wildlife management. We have developed new facts to guide management and generated new funds to support wildlife management. If we have fallen short anywhere, it is in the part of the vision that addresses private landowners and in strengthening relationships between landowners, sportsmen and the public. It is to these roots and this remaining need that I turn our attentions for the good of wildlife habitat and wildlife populations in the future.

Setting a Sustainable Support System in Place for Private Land

To make further gains with private property owners, we should move in two directions as quickly as possible. First, we must seek out and recognize those private property owners who are doing positive things for wildlife. In so doing, we will show that we are "for something," not "against everything." Second, we must establish a reasonable limit on the burdens that accrue to private property in the name of public resources and then provide compensation when burdens go beyond those limits.

What if we were to turn the issue of private property rights and protection of wildlife completely around? Rather than asking when have laws and regulations gone too far and, thus, resulted in a taking of private property, what if we first defined the stewardship responsibilities that go with ownership of private property? This isn't merely looking at the glass of water differently—half full or half empty. Such a view indeed would be a radical shift in the debate that could help re-engineer a positive approach to wildlife management on private lands. Such management would perhaps meet environmental quality needs that are important to society, while, at the same time, honor the constitutional guarantee of no taking of private property without compensation.

Explore with me for a few moments how such a plan might work. I'm assuming we all start with common agreement that no property owner has the right to manage his or her property in such a way as to threaten public safety or directly impact the rights or interests of adjoining owners. But private ownership entails more than "doing no harm." Ownership also carries responsibilities to contribute to the overall health of the system by protecting public resources—air, water and wildlife. How those contributions are measured and when a landowner has met his or her legitimate obligations seem to be the $64,000 questions.

Let's assume for a moment that a county or perhaps a state wanted to intervene in the debate so as to define stewardship responsibilities. The government—or even better, landowners themselves—might suggest that landowners should assume that, on average, 10 percent of each landbase would be necessary to meet basic environmental commitments (e.g., protection of water quality and provision of wildlife habitat. Forest landowners, farmers and others with undeveloped ownership then would develop a plan describing how they propose to meet that standard. Once approved, and perhaps secured by conservation easement, the landowner would be free from additional expectations to make allocations of land for public resources. Should future conditions, such as the listing of a new species as endangered, suggest that additional acres could be impacted, the landowner would be fully compensated for any burdens beyond the base stewardship commitment. I suggest that such ''single bite at the apple'' or regulatory certainty provided by a program would be met with enthusiasm by many, if not most, private landowners. Providing certainty would encourage long-term planning and a positive approach to conservation.

In cases where lands already are developed, e.g., a house lot or commercial property where no lands were retained for public resource needs, a portion of the value of the land could be directed to a public resources mitigation bank. Funds would only be deposited in the bank at the time the lands were transferred to another buyer. Rather than establishing a one-time 10-percent public resources mitigation fee, perhaps the best way to ensure equity and palatability would be to have a 1-percent mitigation levy on the land portion of each sale every time the parcel changed hands.

Let's assume, for instance, that a home was sold for $200,000. If the house were valued at $170,000 and the lot at $30,000, the mitigation levy would be only $300 (1-percent of the $30,000 land value). Because the mitigation levy is built into the sales price and over the long-term, no property owner would be disadvantaged. As all lands ultimately would contribute either by levies to the mitigation bank or in direct lands allocated to public resource protection, equity would be retained across all ownership types.

Funds allocated to the mitigation bank then would be available to pay other landowners whose lands were so essential to conservation that more than 10 percent was needed. For instance, if an owner had a 100-acre tract that required 50 acres to protect an endangered species, the owner would be compensated for lands impacted above the standard 10 percent—the additional 40 acres.

There might be a tendency to spend these new funds to manage lands already in public ownership, but I believe, because public lands have their own funding mechanisms, mitigation bank funds should never be diverted from their private land targets. Maintaining a clear commitment to private ownerships would be imperative to generating and retaining long-term support for the program.

Over the long-term (decades), such a program should accomplish at least three things. First, it should undergird an understanding that all landowners have responsibilities and, thus, a role to play in protection of public resources. Second, such programs should negate regulatory over-reach and ''piling on.'' Finally, such programs would build on the best of the free market system, ensuring a level playing field for all and establishing a self-funding mechanism to support the program.

A clear and fair compensation system would eliminate the unknowns that drive some landowners to cut older trees for fear that their lands might become habitat for endangered species and thereby become restricted. Instead, they would be free to go beyond the minimum—to do more for wildlife—in the absence of uncertainty or fear of future regulatory threats.

While transition to the public resources mitigation levy would not be easy, the debates over private property and public resources would be replaced with positive conservation action. The long-term benefits to conservation could be enormous.

Summary

At this point, I'm sure each of you is experiencing some thoughts that range from "this guy has gone off the deep end" to finding the dozen of loopholes or problems with this proposal. In a world growing by more than 90 million people each year, we must find new ways to protect wildlife habitat and environmental quality. To be effective for the long haul, we must find ways to accomplish conservation objectives that are socially acceptable and that do not disadvantage classes of people. Such changes must be evolutionary, not revolutionary.

If we could use just a portion of the time and energy that goes into developing regulations and constraints to stop private property owners from conducting otherwise legitimate uses of their property, then we might be able to bridge the widening gulf that has the potential to fuel a full-fledged private property rights revolt, a revolt in which wildlife undoubtedly would be the loser.

Building programs that use the free market system and retain individual owner flexibility should have great potential. You may not like the concept as outlined. It is far from perfect. Take it, modify it, improve it. Now is the time for vision and innovation. If you agree that the current debates are getting us no closer to solutions, then view this concept as a discussion starter. It is intended to challenge you to explore new ways to work with private property owners to achieve common goals.

Two of Dr. Bob Lee's guiding principles for sustainability and, likely, re-engineering private stewardship are: "1) secure property rights are essential for people to make sacrifices for the future; and 2) voluntary conformity with conservation programs is possible if local citizens are involved in developing and implementing programs and are allowed to capture economic gains sufficient to maintain their way of life" (Lee 1994). Understanding, advocating and implementing these principles is key to our success as resource managers.

Maybe it is time that we create our own "contract with landowners." That contract would have to be founded on caring, understanding and vision. By recognizing and making heroes out of those landowners who voluntarily make wildlife habitat a priority, we show that we care. By working with private landowners to limit their risks and burdens, we show that we understand. Yet, most importantly, by working to put compensation systems in place to ensure fairness, we show that we have a vision that is balanced and long-term. By caring, understanding and helping to promote fairness, we will promote regulatory certainty and incentives that are foundational to private lands stewardship. If we accept the challenge, we will enlist tens-of-thousands of willing private landowners for the cause of conservation as we work with them to meet mutual objectives.

We must never forget that only rarely do we as professionals "manage" wildlife. Loggers, landowners and developers manage wildlife with their everyday decisions. Only when we become partners with them and they willingly enlist in the conservation cause will we be truly successful.

References

American Forest Council. 1991. The American forest: Facts and figures 1991. Washington, D.C. 24 pp.

Lee, Robert G. 1994. Broken trust, broken land. BookPartners, Wilsonville, OR. 210 pp.
Leopold, Aldo. 1930. Report to the American Game Conference on an American game policy. Trans. Seventeenth Amer. Game Conf., Amer. Game Assoc., Washington, D.C. 309 pp.
Roper Organization. 1993. Conservation leads the environmental debate: The emergence of a more pragmatic public. 1993 National Environmental Forum Survey. Times/Mirror Magazines, New York. 57 pp.
Seymour, R. S. and M. L. Hunter, Jr. 1992. New forestry in eastern spruce-fir forests: Principles and applications to Maine. Maine Agric. and Forest Exp. Sta. Misc. Publ. 716. 36 pp.
U.S. Government Accounting Office. 1979. The federal drive to acquire private lands should be reassessed. A report by the Comptroller General of the U.S. CED–80–14. Washington, D.C. 272 pp.

Implications of the Takings Clause for the Federal Endangered Species Program

Robert Meltz
Congressional Research Service[1]
Washington, D.C.

Putting the Takings Issue in Perspective

Though the constitutional takings issue garners the headlines and, indeed, has become a household phrase, it is not the major challenge facing the federal Endangered Species Act (ESA) today.[2] Hence, before turning to the takings issue, it would be useful to review these other developments, which raise the possibility that the federal endangered species program will be transfigured substantially in the near future.

The Sweet Home *Litigation*

Though it does not raise a constitutional taking issue, the case of *Sweet Home Chapter of Communities for a Great Oregon v. Babbitt*, now awaiting oral argument before the U.S. Supreme Court, goes to the very heart of the ESA's tension with private property rights.[3]

The issue in the case is simple enough. ESA Section 9 prohibits the "taking" of any endangered animal. The term "take," a key ESA concept not to be confused with Takings Clause takings, is generously defined by the ESA to include almost any act adversely affecting a member of a listed species—including "to . . . harm. . . ." The crux is that the U.S. Fish and Wildlife Service (FWS) defines "harm" to include "significant habitat modification or degradation where it actually kills or injures wildlife. . . ."[4] The effect of the FWS definition is to render certain habitat modifications unlawful *per se*. Since the ESA "take" prohibition applies to private as well as public property, the intersection with the development plans of private land owners is all too clear.

In March 1994, the U.S. Court of Appeals for the District of Columbia Circuit ruled that the term "harm" must be read in line with the other component terms in the ESA definition of "take," all of which, in the court's view, envision "the perpetrator's direct application of force against the animal taken."[5] Consequently, it found the FWS definition overbroad and struck it down. In so ruling, the D.C. Circuit took a position contrary to two decisions of the Ninth Circuit upholding the habitat-modification reading of "harm."[6] The Supreme Court, therefore, faces a split in the circuits.

---

[1]The views expressed herein do not necessarily represent those of the Congressional Research Service or its parent agency, the Library of Congress.
[2]The ESA is at title 16, U.S. Code, sections 1531–1544.
[3]17 F.3d 1463 (D.C. Cir. 1994), *cert. granted*, 115 S. Ct. 714 (1995).
[4]50 C.F.R. § 17.3.
[5]17 F.3d 1463 (D.C. Cir. 1994).
[6]639 F.2d 495 (9th Cir. 1981); 852 F.2d 1106 (9th Cir. 1988).

If the Supreme Court upholds the FWS definition, one may expect efforts by congressional conservatives to reinstate the narrower D.C. Circuit holding, possibly through restrictions in the fiscal year 1996 Department of the Interior appropriations bill. If successful, or if the Court invalidates the FWS definition, the agency will be restricted to achieving habitat preservation on private property primarily through Section 7 (when a federal permit is required or there is other federal involvement) or through Section 5 (providing authority for use of eminent domain to purchase species habitat). Whichever scenario unfolds, the future of federal habitat protection on private land is cloudy.

The Court's decision is expected in June 1995.

Amendments to the ESA

The significance of the November 1994 elections for the future of the ESA has been lost on no one. The anti-government sentiment and the particular antipathy of some members of Congress for the ESA pose major challenges to the future of the Act, which will be the subject of reauthorization efforts this year. For example, Chairman Don Young of the House Committee on Resources has appointed an ESA task force, with a vocal critic of the Act, Congressman Richard Pombo, as its chairman.

Property Rights Legislation

After years of simmering in Congress, property rights legislation now is in full boil. On March 3, 1995, the House passed H.R. 925 (repassed as H.R. 9, Division B), part of the Contract with America.[7] Under H.R. 925, as passed, any federal action pursuant to the ESA (or a few other listed statutes) that reduces the value of an affected portion of private property by 20 percent or more, gives the property owner the right to seek compensation from the acting agency. Exemptions in the Act seem unlikely to cover many ESA actions. Passage was by a lopsided 277 to 148 vote.

On March 23, an "omnibus" property rights bill, S. 605, was introduced in the Senate with 22 initial cosponsors. The compensation portions of this bill specify that agency action under the ESA (or any other federal statute) that meets any of five criteria gives the property owner a cause of action in the courts. One of these criteria is a reduction in the value of the affected portion of the property by 33 percent or more. Other bill provisions would allow a right to seek compensation from the agency itself, authority for an administrative appeals mechanism for property owners adversely affected by the ESA, etc. Hearings and a floor vote are virtually assured.

ESA Initiatives by the Department of the Interior

Since arriving at the Department, Secretary Babbitt has launched an aggressive effort to inject flexibility into the ESA within the terms of the existing statute. Whether this effort will be sufficient to deflect the more substantial proposals on the Hill for cutting back the ESA is, as yet, unclear. More details on the Babbitt initiatives follow.

---

[7]The full text of H.R. 925 as passed is at 141 Cong. Rec. H 2629–30 (daily ed. March 3, 1995).

Four Major Paradigms for Conflict Between the ESA and Private Property

Case law under the ESA and other wildlife protection statutes, together with the raging public debate over the ESA and private property, suggest four major paradigms by which the ESA and private land users might theoretically come into conflict. (This paper leaves for another day the question of how much conflict actually is occurring, a frustratingly difficult matter to research.)

Direct Limitations on the Use of Private Property

This type of theoretical ESA impact is the most debated, and the subject of the most "horror stories" (of property owners suffering egregious hardship at the hands of government regulators) put forth by the property rights movement. Recall that the ESA prohibits the "taking" of listed animals, and further bars any federal action (such as granting a permit needed for land development) that jeopardizes the survival of the species or adversely modifies critical habitat. Under both proscriptions, incidental "takings" (those that are incidental to the proposed land use) are allowed, but may require the landowner to prepare a habitat conservation plan (HCP). For the small landowner not able to piggyback onto a wide-area HCP funded by a deeper pocket such as a developer or local government, the HCP hurdle may be a daunting one—one reason why the chief constitutional taking concern under the ESA is with the small landowner.

Ironically, though the spectre of private land use limitation under the ESA has sparked much debate, it has generated not a single court decision in the 22-year history of the Act. (One case, *Good v. United States*, was filed in July 1994 in Florida and concerns a federal wetlands permit denied because of the threat to endangered species habitat.) The reasons for this dearth of cases are hotly debated. Environmentalists assert that it demonstrates the flexibility of the ESA—that the ESA/property rights conflict is overstated. On the other side, property rights partisans argue that the absence of cases stems from the fact that the FWS did not begin enforcing the Act on private property until recently, and from the high costs of takings litigation, the difficulty under the ESA in meeting ripeness requirements, and the small likelihood of winning given the stiff requirements of current takings jurisprudence.

To soften the direct limitations theoretically imposable under the Act and accommodate more economic growth, Secretary Babbit has, first, sped up the HCP approval process. Second, he now is exploiting the greater management flexibility afforded by the Act for threatened, as distinct from endangered, species. The vehicle here is the "4(d) rule," after the authorizing section of the ESA. For example, the Secretary recently has proposed a 4(d) rule for the threatened northern spotted owl that eases incidental "take" prohibitions on non-federally owned owl habitat, and contains the first-ever small landowner exemption under the ESA. Third, the Administration reportedly will propose new regulations for threatened species granting general exemptions to most activities on single-home residential tracts, and for activities affecting less than 5 contiguous acres. Finally, the Department has adopted a so-called "no surprises" policy governing the situation where, after an HCP is approved, new knowledge suggests that greater land set-aside or greater spending by the owner will be needed to preserve the species. Under the policy, the permitholder may be asked to alter management practices, but no additional dedication or expenditure will be sought. Further such burdens will be borne by the government.

Limitation on Access to Public Resources

Though here we address access to or across *public* resources, private property rights nonetheless may be assertedly involved. Perhaps the access itself is characterized as a property right—for example, fishing licenses and grazing permits. Or, the destination for which access across federal land is sought embodies a property right. Private land holdings surrounded by public land or requiring access through public land, and mining and water rights on federal land, illustrate this category. Finally, the argument is made that limitations on use of federal land may undercut the economic viability of operations conducted on nearby private land. A clear instance is the grazing of livestock based at a private ranch, but dependent on a grazing permit for access to federal rangelands.

A few court decisions exist under this category—none, however, under the ESA and none in favor of plaintiffs. Typically, the access right itself (the fishing license or grazing permit) is held not to constitute property. Without property, of course, there can be no taking. In other fact patterns, the access restriction is found not to be sufficiently severe, or the grazing permit is held to confer no compensable rights with regard to the viability of the ranching operation.

The next significant judicial word in this area is likely to come when the Federal Circuit decides *Fallini v. United States*, a case in which wild horses protected under the Wild Free-Roaming Horses and Burros Act are claimed to have interfered with property rights in access to water on Bureau of Land Management rangeland in Nevada.[8]

Limiting an Owner's Ability to Protect Property from Depredations of Protected Animals

This category, particularly timely because of the recent reintroduction of the gray wolf into the Yellowstone ecosystem, brings us to perhaps the oldest type of wildlife statute/property rights conflict. Typically, the problem arises when predators (often, bears or wolves) attack livestock, or when animals (often, waterfowl, deer or beavers) eat forage, crops or trees. Normally, the ancient legal doctrine that government is not responsible for the actions of wild animals—animals *ferae naturae*—dispenses with such claims. The argument made by some property owners, however, is that an exemption should be carved from the traditional rule where the government prevents the property owner from taking adequate measures to protect his property. The ESA offers a defense from its civil and criminal liability provisions for actions taken in good faith belief that they were necessary to protect persons, but no such defense is provided for protection of property. (Special rules, however, do allow FWS agents to "take"—if necessary, shoot—certain nuisance predators.)

The case law under this heading goes back to at least 1917, when beavers reintroduced by New York State into valuable privately owned woodland proceeded to fell numerous trees. The beavers were protected under state law. In this case and most subsequent ones, the courts found no taking, hewing to the rule of government

[8] 31 Fed. Cl. 53 (1994), *appeal docketed* (Fed. Cir. 1994).

nonresponsibility. In the federal courts, the leading case is *Christy v. Hodel*, an ESA case in which a rancher shot a grizzly bear feeding on his sheep, unfortunately for him, in the presence of a FWS agent. The rancher defended against the assessed civil penalty on the ground that to prevent him from defending his sheep effected a constitutional taking. Reasoning once again that the government cannot be held accountable for actions of wild animals, the court found against the rancher. On petition to the Supreme Court, however, a spirited dissent from the denial of certiorari was penned by Justice White, who argued that the case presented serious taking issues.[9]

Non-ESA depredation cases in the federal courts all have reached the same no-taking conclusion as *Christy*, again, despite government constraints on private defensive efforts. For example, no taking was found when wild horses protected under the Wild Free-Roaming Horses and Burros Act consumed private livestock forage,[10] or when geese protected under the Migratory Bird Treaty Act damaged privately owned crops.[11]

The most interesting wrinkle under the depredation heading comes about when, in addition to limiting the landowner's defenses, the government plays a role in the very presence of the animal in the landowner's vicinity. Here, we confront government relocation programs. Plaintiff's argument is that, even if government restrictions on a property owner's defenses are insufficient to overturn the doctrine of nonresponsibility, surely the added factor of government complicity in the animal's presence tips the equities and requires abrogating the traditional rule.

Notwithstanding the persuasiveness of this argument to some, it has thus far failed to convince the few courts to which it has been made. Most recently, it was raised in *Moerman v. State*,[12] where a rancher contended that the state of California took his land by relocating a band of Tule elk onto nearby state-owned land. The elk allegedly occupied the ranch almost continuously, ate crops raised for the rancher's livestock and damaged fences—while the rancher claimed he was prevented from taking adequate defensive measures under state law. The court saw no taking, concluding that, in this case, at least, government intervention did not undermine the animal's *ferae naturae* status because the state only briefly reduced the wild animals to possession, exercised no control after relocation and employed the animals' historic range. Notwithstanding this holding, wildlife managers should note that the more intensive their management efforts, the more likely a court may be persuaded to abandon the rule of government nonresponsibility.

Limits on Commercial Dealings in Species Acquired Before Listing

ESA Section 9 prohibitions include many that bar commercial dealings in endangered species. For example, it is unlawful to import, export or transport interstate in the course of commercial activity any listed animal or plant. From the animal or plant owner's point of view, the rub is that the ESA contains no general grandfather clause from Section 9 prohibitions for species members (or items made therefrom) acquired

[9]490 U.S. at 1115–16 (White, J., dissenting).
[10]Mountain States Legal Fdn. v. Hodel, 799 F.2d 1423 (10th Cir. 1986), *cert. denied*, 480 U.S. 851 (1987).
[11]Bishop v. United States, 126 F.Supp. 449 (Cl. Ct. 1954), *cert. denied*, 349 U.S. 955 (1955).
[12]17 Cal. App. 4th 452, 21 Cal. Rptr. 2d 329, *review denied*, No. S034811 (Cal. S. Ct.1993), *cert. denied*, 62 U.S.L.W. 684 (U.S. Apr. 18, 1994).

before listing. The absence of general grandfathering authority creates the potential for property value loss when specimens acquired before listing lose commercial utility as a result of listing.

In *United States v. Kepler*,[13] the only ESA case to address this question, no taking was found by the ESA's ban on interstate transport of listed animals that allegedly were held lawfully as of ESA enactment. The court reasoned that the ESA barred sales of the listed animals only in interstate and foreign commerce, allowing sales in *intrastate* commerce and (when approved by the Secretary) for scientific and species propagation purposes. Thus, listing did not completely destroy the value of the animals.

Notably, the commercial dealings category includes *Andrus v. Allard*, the only U.S. Supreme Court taking decision dealing with wildlife protection.[14] *Allard* addressed the Eagle Protection Act and the Migratory Bird Treaty Act, which banned commercial transactions in bird parts even if they were lawfully acquired prior to the ban's effective date. The Court found that the ban effected no taking, explaining that, while it foreclosed the most profitable use of the plaintiff's bird parts, other uses, including possession, transport, donation or exhibition for an admissions charge, remained to plaintiffs.

Allard is one of the Supreme Court's most government-friendly taking decisions. Importantly, the Court appeared to reaffirm its vitality recently in its landmark ruling in *Lucas v. South Carolina Coastal Council*.[15] *Lucas* asserted in dictum that due to government's traditionally high degree of control over commercial dealings in personal property, in contrast with land, a personal property owner must be aware that new regulations might render such property worthless. The suggestion was that regulation of commercial dealings in personal property rarely is a taking. Most importantly, the case cited to illustrate the point was *Andrus*. In light of *Andrus* and *Lucas*, it is arguable that ESA restraints on commercial trading in protected species acquired before listing never can effect a taking.

Cross-cutting Issues

Physical Taking or Land-use Regulation

Taking plaintiffs would benefit greatly if courts were to view wildlife protection laws as bringing about a government-caused permanent physical occupation of land by members of the protected species, or a government-caused appropriation of consumed livestock or forage. So characterized, many ESA impacts would be viewed as *per se* takings under Supreme Court precedent.[16]

But, if ESA strictures are viewed instead as land-use regulation, takings law raises difficult and complex hurdles that each plaintiff must relitigate anew—in particular, proving total or new-total reduction in the value of plaintiff's land viewed as a whole. One suspects that in the overwhelming majority of ESA cases, such a showing cannot be made, since lawful economic uses of the property, or some portion thereof, remain.

[13]537 F.2d 796 (6th Cir. 1976).
[14]444 U.S. 51 (1979).
[15]112 S. Ct. 2886 (1992).
[16]See esp. Loretto v. Teleprompter Manhattan CATV Corp., 458 U.S. 419 (1982).

Most courts wrestling with taking challenges to federal wildlife statutes have adopted the land-use regulation label.

Apparent Irrelevance of ESA's Species Preservation Purpose

In the ESA, Congress elevated government's long-recognized interest in managing wildlife for the public good to "the highest of priorities."[17] Notwithstanding, the few pertinent federal cases suggest that regulation to protect wildlife—even to avert extinction—will be evaluated for takings under the same standards as other government action. *Lucas* appears to endorse this view. There, the Court specifically noted conservation of endangered species habitat as a governmental purpose easily characterized as both prevention of public harm (traditionally held to be noncompensable) and creation of public benefit (often held compensable)—in the course of debunking the harm/benefit distinction in takings law generally.[18] In addition, *Lucas* is explicit that its rule of *per se* compensability for "total takings"—when government regulation totally eliminates a parcel's economic use—applies regardless of the public interest advanced as justification for the regulation.

The Impact of Dolan *on Conditions in Incidental Take Permits*

In *Dolan v. City of Tigard*,[19] the Supreme Court's latest foray into takings law, the Court held that when government imposes dedication and exaction conditions on the grant of land-development permits, the burden imposed by the condition on the property owner must be "roughly proportional" to the impact that the proposed development would have on the community. Moreover, in a clear break with the traditional deference of courts to land-use regulators, the Court asserted that the burden of demonstrating "rough proportionality" is on the government; it is not the landowner's task to prove lack of such.

Plainly, *Dolan* places constraints on how far the FWS can go in imposing land dedication and mitigation conditions on the issuance of incidental "take" permits under ESA Section 10. The difficulty for the FWS will lie in how to show "rough proportionality" when the data tend to be very soft—for example, how much of a less desirable habitat should the landowner be required to set aside to make up for the loss of high-quality habitat.

The Conservative Turn in Certain Lower Federal Courts

While many observers focus almost exclusively on the takings decisions of the U.S. Supreme Court, there are two other federal courts that play a central role in the fortunes of federal taking litigators. Those courts are the U.S. Court of Federal Claims and its appellate reviewer, the U.S. Court of Appeals for the Federal Circuit. While the Supreme Court's takings jurisprudence clearly has shifted in the past decade toward greater protection of property owners, the shift quite arguably is a modest one. By contrast, the shift among certain judges of the two aforementioned lower courts has been substantial. Since most takings cases never reach the stratospheric level of Supreme Court review, it is the jurisprudence of these lower courts that for all practical purposes governs the outcome of most cases.

---

[17]TVA v. Hill, 437 U.S. 153, 174 (1978).
[18]112 S. Ct. at 2898 n.11.
[19]114 S. Ct. 2309 (1994).

An illustration is the Federal Circuit's recent ruling in a wetlands/taking case, *Loveladies Harbor v. United States.*[20] There, the court ruled that for purposes of takings analysis, the relevant parcel of land in the case was the acreage that was the subject of the wetlands permit application, not the much larger parcel originally purchased by the plaintiff. The fact that the plaintiff previously had developed and sold off at a profit 75 percent of the original tract was deemed irrelevant. If other courts follow this narrow view of the ''relevant parcel'' concept, wildlife regulation under the ESA or any other statute will be much more vulnerable to takings claims than currently is the case.

Conclusion

Prediction in the area of takings law is precarious, given the vague standards, the evolving nature of the jurisprudence and the conservative rumblings in both the Supreme Court and certain lower federal courts. One can say, however, that, under the mainstream takings jurisprudence of today, successful takings challenges to the ESA are unlikely. Moreover, several developments outside the realm of takings law—the *Sweet Home* litigation, possible ESA amendments and property rights legislation in Congress, the Babbitt effort to lend maximum flexibility to the ESA program—may ensure that the number of situations giving rise to meritorious takings claims will be held to a minimum. The issue is whether such accommodations of private property owners can be achieved without abandonment of effective species conservation.

[20]28 F.3d 1171 (Fed. Cir. 1994).

Special Session 2. *Watershed Management: A Model for the Mississippi River*

Chair
Paul Brouha
American Fisheries Society
Bethesda, Maryland

Cochair
Raymond C. Hubley, Jr.
National Fisheries Research Center
La Crosse, Wisconsin

The MICRA Plan and Progress Toward Its Implementation

Jerry L. Rasmussen
U.S. Fish and Wildlife Service
Columbia, Missouri

The Mississippi Interstate Cooperative Resource Agreement (MICRA) was initially drafted and signed on September 1, 1989 by the fishery chiefs from several Mississippi River Basin states. MICRA came as a result of a shared concern for the ancient paddlefish, and how interstate management of this important species could be better coordinated and implemented.

The Mississippi River Basin covers 1.25 million square miles, and drains 41 percent of the continental United States. Paddlefish historically were distributed throughout most of the Basin's large tributaries. These include the Ohio, Missouri, Tennessee, Arkansas and Red rivers. In recent decades, however, the species has been in decline and even petitioned for listing on the federal list of threatened and endangered wildlife. Some states already list the species on their state lists, while others continue to maintain sport and some commercial fisheries.

During 1989 and 1990, 28 of the Basin's state fish and wildlife agency directors signed on in support of the agreement. The U.S. Fish and Wildlife Service was invited to sign on to the Agreement in January 1991. I began providing my services as Coordinator the following March.

By August 1991, through assistance of the American Fisheries Society and a federal grant using "Sport Fisheries Restoration Funds," we had drafted and adopted a Comprehensive Strategic Plan. That Plan includes 10 major goals.

1. Develop a formal framework and secure funding for basin-wide networking and coordinating mechanisms that complement existing and emerging administrative entities.
2. Develop public information and education programs to disseminate information that supports fishery resource management in the Mississippi River Basin.

3. Develop an information management program based on standardized methods for collecting and reporting fishery resource data, basin-wide.
4. Determine and document the socio-economic value of fishery resources and related recreation.
5. Improve communication and coordination among entities responsible for fisheries resource management in the Mississippi River Basin.
6. Periodically identify and prioritize issues of concern in the Mississippi River Basin for coordinated research that supports cooperative resource management.
7. Identify and coordinate fishery management programs to address species and habitat concerns from an ecosystem perspective.
8. Develop compatible regulations and policies for fishery management to achieve interstate consensus on allocation of fishery resources.
9. Develop protocols, policies and regulations for disease control, introduction of exotics, maintenance of genetic integrity, and maintenance and enhancement of indigenous species.
10. Preserve, protect and restore fishery habitats basin-wide.

The Plan identifies 93 rivers and streams and 98 fish species which (at some time during their life cycle, in certain locations in the basin) come under the umbrella of interjurisdictional management. The term "interjurisdictional river" is defined as those rivers that flow between or are common to two or more state boundaries, or that flow between two or more land-management jurisdictions. The term "interjurisdictional species" is defined as those fish that depend on interjurisdictional rivers during some part of their life cycle and, therefore, come under the management of two or more government entities.

During autumn 1991, MICRA began addressing funding concerns and established a voluntary dues structure to carry out day-to-day business. We also began working with Congressman Steve Gunderson on his Interjurisdictional Rivers Fisheries Resources Act (first introduced in 1992). While not yet passed by Congress, the concepts developed in the Gunderson Bill have enjoyed growing support over the last three years.

In autumn 1991, the states also began inviting other federal agencies, commissions, interstate groups, power companies and Indian tribes to join the agreement. To date, the Tennessee Valley Authority, U.S. Bureau of Reclamation, National Biological Service and two Indian tribes, the Chickasaw Nation in Oklahoma and Chippewa-Cree Tribe in Montana, have signed on to the Agreement.

In January 1992, we began our information exchange process through publication of a bimonthly newsletter called "River Crossings." We now are in our fourth year of publishing that document and continue to receive many words of encouragement from our readers who feel it is serving an important role in river management.

In 1994, we drafted a Constitution and Bylaws to formalize our organizational structure and guide future implementation and decision-making processes. Under that Constitution, MICRA changed its title from an "Agreement" to an "Association." So we now refer to our organization as the Mississippi Interstate Cooperative Resource *Association.*

The Association is composed of one representative from each member state and entity, each with an equal vote in the MICRA decision-making process. Association members are required to be senior officials of each member agency or entity with decision-making authority and a strong interest in river management. Leadership

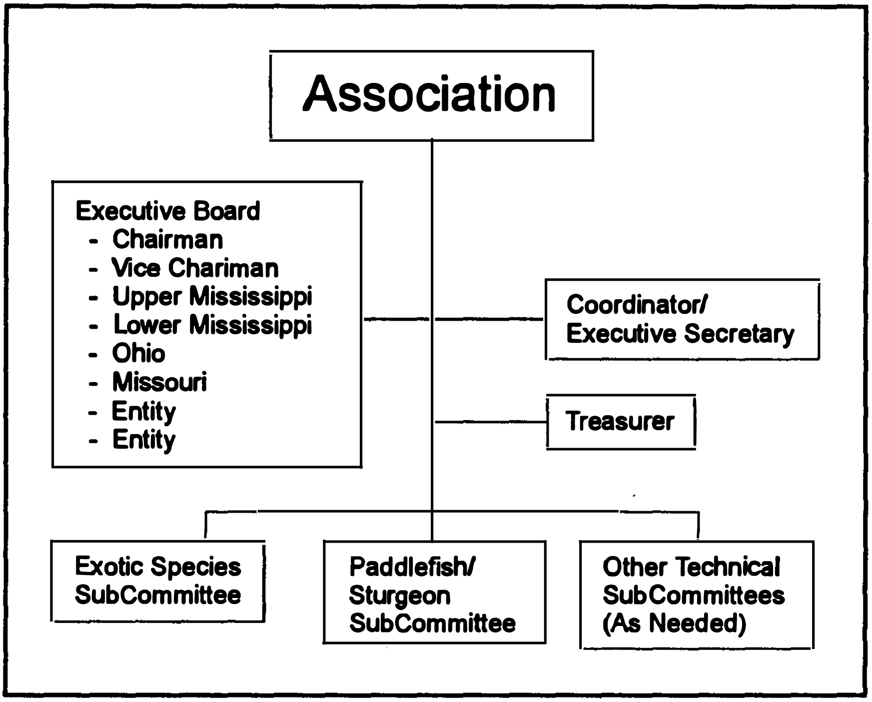


Figure 1. MICRA organizational chart.

within the Association (Figure 1) is provided through a Chairman, Vice Chairman, Treasurer and Executive Board. Each of these officers is elected for two-year terms by the Association membership. Members of the Executive Board include the Chairman; Vice Chairman; state representatives from the Upper Mississippi, Lower Mississippi, Ohio and Missouri river basins; and two entity members. Executive Board members serve staggered terms to maintain membership continuity. The Treasurer is a volunteer elected for an unspecified term. The Coordinator/Executive Secretary is a non-elected position funded by the U.S. Fish and Wildlife Service, who also provides office space and facilities for conducting the Association's day-to-day business, and the keeping of MICRA files and records.

The Association's technical business is completed through a series of Subcommittees that are established as needed. They consist of appointed members from the Association's interested member agencies and entities. Two such Subcommittees presently exist (the Paddlefish/Sturgeon Subcommittee, formed in 1992, and the Exotic Species Subcommittee, formed in 1994).

The Paddlefish/Sturgeon Subcommittee developed its own Strategic Plan in 1993 and received formal endorsement from all Association members. Plan implementation presently is focussing on the needs of the paddlefish through development of two projects. The first project, as yet unfunded, would complete a basin-wide survey of all existing information on the paddlefish and all sturgeon species and their management.

The second project (beginning last month) is implementing a multi-year, basin-wide paddlefish tagging survey. This survey will conduct a paddlefish stock assessment and collect information on paddlefish movement, exploitation, age and growth, and reproduction. The project, endorsed by the International Association of Fish and Wildlife Agencies in September 1994, is being funded this year through year-end Federal Aid Administrative funding.

Seventeen of MICRA's 28 member states are involved in implementing the project. This year, participation is limited to those states having waters which lie below the Basin's high dams. We are hopeful that funding in future years will allow inclusion of the remainder of the Basin states whose waters support paddlefish. Internal coded wire tags are being used to mark both captured and hatchery-reared paddlefish. Each participating state is collecting paddlefish through their own field surveys or through work with commercial fishermen. As many adult fish as possible will be tagged; and all state, federal and private hatcheries are being encouraged to tag paddlefish slated for release within the Basin. MICRA is supplying all tags.

Data for the survey will be provided by our own recaptures, as well as through tag returns from sport and commercial fisherman. Since fishermen will be unable to identify tagged fish, return of the entire dorsal fin or rostrum from both tagged and untagged fish will be required. Recovery of both tagged and untagged fish will increase the statistical power of data recovered and give us the ability to complete an unbiased assessment of paddlefish populations, basin-wide. A reward system is being used to enhance fishermen participation and tag recovery. If funds can be obtained to continue this project over several years, we feel its results will rival that of major salmon-tagging projects on the west coast. After a number of years, we should be able to obtain very accurate estimates of the impact of harvest and stocking on native paddlefish populations.

The paddlefish tagging survey provides MICRA the opportunity to demonstrate its capability to implement large, complex projects involving a wide array of rivers and participants. Project funding from the U.S. Fish and Wildlife Service comes directly to the MICRA treasury. From there, MICRA distributes appropriate funding to the various state cooperators through joint cooperative agreements.

In 1994, MICRA also began participating in smaller, multi-year projects between the U.S. Fish and Wildlife Service and individual states. MICRA's facilitation mechanism provides a convenient bridge to reduce overhead costs and fund projects that otherwise may be difficult to complete. We presently have a Cooperative Agreement with Missouri to complete a prelisting survey of sicklefin, sturgeon and flathead chubs on the Missouri River, and an agreement with Wisconsin to assess the feasibility of developing an Upper Mississippi River mussel refugia at the Genoa National Fish Hatchery in Genoa, Wisconsin.

MICRA also is independently sponsoring the development of a research proposal to assess the "true" economic benefits of commercial navigation on the Missouri River. This project involves economists from five different state universities. Missouri River navigation economics long have been questioned by numerous regional and national groups, including some reviewers at the Office of Management and Budget (OMB) in Washington, D.C. Navigation presents a major obstacle to rehabilitation of the lower Missouri River, and to fisheries management in the large Dakota and Montana reservoirs. Our proposal to evaluate its economics will be submitted to the Corps of Engineers for funding.

MICRA's first three years were dedicated to the "growing pains" of getting to know one another better, and developing a strong organizational structure and effective planning documents. In 1994, our fourth year, we played major roles in the White House Floodplain Management Review Committee through (1) involvement of our Coordinator/Executive Secretary on the Galloway Committee, (2) involvement of our members on the various floodplain management technical committees, and (3) through the information-transfer mechanism provided by our newsletter. MICRA also made major strides in 1994 by initiating its first cooperative on-the-ground projects.

Thus, we are beginning our fifth year with an optimistic look at the future. We anticipate that our paddlefish project will stimulate increased member activity and we likely will gain some new participants. We also plan to continue work with the U.S. Fish and Wildlife Service and others to facilitate implementation of additional multi-year projects. We hope to continue our work with Congressman Gunderson on his Interjurisdictional Rivers Fisheries Resources Bill and are hopeful that our successes will convince Congress and others that MICRA is a viable and effective tool deserving of their recognition and support.

In the meantime, we plan to continue our steady, methodical progress toward becoming an effective advocate for interjurisdictional river fisheries in the Mississippi River Basin.

Maintaining and Restoring the Ecological Integrity of the Mississippi River: Importance of Floodplains and Floodpulses

Richard E. Sparks
Illinois Natural History Survey
River Research Laboratory
Havana

Introduction

Floodplains and Floodpulses

Floodplains are creations of alluvial rivers that regularly overflow their banks and deposit sediments in broad valleys that often are miles wide. During periods of low flow, the rivers occupy channels. During rainy seasons or when winter snow melts, the rivers rise onto their floodplains, recharging the floodplain wetlands, forests and lakes with fresh supplies of water, nutrients and sediments. Floodpulse refers to the entire annual cycle of the water level, from low flow to flood crest and back to the low elevation (Junk et al. 1989). There may be more than one flood per year. During great floods, the floodplains do not merely store water, they become part of the flowing river itself, conveying water slowly downstream through the forests and marshes. Over millennia, plant and animal species have adapted to exploit, tolerate or escape seasonal floodpulses. Exceptional great floods and droughts constitute disturbances that may either advance or reset successional processes and increase habitat diversity. The flood-adapted animals and plants, the seasonal floodpulses and infrequent great floods and droughts, the river and its channels, and the complex patchwork of floodplain habitats, together, constitute the dynamic and phenomenonally productive river/floodplain ecosystem (Junk et al. 1989, Sparks 1995).

Current Status

There were fewer than 100 large river/floodplain ecosystems in the world, prior to large-scale human alterations (Welcomme 1985). Today, the number of large river/floodplain ecosystems that retain their natural structure and function is much reduced and still dwindling. Although the Mississippi River is altered, some reaches retain a surprising degree of structural and functional integrity. The river has not been impounded behind high storage dams, such as those on the Colorado, Columbia and upper Missouri rivers. The navigation dams on the upper Mississippi maintain water depths for navigation during the low flow season, but do not stop floods. The Mississippi is unimpounded downstream from the mouth of the Missouri near St. Louis. Sizable floodplains have been preserved along the upper Mississippi north of St. Louis in the National Fish and Wildlife Refuge System and a collection of state refuges, parks, and hunting and fishing areas (National Research Council [NRC] 1992). A large tributary, the Illinois River, also retains floodpulses and floodplains, and a major distributary (branch) of the Mississippi, the Atchafalaya, is building new deltaic floodplain in the Gulf of Mexico, thereby increasing North America's largest remaining (2,200 mi^2: 5,700 km^2) river overflow swamp (NRC 1992, Sparks 1995).

These substantial remnants constitute a national treasure, comparable in value to other distinctive ecosystems such as the Everglades or Chesapeake Bay. In 1986, the U.S. Congress designated the upper Mississippi River and the Illinois River as nationally significant ecosystems, as well as nationally significant waterways for commercial navigation. The National Research Council (NRC) noted the rarity and value of intact river/floodplain ecosystems and recommended that portions of the Atchafalaya and the upper Mississippi be protected and used as reference standards for management and recovery of other reaches and rivers (NRC 1992: 244–245).

Window of Opportunity

In 1986, the U.S. government funded a 12-year environmental management program for the upper Mississippi and Illinois rivers, as well as a replacement dam and greater lock capacity at St. Louis. Plans for even greater expansion of navigation capacity currently are being developed by the U.S. Army Corps of Engineers (Corps). But federal and state natural resource agencies and several environmental groups fear that the integrity of the upper Mississippi is being compromised. They have issued their own strategies and plans for conserving and restoring the river (Robinson and Marks 1994, Upper Mississippi River Basin Association 1994, Upper Mississippi River Conservation Committee 1993). The same groups have urged the Corps to extend the navigation expansion study beyond a narrow assessment of the environmental impacts of increased boat traffic to a much broader assessment of the future of the rivers, including opportunities to use the navigation dams for ecosystem management.

In 1993, 1994 and again this year, international attention was focused on large rivers and their floodplains when disastrous floods occurred in Bangladesh, western Europe and the United States. Now questions are being asked about the effectiveness and cost of current flood and floodplain management policies, and about the potential for reducing future flood damage by preserving and restoring large river/floodplain ecosystems and portions of their tributary watersheds and wetlands (Interagency Floodplain Management Review Committee [IFMRC] 1994, Sklar 1993, Sparks and Sparks 1994).

Ecosystem Management

The goal of ecosystem management can be maintenance and restoration of ecological health or ecological integrity. Karr (in press) points out that the two goals are not the same.

Ecological Health

Ecological health ''describes the preferred state of sites modified by human activity (e.g., cultivated areas, plantation forests, industrial parks, and cities). Such sites do not have integrity in an evolutionary sense, but they may be considered 'healthy' when present use neither degrades them in ways that preclude that use in the future nor degrades areas beyond their borders'' (Karr in press).

Ecosystem Integrity

Ecological integrity has been defined as "the capability of supporting and maintaining a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region" (Angermeier and Karr 1994). The same authors state that ecological integrity includes elements (genes, species, populations, assemblages and landscapes) and the processes that generate and maintain the elements (e.g., selection, evolution, nutrient cycling, disturbance, succession).

Ecosystem management for ecological integrity includes: (1) maintaining water and sediment quality within limits that preserve ecological integrity; (2) maintaining or restoring the master processes (*sensu* Power et al. 1995) that enable the river/floodplain ecosystem to maintain, repair and rejuvenate itself; and (3) protecting the ecosystem from invasion by foreign pests (and their associated parasites and diseases). Master processes include the abiotic processes of erosion and sedimentation that maintain floodplains and deltas and the biotic processes of colonization and succession that rebuild communities following disturbances. Giving the ecosystem some scope to maintain itself probably is more cost-effective in the long run than attempting to control or replace all natural functions with human intervention.

Reference Standard

The reference standard for ecological integrity is the natural habitat of the region. The natural habitat indicates how far the altered ecosystems depart from natural patterns and provides the performance standards and management objectives for the altered systems. The natural habitat can be reconstructed from historical data that describe the predisturbance system (e.g., Kofoid 1903, Nelson et al. 1994) and by applying general principles derived from studies of less-developed tropical rivers (e.g., Bayley 1995). Fortunately, there also are a few relatively intact reaches left in the temperate zone that could provide reference standards (NRC 1992).

Examples of Ecosystem Management

Restoring annual floodpulses. Although the floodpulse still occurs in the upstream portions of the navigation reaches on the upper Mississippi and Illinois rivers, it is attenuated downstream and even inverted near some of the dams (Sparks 1995). The floodpulse could be restored to more of the river if the mid-reach control procedure for operating the dams, which causes inversions of the floodpulse, were replaced with dam control. Moving the control points to the dams should not affect navigation, but would require federal purchase of additional flood easements to accommodate more extensive flooding.

Drawdowns to compact sediments and restore vegetation. Every 10 years or so, entire navigation reaches might be drawn down during the summer to expose mud flats, to dry and compact sediments, and to stimulate regeneration of vegetation. The drawdowns would approximate historic summer water levels, prior to construction of the dams (Bayley 1991). Summer is the slack portion of the navigation season, so the impacts on commercial traffic should be slight. Also, the drawdowns could be done when the locks and dams were closed to navigation for rehabilitation or repair. Recreational boaters would be adversely affected, but might be willing to move their boats temporarily to an adjacent reach that was not drawn down, in return for long-term improvements in water clarity and habitat quality. The extent of the drawdown would have to be negotiated among the affected parties.

Restoration of landforms. Construction of navigation impoundments on the upper Mississippi River and its tributaries in the late 1930s and early 1940s created sediment traps at the same time that sediment loading of the mainstem rivers began to increase with the intensification of agriculture (more row cropping and fall plowing, and continued land clearing, land drainage and stream channelization). Excessive sedimentation of the impoundments and natural backwaters is widely regarded as one of the most important threats to the river/floodplain ecosystems. Most of the habitat rehabilitation and enhancement projects that are part of the federally funded Environmental Management Program for the Upper Mississippi River address this problem by building or maintaining levees to keep sediment-laden river water out of backwaters and floodplain impoundments, or by dredging accumulated sediments. The dredge spoil sometimes is used to create islands that serve as wind and wave breaks.

From a geological perspective, the river simply is building itself new floodplains by filling the permanently inundated areas with sediment. The new sedimentary equilibrium that will be reached in some places as early as 2050 might look like the predisturbance floodplain, but at a higher elevation (Bhowmik et al. 1986). A less desirable scenario is that the new floodplain in the vicinity of the dams will lack topographic relief (natural levees and swales), and will, therefore, have less habitat diversity, because the range of variation in water level has been reduced by the dams. Sedimentation and deposition can only build land to the height of the flood (i.e., sediment does not jump out of water). Since the range between the average flood height and the average low flow now is reduced in comparison to the predam era (because the dams keep the water higher during the low flow period), the range of land elevation is likely to be less as well. The combined predictive expertise of fluvial geomorphologists and ecologists is needed to address questions like these. In the meantime, it is important to reduce sediment loading of the main river by treating watersheds, tributary channels and riparian zones to reduce soil erosion and erosion of tributary stream banks and beds. Such treatment also will help reduce the extreme fluctuations in water delivery that characterize the altered tributaries, thereby smoothing the floodpulse in the main river. The same practices also would reduce the pesticides and excessive nutrients that are delivered to the main rivers in dissolved form or attached to soil particles (Goolsby et al. 1993).

Some proposed suggestions for arresting or reversing the sedimentation that is occurring clearly are impractical. Dredging the 14,000,000 metric tons of sediment the Illinois River deposits annually in its floodplain and backwaters, much less what the Upper Mississippi River deposits, would bankrupt the nation (Lee 1989). Raising the navigation dams to deepen and expand the lakes and backwaters merely will increase the sediment trapping efficiency and the wind fetch, so these larger, muddier lakes will last only 20–30 years until they fill with sediment to about the same water depths as now.

The most that probably can and should be done is to guide the sedimentation that is occurring now, perhaps by installing deflection dikes to keep some areas scoured out, while increasing the rate of sedimentation elsewhere, so that when the river finally attains sedimentary equilibrium, it will look something like it did in 1900. In contrast to existing navigation structures that close off side channels and spur dikes that confine the river flow to the 9-foot navigation channel and keep it scoured out, these new structures would divert some flow to create or maintain side channels. If some areas must be dredged, the embryonic natural levees and islands that form behind the deflection dikes would be logical places to put the dredge spoil.

In the predisturbance river/floodplain ecosystem, low, broad natural levees once screened floodplain lakes and backwaters from winds and the silt loads of the river. In some places, flood water not only had to cross the natural levees but also shallow wetlands before it could reach lakes that were farther away from the river. These lakes thus were doubly protected from sediment by a natural system that we could imitate.

Particular attention should be paid to the channelized tributaries that now mainline sediments directly into the rivers, instead of depositing sediments at the toe of the river bluffs. In some of these tributaries, channelization on the floodplain initiated erosion (head-cutting) that ate its way up the entire watershed (Hajic 1990). Prior to channelization, many of these tributary channels turned downstream on the floodplain, paralleling the main river for miles. The tributaries created topographic relief by building natural levees and occasionally deepening other areas at meander bends. Sediments were stored on the floodplain before reaching the rivers. Dechannelization of at least some of these tributaries should be part of ecosystem management. Allowing the tributaries to meander and lengthen would reduce the slope, build natural levees and possibly initiate a watershed healing process that would work its way up the tributaries.

Dispersal barriers for foreign pests. Maintenance or restoration of habitat will not maintain biodiversity if the habitats are occupied by invading species, such as the zebra mussel (*Dreissena polymorpha*), that displace native species. Invading species also can cause economic damage, alter food chains and ecosystem processes, and introduce parasites and diseases, including some that are threats to human health. International trade agreements, such as the General Agreement on Tariffs and Trade (GATT) and the North America Free Trade Agreement (NAFTA), increase the rate of introduction of new pests via freshwater ballast in ocean-going ships. Once aquatic pests are in North America, they can move between drainage systems that now are artificially connected by canals. The Mississippi Drainage is artificially connected to the St. Lawrence-Great Lakes Drainage via the Illinois River and the locks and canals at Chicago. Commercial and recreational boats on the freshwater lakes and rivers act as dispersal agents for many pests, such as the zebra mussel.

Border protection against biological invasions is a federal responsibility. The U.S. government should extend the law requiring ocean-going ships to exchange freshwater ballast with seawater to all ports. The law currently applies just to the St. Lawrence Seaway, even though pests can enter the U.S. through many ports, including New Orleans. The government also should have more stringent regulations on the intentional introduction of aquatic species. Examples of foreign aquatic species that were intentionally brought to the U.S. and then either escaped or were stocked into rivers, and now are regarded as pests or potential pests, include: common carp (*Cyprinus carpio*); grass carp (*Ctenopharyngodon idella*); bighead carp (*Hypophthalmichthys nobilis*); black carp (*Mylopharyngodon piceus*, brought in as a potential control for the zebra mussel); and Asian clam (*Corbicula fluminea*).

A plan for preventing the introduction to the Mississippi of four more nonindigenous aquatic pests that already are in southern Lake Michigan should be prepared as soon as possible (Mills et al. 1994). Dispersal barriers that use warm water, chemicals (e.g., chlorine) or ultrasound should be tested in the Chicago locks. Management of zebra mussels and other pests already in the Mississippi and its tributaries probably will require a long-term effort, like the program in the Great Lakes for management of the sea lamprey.

Impediments to Ecosystem Management for Ecological Integrity

The greatest impediment may be lack of understanding of how river/floodplain ecosystems function, so that floods are regarded as unnatural disruptions that must be controlled and floodplain lakes are managed as though they were isolated farm ponds or reservoirs. After years of attempts to control river systems, it is difficult to win acceptance for release of some constraints. Also, the expanded water areas created by the navigation dams in the 1940s are taken as the reference standard for restoration, when, in fact, the river is inexorably filling these with sediment and creating something that eventually may look more like the predam river/floodplain ecosystem.

State and federal fish and wildlife agencies often are pressured to dredge backwaters or build levees to gain more control over the water regime to satisfy constituents who see reduced wildlife and fish populations on a favorite area in a given year as a failure of the agency or local manager. Different species have different requirements and human advocates, so the approach of compartmentalizing the floodplain to optimize management for a particular group of animals (and human advocates) can become quite controversial and contentious. Rehabilitation and enhancement aim to improve areas for particular species, with the term ''rehabilitation'' usually applied to areas that have been degraded previously (e.g., U.S. Army Corps of Engineers 1991: 23).

The ongoing dechannelization of the Kissimmee River in Florida, and reconnection of the river with its floodplain, exemplify the contrasting management approach of restoring ecosystem integrity instead of ecosystem health for specific uses. Competing interests were able to agree on the goal of restoring the natural hydrological regime and river configuration that once had sustained all the native species, and specifically rejected an impounded, highly managed system (Loftin et al. 1990).

Summary

Ecosystem management works with natural processes such as erosion, sedimentation and seasonal floodpulses, attempting to manage and guide them, rather than completely thwarting them. Hunters, fishers and preservationists who now are at loggerheads over how much land, money and management effort will be devoted to this or that species could find common ground in restoring the floodplain and the floodpulse that maintains all the species. Now is a good time to consider ecosystem management of these large river/floodplain ecosystems, with national and world attention focused on the disastrous floods of 1993–1995. Nonstructural approaches to flood management are congruent with restoration of floodplains and riparian zones (IFMRC 1994, NRC 1992). Ecosystem management actually could save money and increase economic efficiency in the long run, because natural services are restored (flood storage, conveyance and moderation; water purification; production of fish and wildlife; preservation of biodiversity) instead of maintained by human intervention at great cost and considerable risk of failure. Allowing phenomenally productive river/floodplain ecosystems to preserve species and produce fish, wildlife and forests probably is cheaper and less problematic than building and operating impoundments, hatcheries, and zoological or botanical parks.

References

Angermeier, P. L. and J. R. Karr. 1994. Biological integrity versus biological diversity as policy directives. Protecting biotic resources. BioScience 44(10): 690-697.

Bayley, P. B. 1991. The flood pulse advantage and the restoration of river-floodplain systems. Regulated Rivers: Res. and Manage. 6: 75–86.

———. 1995. Understanding large temperate and tropical river-floodplain ecosystems. BioScience 45(3): 153–158.

Bhowmik, N. G., J. R. Adams and R. E. Sparks. 1986. Fate of navigation pool on Mississippi River. J. Hydraulic Engineering 112(10): 967–970.

Goolsby, D. A., W. A. Battaglin and E. M. Thurman. 1993. Occurrence and transport of agricultural chemicals in the Mississippi River Basin. July through August 1993. U.S. Geol. Surv. Circ. 1120-C, U. S. Gov. Print. Off., Washington, D.C. 22 pp.

Hajic, E. R. 1990. Late Pleistocene and Holocene landscape evolution, depositional subsystems, and stratigraphy in the lower Illinois River Valley and adjacent central Mississippi River Valley. Ph.D. thesis, Univ. Illinois, Champaign. 301 pp.

Interagency Floodplain Management Review Committee. 1994. Sharing the challenge: Floodplain management into the 21st Century. Report of the Interagency Floodplain Management Review Committee to the Administration Floodplain Management Task Force. U.S. Gov. Print. Off., Washington, D.C. 246 pp.

Junk. W. J., P. B. Bayley and R. E. Sparks. 1989. The flood pulse concept in river-floodplain systems. Pages 110-127 *in* D. P. Dodge, ed., Proceedings of the International Large River Symposium. Can. Spec. Publ. Fish. and Aquatic Sci. 106. 629 pp.

Karr, J. R. In press. Ecological integrity and ecological health are not the same. Pages xx–xx *in* P. Schulze, ed., Engineering within Ecological Constraints. Nat. Acad. Press, Washington, D.C.

Karr, J. R. and D. R. Dudley. 1981. Ecological perspective on water quality goals. Environ. Manage. 5: 55–68.

Kofoid, C. A. 1903. Plankton studies. IV. The plankton of the Illinois River, 1894–1899, with introductory notes upon the hydrography of the Illinois River and its basin. Part I. Quantitative investigations and general results. Illinois St. Lab. of Natur. Hist. Bull. 6(2): 95–635.

Lee, M. T. 1989. Soil erosion, sediment yield, and deposition in the Illinois River Basin. Pages 718–722 *in* Proceedings of the International Symposium on Sediment Transport Modeling. Amer. Soc. Civil Engineers, New Orleans, LA.

Loftin, M. K., L. A. Toth and J. T. B. Obeysekera. 1990. Kissimmee River restoration. Alternative plan evaluation and preliminary design report. South Florida Water Manage. District, West Palm Beach. 532 pp.

Mills, E. L., J. H. Leach, J. T. Carlton and C. L. Secor. 1994. Exotic species and the integrity of the Great Lakes: Lessons from the past. BioScience 44(10): 666–676.

National Research Council. 1992. Restoration of aquatic ecosystems. Science, technology, and public policy. Nat. Acad. Press, Washington, D.C. 552 pp.

Nelson, J. C., A. Redmond and R. E. Sparks. 1994. Impacts of settlement on floodplain vegetation at the confluence of the Illinois and Mississippi rivers. Trans. Illinois St. Acad. of Sci. 87(3–4): 117–134.

Power, M. E. G. Parker, W. E. Dietrich, A. Sun and J. T. Wootton. 1995. Hydraulic food chain models: An approach to the study of food web dynamics in large rivers. BioScience 45(3): 159–167.

Robinson, A. and R. Marks. 1994. Restoring the big river. A clean water act blueprint for the Mississippi. Izaak Walton League of Amer. and Natur. Resour. Defense Coun., Minneapolis, MN. 53 pp.

Sklar, L. 1993. Demonstrations rally opposition to Bangladesh flood action plan. World Rivers Rev. 8(3): 1, 12–13.

Sparks, R. E. 1995. Need for ecosystem management of large rivers and their floodplains. BioScience 45(3): 168–182.

Sparks, R. E. and R. M. Sparks. 1994. After floods: Restoring ecosystems. USA Today 123(2,590): 40-42.

U.S. Army Corps of Engineers. 1991. Upper Mississippi River System Environmental Management Program definite project report (R–7F) with integrated environmental assessment. Lake Chautauqua rehabilitation and enhancement. LaGrange Pool, Illinois Waterway, Mason County, IL. Rock Island District U.S. Army Corps of Engineers. 201 pp.

Upper Mississippi River Basin Association. 1994. Alternative mechanisms for formulating an ecosystem management strategy for the Upper Mississippi River. Discussion draft by Upper Mississippi River Basin Association, St. Paul, MN. 32 pp.

Upper Mississippi River Conservation Committee. 1993. Facing the threat: An ecosystem management strategy for the Upper Mississippi River. A call for action from the Upper Mississippi River Conservation Committee. Rock Island, IL. 17 pp.

Welcomme, R. L. 1985. River fisheries. Food and Ag. Org. Fish., tech. paper 262. Food and Ag. Org. of United Nations, Rome. 330 pp.

Protecting Healthy Fish Stocks: A Pacific Northwest Approach

Guido R. Rahr III
Oregon Trout
Portland, Oregon

Let us now at the eleventh hour, take pity on our long-persecuted salmon and do him the poor and tardy justice of giving him, in our broad land that he has done so much for, one place where he can come and go unmolested and where he can rest in safety. Livingston Stone (1982).

Introduction

The Pacific Northwest once was among the greatest salmon and steelhead producing regions on earth. But within the last 150 years, the cumulative effects of overharvest, habitat loss, hydroelectric development and aggressive fish hatchery programs have caused the decline and extinction of salmon and steelhead stocks[1] over most of their range south of Canada (see Nehlsen et al. 1991, Kaczynski and Palmisano 1994, Botkin et al. 1995). The magnitude of the salmon problem became clear in 1991, when Willa Nehlsen and two other researchers completed a study that identified 214 native stocks in California, Oregon, Idaho and Washington that were facing a high or moderate risk of extinction, or were of special concern. Of these, 101 stocks were found to be at high risk of extinction, i.e., having annual escapements[2] that are declining or have fallen below 200 fish within the previous five years (Nehlsen et al. 1991). Other studies have identified 100 additional stocks for a total of 314 stocks of anadromous salmonids at risk of extinction (Forest Ecosystem Management Assessment Team [FEMAT] 1993: V–10). In 1990, the Sacramento River chinook (*Oncorhynchus tschawytscha*) was listed for protection under the Endangered Species Act, followed by the Snake River sockeye (*O. nerka*) and the Snake River spring/summer and fall chinook in 1991. Currently, an additional nine petitions to list salmon and steelhead for protection under the ESA are pending (NMFS 1994).

This paper will show how the fundamental approach toward salmon and steelhead management has been reactive in nature and, consequently, failed to protect native stocks from declining to the point that they are at risk of extinction.

Oregon Trout, a native fish conservation organization, proposes the identification, special recognition and protection of the healthiest remaining stocks of native anadromous salmonids in the Pacific Northwest as a strategy for long-term salmon and steelhead survival. The aquatic ecosystems and native fish fauna of the Mississippi River share many of the same threats as the rivers and streams of the Pacific Northwest. Hopefully, the issues and strategies described in this paper will be helpful to natural resource managers concerned about the native fish assemblages of the Upper Midwest.

[1]A stock of salmonid fish is defined here as a geographically or temporally segregated population or group of populations (see Ricker 1972).
[2]"Escapement" refers to the number of adult fish that return to spawn.

Fish Management Agencies Failed to Act Soon Enough to Prevent Decline of Native Fish Stocks.

In many cases, the agencies charged with managing salmonid stocks failed to implement conservation measures until native stocks were declining or at risk of extinction. Instead of making native stocks the management priority, state and federal agencies directed most of their resources toward programs to replace declining wild runs with hatchery fish, thus further endangering native stocks (Goodman 1990, Waples 1991, Hilborn 1992, White et al. 1994). Comprehensive inventories of native stocks only have been compiled within the last four years (Chilcote et al. 1992, Washington Department of Fisheries [WDF] 1992). Stock monitoring programs have been inconsistent and often inaccurate, and commercial harvest levels have been excessive (Pearcy et al. 1992, Jacobs and Cooney 1991, Botkin et al. 1994, Overholtz in preparation). Fish management agencies lumped native stocks together for management purposes instead of setting and meeting escapement goals for each stock and, then, failed to control harvest of depressed native stocks such as coho (*Oncorhynchus kisutch*) and spring chinook until they were candidates for protection under the Endangered Species Act.

The Endangered Species Act Alone Will Not Save Salmon and Steelhead Stocks

In many cases, it took the Endangered Species Act to move federal and state government to protect dwindling native salmon stocks, but the ESA alone will fail to protect populations at ecologically and economically functional levels, in large part because the ESA offers protection only after the target populations are at perilously low levels (Moyle and Yoshiyama 1994, Jones 1994). For example, the Sacramento River winter chinook had declined from an average annual run size of 86,509 from 1967–1969 to 550 in 1989 before it was listed as threatened under the ESA (Nehlsen et al. 1991). Snake River fall chinook had declined from 30,000 in 1962 to 1,000 fish in 1993 (Northwest Power Planning Council [NPPC] 1994), two years after they were listed for protection under the ESA. The Snake River sockeye had declined from an average of 3,000 fish in 1954–1959 to 1 fish in 1994, three years after it was listed for protection under the ESA (Jeff Gislason personal communication: 1994). Waiting until populations have declined to such low levels dramatically reduces the chance of recovery. Small populations can become locked into an ''extinction vortex'' where the effects of inbreeding, disease and vulnerability to catastrophic events make it difficult for small populations to escape extinction (Gilpin and Soule 1986). No fish species has been removed from the ESA list since the passage of the Act in 1973. Under the ESA and section 7 regulations, species ''recovery'' is defined as no longer needing special protection to ensure its continued existence (Rohlf 1989). Recovery under the ESA does not necessarily mean the restoration of long-term ecological or economic viability. Finally, the recovery of small salmon populations is expensive. Snake River sockeye recovery efforts by the Bonneville Power Administration alone from 1991–1994 have totalled $6 million and are estimated to cost $2 million per year after 1995 (Jeff Gislason personal communication: 1994). Efforts taken by federal agencies and other organizations to recover all salmon runs in the Columbia River Basin between 1981 and 1991 have cost more than $1 billion, including $537 million spent on hatchery fish production (General Accounting Office [GAO] 1991).

Once the cause of decline are entrenched, arresting the slide of a salmon run toward extinction is difficult and, in many cases, may be impossible. Despite the most expensive salmon restoration effort on earth, between 1981 and 1995 two Columbia River stocks have become extinct and three more stocks were added to the ESA list (including the Snake River chinook—once among the largest populations of chinook salmon on earth). The wild salmon runs of the Columbia Basin continue to decline.

The laws and policies that guide the management of natural resources have not succeeded in preventing the decline of native salmonids and their ecosystems, in large part because conservation measures are instituted too late. While agencies and conservation organizations direct the vast majority of their resources and attention toward recovering or replacing the most threatened stocks, stocks that still are healthy remain unprotected. As more weakened stocks approach extinction, fishing pressure could intensify on the remaining healthy stocks until they, too, are driven toward extinction.

Protecting the Healthy Stocks—Fish Refuges?

The protection of fish and wildlife traditionally focussed on the establishment of reserves, refuges and parks, managed under the authority of the federal government (National Park Service, USDA Forest Service, U.S. Fish and Wildlife Service) and nongovernmental organizations (Nature Conservancy, local land trusts), and state and federal wild and scenic river designations. These areas carry various degrees of protection for aquatic biodiversity, but few refuges have been established to protect fish populations (Williams 1991, Hubley 1994) and none have been established to protect salmonids in the Pacific Northwest. This fact is surprising considering the economic and symbolic value Americans place on salmonid fish.

Over the last 100 years, there have been repeated calls for the establishment of refuges for salmon and other fish. The first was delivered at the twenty-first annual meeting of the American Fisheries Society in 1892 by Livingston Stone, who made an eloquent plea for the establishment of National Salmon Parks. Citing the demise of the buffalo and the decline of salmon on both east and west coasts, Stone pleaded to "Provide some refuge for the salmon, and provide it quickly, before complications arise which may make it impractible, or at least very difficult. . . . If we procrastinate and put off our rescuing mission too long, it may be too late to do any good. After the rivers are ruined and the salmon gone they cannot be reclaimed" (Stone 1892: 160). Seventy years later, after dramatic and widespread declines of salmon and steelhead, U.S. Assistant Secretary of Interior, Ross L. Leffler (1953: 3), proposed an "anadromous fish sanctuary in the Snake River basin, including the Salmon, Clearwater, Grand Ronde and Imnaha rivers" at the annual meeting of the Western Association of State Game and Fish Commissioners. A year later, the Director of the Washington State Department of Fisheries wrote, "Thus it appears a logical conclusion to fulfill the desires of our people is that certain remaining natural salmon spawning areas be set aside as salmon parks or sanctuary areas to preserve at least a portion of the natural runs of salmon in the Columbia River Basin" (Moore et al. 1960: 122). Forty years later, the native salmon and steelhead of the upper Columbia Basin are approaching extinction.

The call for sanctuaries for salmonids continues. In 1983, Helle proposed the designation of ''gene banks'' for wild fish stocks within national parks and other federal lands where hatchery stocking and other activities that would jeopardize the survival and genetic integrity of the stocks should be prohibited (Helle 1984). In 1993, May proposed the preservation of the last remaining ''heritage populations'' of native brook trout (*Salvelinus fontinalis*) in New York State. Behnke (1990) and Allen and Flecker (1993) called for a nationwide network of aquatic reserves. Wright (1984) described a need for ''core populations,'' or unusually productive populations near historical abundance, needed to seed habitat throughout a watershed or larger region. In 1993, the Oregon Chapter of the American Fisheries Society identified a statewide system of critical areas for aquatic biodiversity that would form a comprehensive system of ecological reserves, administratively protected areas and priority areas for restoration (Henjum et al. 1994). Moyle and Yoshiyama (1994) proposed the creation of Aquatic Diversity Management Areas (ADMAs) in California, where biodiversity conservation would be the top management priority. The Oregon Trout Steelhead Committee proposed the establishment of sanctuaries for native steelhead (Oregon Trout 1994). Reisenbichler (in press) suggested ''refuge populations,'' where native fish are protected from habitat degradation, intensive fishing pressure and interactions with hatchery fish.

Bills introduced at the federal level to identify and protect fish populations generally have been unsuccessful. In 1979, a proposal to establish a ''National Fisheries Heritage System'' through administrative order was advanced to Secretary of Interior Cecil Andrus, but Andrus left office before approving it (Hubley 1994). In 1990, a bill to establish a ''National Fishery Resource Conservation Act'' (S.2772) to authorize the USFWS to acquire and protect fish habitat died in the U.S. Senate, and, in 1991, the ''Fish Habitat Conservation Act'' (H.R. 1679), another proposal to authorize the U.S. Fish and Wildlife Service to acquire fish habitat to be protected in ''National Fish and Wildlife Refuges,'' stopped in the House of Representatives. Two more federal proposals to protect fish habitat were introduced in 1994 and may be reintroduced in 1995: the ''River and Watershed Protection Act of 1994 (H.R. 4213), an amendment to the Land and Water Conservation Fund to authorize the Secretary of Interior to establish a national registry of rivers and watersheds for restoration; and the ''National Aquatic Ecosystem Restoration Act of 1994'' (H.R. 4481), a program to restore rivers through voluntary cooperation of federal, state, tribal, corporate and private interests.

In the Pacific Northwest, the decline of salmon has become an issue of growing regional concern. With salmon in the spotlight, this is an opportune time to reintroduce the concept first advanced by Livingstone Stone and reiterated by others over the last 100 years. Oregon Trout offers a four-part strategy to protect healthy salmonid stocks: (1) identification; (2) designation; (3) wild fish management; and (4) research.

1. Locating the healthy stocks. If the goal of salmon conservation is to ensure that self-sustaining populations of salmon and steelhead survive at economically and ecologically viable levels, then wild, locally adapted stocks must be protected. The most effective way to achieve this may be to identify and protect those native stocks that persist at healthy levels today. These stocks may provide long-term benefits to other stocks at risk of extinction because they may serve as ''source populations'' for future efforts to recolonize adjacent habitats where native stocks are extinct, but where the factors causing their extinction have been removed.

There is a growing movement among scientists and some natural resource managers and non-governmental organizations to prioritize conservation programs based on protecting the most biologically diverse and undisturbed areas first (Johnson et al. 1991, Frissel 1993, FEMAT 1993, Doppelt et al. 1993, Moyle and Yoshiyama 1994, Henjum et al. 1994, Nehlsen et al. in preparation). Nickelson et al. (1993) developed a salmon conservation strategy for Oregon coastal basins that focusses on "source" watersheds where salmonids are relatively abundant and "recovery" watersheds where salmonid populations are limited by habitat degradation.

In an effort to locate and help protect regional nodes of salmonid productivity, Oregon Trout sponsored a team of scientists to inventory the healthiest native stocks of salmon and steelhead in the California and the Pacific Northwest. Huntington et al. (1994) identified 121 stocks that fit eight criteria describing stock health and abundance. Most of the stocks rated healthy were found in coastal river systems in Oregon and Washington and two-thirds of the stocks were fall chinook, chum (*O. keta*) and winter steelhead (*O. mykiss*). Only one stock from California and no stocks from Idaho were rated healthy (due in part to the presence of eight mainstream Columbia River hydroelectric dams). Within the vast Columbia Basin, only three stocks were rated healthy.

To capture the populations of fish that will be the most useful for protecting the ecological and genetic legacy of the species, the healthiest stocks within each evolutionarily significant unit (ESU) (see Waples 1991) must be identified and protected. Available data suggest some of the rivers where healthy stocks located by Huntington et al. (1994) are located do function as regional strongholds for races of salmon and steelhead endangered throughout most of their range. For example, the North Fork of the Umpqua River in Oregon contains the last healthy stocks of coastal summer run steelhead and coastal spring run chinook, both species at risk of extinction throughout most of their range. The Wenatchee River in Washington contains the last healthy run of Columbia River sockeye salmon, and the North Fork of the John Day River in Oregon is home to the last healthy population of Columbia Basin spring run chinook salmon, a race that once dominated the Columbia and Snake river systems (Figure 1).

2. Designate the health stocks as Wild Fish Heritage Waters. To be successful, any proposals to protect salmonid populations will have to be based on principles of conservation biology and landscape ecology, yet address landowner and jurisdictional boundaries, and social and political realities. In an attempt to integrate these forces to help prioritize and protect rivers with diverse and/or productive assemblages of native fish, Oregon Trout proposes the establishment of a system of Wild Fish Heritage Waters to help protect healthy native stocks of fish of regional ecological, genetic and economic importance. In the case of the Pacific Northwest, Wild Salmon or Steelhead Heritage Rivers would be established. The Wild Fish Heritage Waters system is based in concept on a proposal for a National Fisheries Heritage System developed within the U.S. Fish and Wildlife Service in 1979 (Ray Hubley personal communication: 1995). The purpose of designation, through law or rule, would be to elevate the status of Wild Fish Heritage Waters. Specifically, designation would help: (1) focus national and local recognition of the ecological and economic value of healthy native stocks and their habitats; (2) increase local recognition and support for native fish conservation through signs and educational programs; and (3) focus

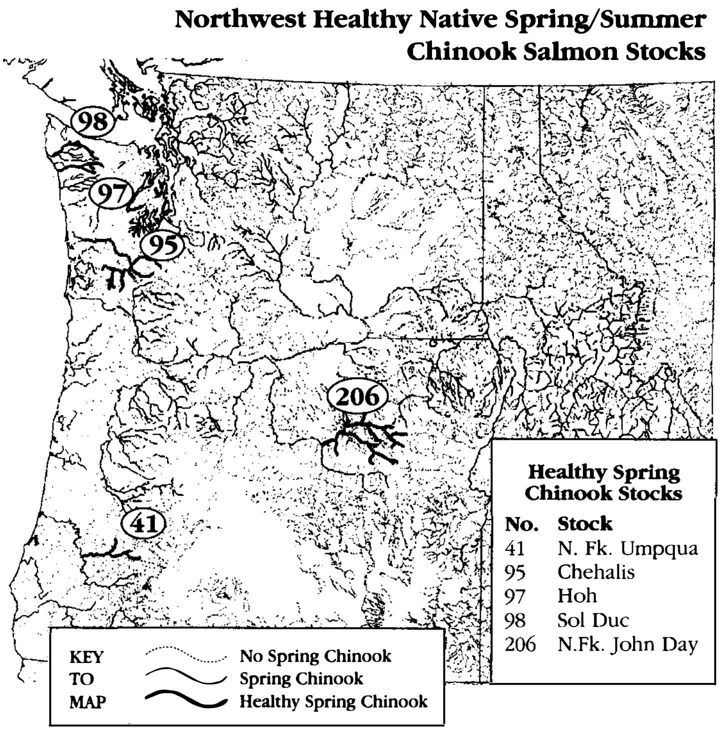


Figure 1. Rivers with healthy native stocks of salmon and steelhead in the Pacific Northwest.

government and private support for voluntary programs to develop incentives for habitat conservation, land easements and acquisition, watershed assessments and action plans, and the establishment of local watershed councils (see Pacific Rivers Council 1994).

3. Native fish management programs. In the Pacific Northwest, fish management agencies have limited control over many factors threatening fish stocks such as riparian habitat loss, instream flow and barriers to fish passage. But the protection of healthy native fish stocks could be improved through support for management programs that reduce risk to native fish from hatchery programs, sport and commercial overharvest, and danger from introduced species. We suggest a native fish management program (after Bakke 1994) be developed for healthy stocks that includes: (1) the conservation of native stocks as the management priority; (2) inventories of native fish and other aquatic biota; (3) monitoring of fish (juvenile and adult) abundance and life-history variation; (4) escapement goals that maximize population health and allow for full seeding of available habitat; and (5) the elimination of transfers of exotic stocks into the watershed.

4. Research. A key to the survival of anadromous salmonids may lie with a better understanding of the factors that have enabled some stocks to thrive while the majority continue to decline. Factors influencing salmonid stock health may include large-scale climatic fluctuations such as El Nino, regional weather patterns, local human population density, land ownership patterns, land-use practices, such as agriculture, forestry and water use, and fish management practices, such as harvest and hatchery programs. Some stocks may be naturally more vulnerable to human disturbance because of factors such as the timing of migration and spawning, length of freshwater rearing, and ocean migration patterns. Long-term research and monitoring programs will help natural resource managers develop a better understanding of the impacts of different management decisions (fish harvest, land use, forestry practices, stream flow, water quality) on salmon and steelhead populations and provide baseline indices of ocean and freshwater productivity.

Conclusions

Today, the majority of native salmon and steelhead stocks in the Pacific Northwest are declining. We have reached a point where we must take steps to prevent the loss of the salmon and steelhead populations necessary to prevent the extinction of the species and its locally adapted races. This does not mean triage, but only that we need to offer some protection to the healthy native stocks in addition to preventing the loss of the stocks approaching extinction. Identification, designation, wild fish management and research are only the first steps in preventing loss of our most robust stocks. Ultimately, our society will have to strike an equilibrium between the needs of a growing human population and the need to protect the ecosystems from degradation and the native fish stocks from overharvest whether they are the salmon stocks of the Pacific Northwest or important fish assemblages in the Mississippi River watershed.

Acknowledgements

I would like to thank the following individuals for their time, advice and comments: Ray Hubley, Geoff Pampush, Bill Bakke, David Moskowitz, Kathleen Williams, Lee Lane, Bill Overholtz, Chuck Huntington and Willa Nehlsen. I also would like to thank the Geraldine R. Dodge Foundation, the Charles Engelhardt Foundation, the James Ford Bell Foundation, the Lazar Foundation, the Weeden Foundation, and the members of Oregon Trout for their generous support of the Healthy Stocks Program.

References

Allan, J. D. and A. S. Flecker. 1993. Biodiversity conservation in running waters. BioScience 43: 32–43.

Bakke, B. M. In press. Wild trout in North America: Regional perspectives. Proc. Wild Trout V Conf., Yellowstone, WY.

Benke, A. C. 1990. A perspective on America's vanishing streams. J. No. Amer. Benthol. Soc. 9:77–88.

Bodenmiller, D. 1994. Fishery impacts on Tillamook system coho. Pages 5–1 to 5–28 *in* Tillamook Bay coho stock status report. Oregon Dept. Fish and Wildl., Portland.

Botkin, D., K. Cummins, T. Dunne, H. Regier, M. Sobel and L. Talbot. Status and future of salmon in western Oregon and northern California. Report No. 8. The Center for Study of Environ., Santa Barbara. CA.

Chilcote, W., C. Dale, K. Kostow, H. Schaller and H. Weeks. 1992. Wild fish management policy biennial progress report. Oregon Dept. Fish and Wildl., Portland.

Doppelt, B., M. Scurlock, C. Frissel and J. Karr. 1993. Entering the watershed: A new approach to save America's river ecosystems. Island Press, Washington, D.C.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: An ecological, economic and social assessment. USDA For. Serv., Nat. Ocean. Atmos. Admin., Bur. of Land Manage., Nat. Park Serv. and Environ. Protection Agen., Portland, OR.

General Accounting Office (GAO). 1992. Endangered species: Past actions taken to assist Columbia River Salmon. GAO/RCED-92-173BR.

Gilpin, M. E. and M. E. Soule. 1986. Minimal viable populations: Processes of species extinction. Pages 19–35 *in* M. J. Soule, ed., Conservation biology: The science of scarcity and diversity. Sinaeur Inc., Sunderland, MA. 584 pp.

Goodman M. L. 1990. Preserving genetic diversity of hatchery stocks: A call for federal regulation of hatchery programs. Environment. Law 20: 111-166.

Helle, J. H. 1984. "Gene banks" for wild fish stocks. Pages 41–44 *in* J. M. Walton and D. B. Houston, eds., Proceedings of the Olympic wild fish conference. Peninsula Coll. and Olympic Nat. Park, Port Angeles, WA.

Henjum, M. G., J. R. Karr, D. L. Bottom, D. A. Perry, J. C. Bednarz, S. G. Wright, S. A. Beckwitt and E. Beckwitt. 1994. Interim protection for late successional forests, fisheries and watersheds: National forests east of the Cascade crest in Oregon and Washington. The Wildl. Soc., Bethesda, MD.

Huntington, C., W. Nehlsen and Jon Bowers. 1994. Healthy stocks of anadromous salmonids in California and the Pacific Northwest. Oregon Trout, Portland.

Hubley, R. 1994. Fish refuges, are we almost there? Fisheries 18(11): 30.

Jacobs, S. E. and C. X. Cooney. 1991. Improvements of methods used to estimate the spawning escapement of Oregon natural coastal coho salmon. Ann. Progress Rept. Contract F–145–1, ODFW, Portland, OR.

Johnson, K. N., J. F. Franklin, J. W. Thomas and J. Gordon. 1991. Alternatives for management of late successional forests of the Pacific Northwest. A report to the Agriculture and Merchant Marine and Fisheries Committees of the U.S. House of Representatives. Scientific panel on late successional ecosystems. Washington, D.C.

Jones, S. 1994. Endangered Species Act battles. Fisheries 19(1): 22–25.

Leffler, R. L. 1959. The program of the U.S. Fish and Wildlife Service for the anadromous fishes of the Columbia River, a speech delivered at a meeting of the Western Association of State Fish and Game Commissioners, Portland, Oregon, July 1, 1959. Oregon Game Bull., Portland.

Kaczynski, V. W. and J. F. Palmisano. 1993. Oregon wild salmon and steelhead trout: A review of management and environmental factors. Oregon For. Ind. Counc., Portland.

May, B. 1993. Heritage brook trout in the northeastern USA: Genetic variability within and among populations. Trans. Amer. Fish. Soc. 122(4): 515–527.

Moore, M., K. McLeod and D. Reed. 1960. Fisheries: Fish farming and fish management. Washington Dept. Fish., Olympia.

Moyle, P. B. and R. M. Yoshiyama. 1994. Protection of aquatic biodiversity in California: A five tiered approach. Fisheries 19(2): 6–18.

Nawa, R. In preparation. Stock status, stocks origin, percent wild spawners, and causes of declines of chinook salmon in California, Oregon, Washington and Idaho. Present. 31st Ann. Meet. and Symp. Oregon Chapt. Amer. Fish. Soc., Ashland.

Nehlsen, W. In preparation. Prioritizing watershed and wild salmon restoration: Summary of the framework developed under the sponsorship of Oregon Senate President Bill Bradbury. Proc. 1994 Chinook and Coho Workshop. The Amer. Fish. Soc., Oregon Chapt., Corvallis.

Nehlsen, W., J. E. Williams and J. A. Lichatowich. 1991. Pacific salmon at the crossroads, stocks at risk from California, Oregon, Idaho and Washington. Fisheries 16(2): 4–21.

National Marine Fisheries Service. 1994. NMFS Northwest Region Petition and Status Review Summary. Portland, Oregon.

Nickelson, T. et al. 1993. Watershed and aquatic habitat restoration strategy for coastal Oregon basins. Product F–1 for Oregon Coastal Salmonid Restoration Plan. Oregon Dept. Fish and Wild., Corvallis.

Northwest Power Planning Council. 1992. Strategy for the salmon. Portland, Oregon. 98 pp.

Oregon Trout Steelhead Committee. 1994. A proposal for wild salmonid reserves. Unpubl. manus., Oregon Trout, Portland.

Overholtz, W. J. In preparation. Toward the year 2000, managing for the future: Assessment and prognosis for the OCN coho stock. Oregon Trout, Portland.

Pearcy, W. Ed. 1992. Oregon natural coho review team report: An assessment of the status of the Oregon coastal natural coho stocks as required under the definition of overfishing. Pacific Fish. Manage. Counc., Portland, OR.

Reffalt, W. 1991. The endangered species lists: Chronicles of extinction. Pages 77–85 *in* K. A. Kohm, ed., Balancing on the brink of extinction, the endangered species act and lessons for the future. Island Press, Washington, D.C.

Reisenbickler, R. R. In press. Genetic factors contributing to declines of anadromous salmonids in the Pacific Northwest. *In* D. Stouter and R. Naimen, eds., Pacific salmon and their ecosystems. Chapman Hall, Inc.

Ricker, W. E. 1972. Hereditary and environmental factors affecting certain salmonid populations. Pages 19–160 *in* R. C. Simon and P. A. Larkin, eds., The stocks concept in Pacific salmon. Univ. British Columbia, Vancouver.

Rohlf, D. J. 1989. The Endangered Species Act, guide to its protections and implementation. Stanford Environ. Law Soc., Stanford Law School, Stanford, CA. 207 pp.

Stone, L. 1982. A national salmon park. Pages 149–162 *in* Trans. Amer. Fish. Soc., New York, NY.

Waples, R. S. 1991. Definition of "species" under the Endangered Species Act: application for Pacific salmon. Nat. Marine Fish. Serv., Northwest Fish. Ctr. Seattle, WA.

Washington Department of Fisheries, Washington Department of Wildlife and Western Washington Treaty Indian Tribes. 1992. Washington state salmon and steelhead stocks inventory. Washington Dept. Wildl. and Fish., Olympia. 212 pp.

White, R. J., W. Nehlsen and J. R. Karr. 1994. Better roles for fish stocking in aquatic resource management. Present. Amer. Fish. Soc. Symp., Albuquerque, NM., March 12–17.

Williams, J. E., J. E. Johnson, D. Hendrickson, S. Contreras-Balderas, J. D. Williams, M. Navarro-Mendoza, D. E. Mcallister and J. E. Deacon. 1989. Fishes of North America endangered, threatened, or of special concern: 1989. Fisheries 14(6): 2–20.

Habitat Rehabilitation and Enhancement Program Case Studies: Lake Onalaska Islands and Hydrological Modification of the Finger Lakes

Robert F. Gaugush, David Soballe, Sara Rogers and Jennifer Sauer
National Biological Service
Onalaska, Wisconsin

John Barko and Bill James
Waterways Experiment Station
Vicksburg, Mississippi

Barry Johnson, Brent Knight and Teresa Naimo
National Biological Service
La Crosse, Wisconsin

Introduction

The Upper Mississippi River System (UMRS) long has been recognized as a unique natural resource. In the Water Resources Act of 1986 (Public Law 99–662), the U.S. Army Corps of Engineers (COE) was given responsibility to ensure the development and enhancement of the UMRS. The National Biological Service (NBS) and several states (Minnesota, Wisconsin, Iowa, Illinois and Missouri) are participating as partners with the COE in the resultant COE-sponsored Environmental Management Program (EMP). One of several major thrusts within the EMP involves habitat rehabilitation. The Environmental Management Technical Center (EMTC) of the NBS has been requested by the COE to provide technical assistance in planning and conducting ecological monitoring efforts in conjunction with various Habitat Rehabilitation and Enhancement Projects (HREPs).

The two case studies that follow, the Lake Onalaska Islands Project and the Finger Lakes Hydrologic Modification Project, are typical of the HREPs being conducted under the EMP.

The Lake Onalaska Islands Project

Lake Onalaska is a shallow backwater lake that was formed by the impoundment of the Mississippi River by Lock and Dam 7 in 1937 (Figure 1). When this and other navigation pools were formed, natural river bank levees and other areas of higher elevation became islands. This structural diversity was gradually reduced by the action of river currents, waves and wind. The continuous inundation of part of the floodplain and constraining the river to the main channel prevents the formation of new islands. Island construction HREPs have been conducted to restore some of the physical heterogeneity to the navigation pools. The islands were constructed in Lake Onalaska

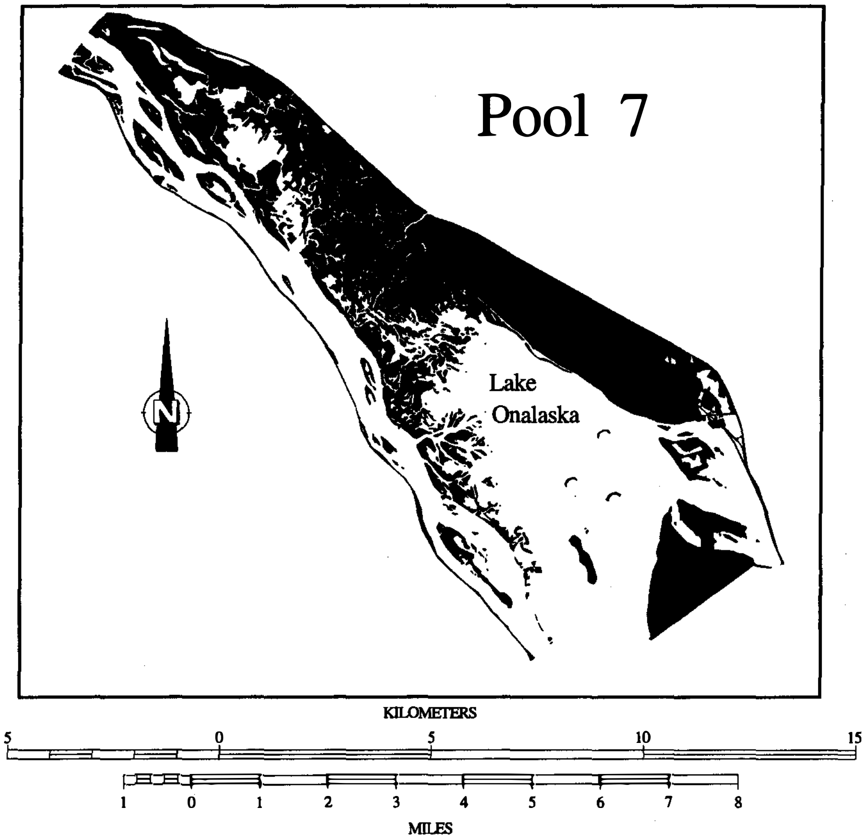


Figure 1. Pool 7 of the Upper Mississippi River, Lake Onalaska, and the three man-made islands.

to improve water clarity, reduce wind/wave induced erosion on existing land areas, enhance habitat diversity and provide predator-free waterfowl nesting/loafing habitat (U.S. Army Corps of Engineers 1988).

The Lake Onalaska islands study is primarily designed to examine the physical responses to island construction. The study was initiated in 1992 and is anticipated to span approximately five years. Ongoing studies focus on the influence of islands on current velocity, wave patterns, sediment distribution, water quality and vegetation distribution (Gaugush et al. in press).

The physical presence of an island produces localized changes in the current velocity patterns in the area of the island. In general, an island produces a "shadow" zone of reduced velocity directly downstream of the island, a hydraulic cushion just upstream of the island where velocities are reduced and higher velocity areas on the sides of the island. These changes act to generate responses in sediment distribution, water quality and, eventually, the distribution of vegetation.

Patterns of sedimentation also change in response to the presence of islands. Sediment trap data demonstrate that gross, as opposed to net, sedimentation is much higher upstream of the islands than in the shadow zones downstream of the islands. Due to the shallow depths of Lake Onalaska and the resultant susceptibility of the sediments to be resuspended by wave action, sediment traps can only estimate the gross sedimentation rate and not the net deposition.

Island creation has caused changes in the sediment distribution around the islands since their construction in 1989. Relatively large areas of deposition have formed downstream of the islands. In the zones of reduced velocities, fine particulate matter settles out to produce a sediment type that is very different than that found in the rest of the lake. Sediments behind the islands have lower bulk density, smaller particle sizes, higher moisture content and higher organic content.

Using the current velocity and sediment distribution data, a map of energy zones around the islands can be developed (Figure 2). Most of the area around this particular island is in the transport zone where particulate matter is routed through the zone

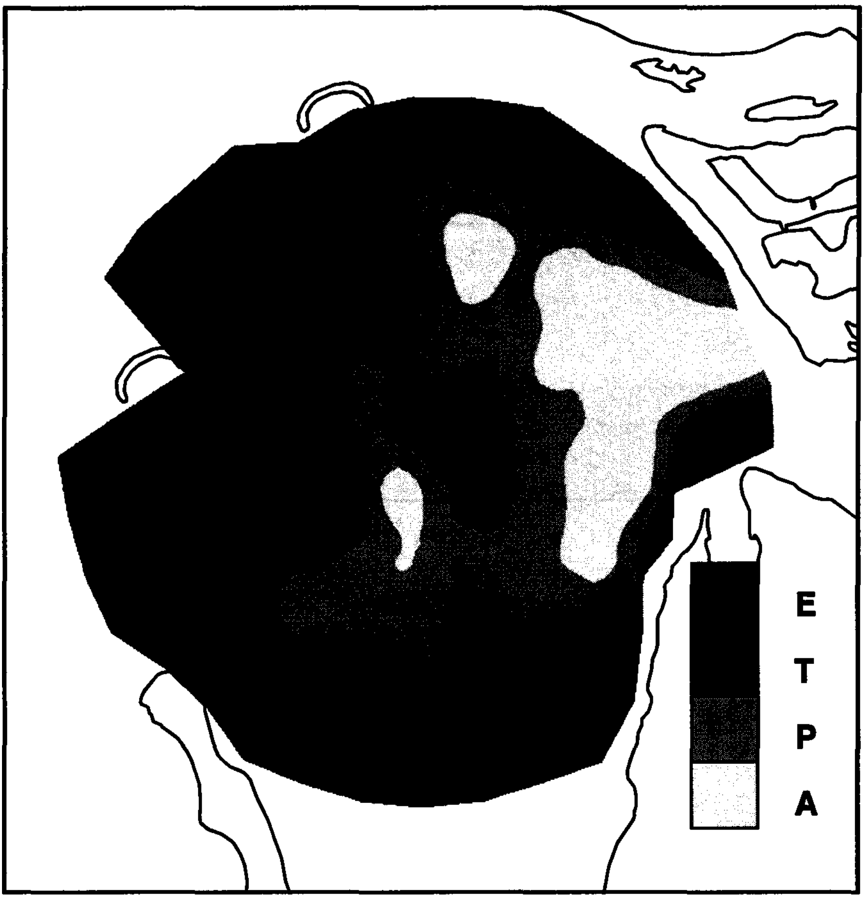


Figure 2. Energy zones (erosion [E], transport [T], probable accumulation [P] and accumulation [A]) around Arrowhead Island in Lake Onalaska.

without long-term deposition or accumulation. The accumulation zones correspond to the areas of the hydraulic cushion and the shadow downstream of the island. Erosion dominates in either high current velocity areas or where depth is so shallow that the sediments are constantly winnowed by wave action.

There are significant water-quality changes associated with the introduction of man-made islands. The reduced velocities in the shadow zone imply that the water exchange with the rest of the lake is much reduced. This reduced water exchange, during the growing season, allows for the development of much more lake-like conditions when compared with the rest of the more riverine Lake Onalaska. With reduced velocity, water temperature increases, water clarity improves as particulate matter settles out and phytoplanktonic production increases with improved light conditions.

The results from these studies are expected to aid in the development of an empirical model relating depth, wind effects and current velocity to sediment distribution. A model of this type could be used to predict distribution in other navigation pools of the UMRS. Knowledge gained from the Lake Onalaska islands study already is being used in other HREPs, most notably in the Pool 8 Islands Project and the Swan Lake Project on the lower portion of the Illinois River.

The Finger Lakes Hydrologic Modification Project

The Finger Lakes complex consists of six connected lakes located in Navigation Pool 5, just downstream from the dike at Lock and Dam 4, near Kellogg, Minnesota (Figure 3). An ungated culvert through the dike, into Lower Peterson Lake, provided the only direct inflow to this system. During the winter, several of these lakes experience low oxygen concentrations and extremely low water temperatures, conditions that substantially reduce their suitability for fish. To improve winter fish habitat, the COE, St. Paul District, retro-fitted the existing culvert system and installed additional controlled-flow culverts to regulate the hydrology of the lake complex in 1994. During the period 1991–1994, pre- and post-construction monitoring data were obtained by the NBS and the COE to evaluate project success.

The Finger Lakes investigation is designed to examine experimentally the effects of management measures directed toward fisheries improvements, with adequate attention also to effects of a wide variety of other important and interrelated variables. Ongoing studies focus on changes in hydrology, water quality, sedimentation, vegetation, fish and invertebrates affected by hydrologic modification. A major goal of the Finger Lakes HREP is to improve winter habitat conditions for fish. Associated efforts are aimed at quantifying spatial/temporal patterns and interrelationships among water movement, oxygen, sediment type, vegetation, macroinvertebrates and temperature (Barko et al. 1993, 1994).

Hydrological studies (dye studies and current velocity measurements) have elucidated the general patterns of water movements in the Finger Lakes complex. Under pre-project conditions, flows, from the single ungated structure entered the northern end of Lower Peterson Lake, moved through it into Schmokers Lake, into the extreme southern end of First Lake, and then out of the complex.

Pre-project water quality studies have shown that Clear, First and Third lakes (those without direct connection to the river) can differ greatly from Lower Peterson and

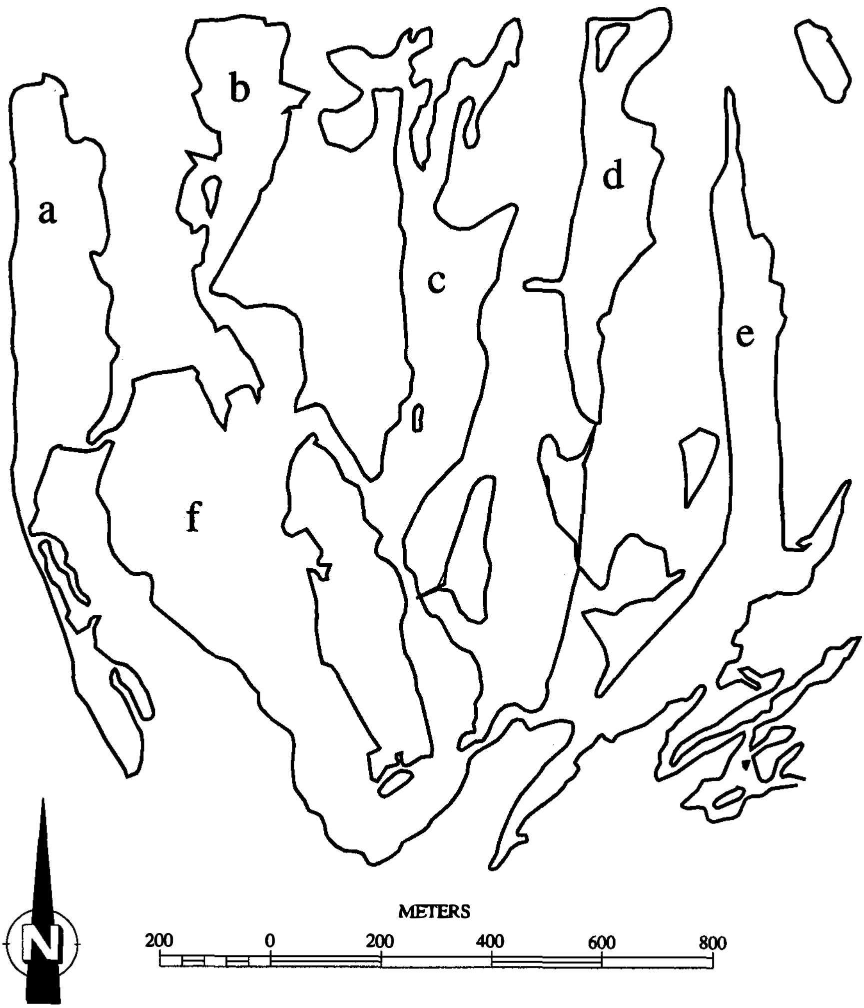


Figure 3. The Finger Lakes complex below the dike of Lock and Dam 4. The lakes are: (a) Clear, (b) Lower Peterson, (c) Third, (d) Second, (e) First and (f) Schmokers.

Schmokers Lakes (those with inputs from the river). During the winter, the culvert into Lower Peterson Lake provides it and Schmokers Lake with high oxygen concentrations, but water temperatures are too low to meet the requirements of the centrarchid fishery. The other lakes exhibit intermittent and frequent periods of anoxia in the winter.

Pre-project fisheries investigations were able to define those areas of the Finger Lakes complex that were suitable for bluegills (*Lepomis macrochirus*), black crappie (*Pomoxis nigromaculatus*) and largemouth bass (*Micropterus salmoides*) (Figure 4). Winter habitat conditions were found to be suboptimal over most of

Figure 4. Mid-winter physical habitat conditions in Clear, Lower Peterson, Third and Schmokers lakes.

the complex due either to high current velocities (> 1 cm/sec) or low oxygen concentrations (< 1 mg/L). Fish radiotelemetry data indicated that both bluegill and black crappie preferred areas with dissolved oxygen concentrations greater than 1 milligram per liter, no current velocity and water temperatures greater than 1 degree Celsius. Fish movement was initiated when oxygen concentrations dropped to 1–2 milligrams per liter. Fish would tolerate low temperatures to find adequate oxygen but always avoided current velocities greater than 1 centimeter per second.

The installation of gated culverts has re-established the connection between these lakes and the Mississippi River. Sedimentation and sediment distribution data suggest that both the patterns and quality of sedimenting material will change under the new hydrologic regime. The data indicate that gross sedimentation rates will increase with an associated reduction in the amount of organic matter in the settling particulate matter as these lakes shift from a lacustrine state to a more riverine state. Post-project monitoring and experimental manipulation of flow into the Finger Lakes complex will be directed at determining the winter flow conditions that will optimize winter habitat conditions. An attempt will be made to maximize those areas with low current velocity (< 1 cm/sec), adequate dissolved oxygen (> 1 mg/L) and relatively warm water (2–3 °C).

References

Barko, J. W., R. F. Gaugush, W. F. James, B. J. Johnson, T. J. Naimo, J. T. Rogala, S. J. Rogers and D. M. Soballe. 1993. Hydrologic modification for habitat improvement in the Finger Lakes: Pre-project Report Number 2, 1993. U.S. Fish and Wildlife Service, Environmental Management Technical Center, Onalaska, Wisconsin; U.S. Fish and Wildlife Service, National Fisheries Research Center, La Crosse, Wisconsin; and U.S. Army Corps of Engineers, Waterways Experiment Station, Eau Galle Limnological Laboratory, Spring Valley, Wisconsin. EMTC 93–T002. 57 pp.

Barko, J. W., R. F. Gaugush, W. F. James, B. J. Johnson, B. C. Knights, T. J. Naimo, S. J. Rogers, J. S. Sauer and D. M. Soballe. 1994. Hydrologic modification for habitat improvement in the Finger Lakes: Pre-project Report Number 3, 1994. Report by the National Biological Survey, Environmental Management Technical Center, Onalaska, Wisconsin; the U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi; the National Biological Survey, National Fisheries Research Center, La Crosse, Wisconsin for the National Biological Survey, Environmental Management Technical Center, Onalaska, Wisconsin, September 1994. LTRMP 94–T002. 56 pp.

Gaugush, R. F., J. W. Barko, D. M. Soballe and S. J. Rogers. In press. Effects of islands on selected environmental conditions in the Upper Mississippi River System: Progress report number 2, 1995. Report for the National Biological Survey, Environmental Management Technical Center, Onalaska, Wisconsin, February 1995. LTRMP 95.

U.S. Army Corps of Engineers. 1988. Upper Mississippi River System Environmental Management Program. Definite Project Report/Environmental Documentation (SP–1). Lake Onalaska Dredge Cut and Island Creation. Habitat Rehabilitation and Enhancement Project. St. Paul District. August 1988.

Special Session 3. *Conservation and Ecology of Raptors*

Chair
WILLIAM A. BURNHAM
The Peregrine Fund
Boise, Idaho

Cochair
GEOFFREY L. HOLROYD
Canadian Wildlife Service
Edmonton, Alberta

Raptor Populations: The Basis for Their Management

William A. Burnham and Tom J. Cade
The Peregrine Fund
World Center for Birds of Prey
Boise, Idaho

Introduction

The chair was asked to introduce this Session on "Conservation and Ecology of Raptors" by linking it to the conference theme, "balancing social, professional and conservation responsibilities." The theme can be interpreted to mean using our obligation as wildlife professionals to be objective, scientifically accurate and informative in balancing the needs of people (individuals, communities and nations) with the imperative to conserve biological diversity and natural resources for future generations.

Human Needs, Values and Understanding

Human uses of natural resources are having major impacts on nature and are likely to increase with the demands of a growing human population. Although important, existing parks and refuges are too few, too scattered and too small to preserve the world's biological diversity. In particular, most are too small to sustain viable populations of many sparsely distributed species, including rare raptors. Even in affluent societies, aesthetic values alone are insufficient justification to preserve our natural world. Local people must benefit from native flora and fauna and be involved in their management; otherwise, the natural biodiversity of an area usually declines. "If you want to maintain natural habitats, you must give value to the habitats. . . . In Nigeria, a 20-year ban on hunting has resulted in habitats converted to agriculture and other uses," according to IUCN representative Anada Tiega (Parsons 1994).

The value of nature, including wildlife, must be recognized if humans are to desire that it survive. A standing tropical forest must be as valuable and desirable as a field of corn or pasture that could replace it. It is unrealistic to think we can exclude people from sufficiently large areas of natural habitats as the primary device for maintaining biodiversity. To conserve nature, we must find ways to manage environments so that natural biological processes and species, including humans, are nourished in perpetuity. We also must resolve how to conserve all natural resources on which humans depend and emphasize sustainable use of those that are self-renewing.

More and more people in developed nations are separated from their natural world and the processes required to meet human needs. Knowledge about nature assists humans to understand their complete dependence on the environment. Increasingly, that experience is received only through television and the glossy pages of magazines and books. Attitudes and opinions are shaped largely by information purchased on cable networks, through memberships and on broadcast media, and not from real life experiences. Almost everything needed is obtained packaged ready for use. Meat appears on shelves, milk in cartons, lumber at stores, and electricity magically flows at every plug and light switch. Most North Americans and Europeans have limited familiarity with the work required to raise and harvest food and timber or the environmental costs of meeting these ongoing needs. Some may object to most forms of electrical power generation while enjoying the many benefits of electricity. Separation from the processes for sustaining human needs and lack of direct experience in nature lead to misunderstandings and extremes in attitudes.

Richard Leakey, while Director of the Kenya Wildlife Service, was quoted as saying, ''to care about the environment requires at least one square meal a day'' (Schmindheiny 1992). Especially in the developing world, extremes in attitudes can be caused by hunger and other life and death concerns. A private forest manager in the Philippines explained that he could not hire enough guards to keep local people from cutting down the company's forests or to defend against the insurgent guerilla forces. Instead of using guards in forest border areas, the company allowed local people to use a small area of land for gardens and annually provided them with fast-growing seedlings, which the company purchased after eight years for paper production. The monoculture plantings were in deforested buffer areas adjacent to valuable native hardwood forest the company selectively harvests. Now, local people have ''one square meal a day,'' guerrillas are not a factor, poaching of timber has ceased and no guards are required. The Philippine Eagle Foundation, a nonprofit Philippine-based organization, is employing similar techniques but, in this case, using mixed native tree plantings in degraded forest areas where Philippine eagles (*Pithecophaga jefferyi*) remain.

Effect of Extremes

Both extreme protection and extreme overuse of natural resources ultimately are unsustainable. Exclusive resource protection by one society always means overuse of another's natural resources and also may unwittingly contribute to greater adverse environmental impacts than the well-managed use of natural resources. Excessive restrictions may encourage use of energy-expensive synthetic replacements for renewable natural resources, replacements which require more non-solar energy and result in undesirable byproducts.

Both as individuals and as wildlife professionals, we are being increasingly affected by extremes. We have a dilemma. Attempting to conserve all the world's biological diversity could require all of our time, energy and money, yet, we still might not succeed. We frequently focus on crises caused by extremes, which also attract money; and the factual information (science) we generate is used selectively or distorted by others to support their political agendas. Also, while we emphasize factual accuracy and rational discourse, others use human emotions and sensationalism. Terms like "endangered" have become so overused as to become almost meaningless. An "endangered or threatened species" can exist as tens or even hundreds of thousands of organisms or as just a few individuals. Such designations have become emotional and political symbols, not useful biological terms. Further, biologists may appear to agree with protectionists and animal rights extremists. Most times we do not voice alternative opinions because of pressure, worry over conflict, feeling it is not worth the effort and time, or that it is unprofessional.

Government and Regulations

Governments, international agencies and bodies, conventions, and treaties are contributing to extremes. Government is so congested with a myriad of complex laws and regulations, often administered by hard-pressed officials who do not understand the purpose of the regulations, that government functions best in crisis when it can abbreviate itself. Government's easiest response to problems is to say "no," pass laws and promulgate regulations to restrict human activities. Although some control is needed, each new law and regulation has a direct cost in development, implementation and enforcement, but the indirect cost in lost or heavily restricted private initiatives can be much greater. Each action builds bigger government, and someone must pay. We pay in taxes and fees and in loss of personal and professional freedom.

We also pay by wasting organizational and personnel resources critically needed for nature conservation. For instance, the Mauritius kestrel (*Falco punctatus*) was being captively bred in the United States by The Peregrine Fund so that young could be released back to Mauritius. The program, however, had to be discontinued because, beginning even a full year in advance, United States permits could not be secured on time for young to be released in Mauritius at the proper age. Without a complete overhaul of the permitting process, it is doubtful that any United States-based captive breeding program producing young needing to be released at a critical developmental stage at an overseas location can succeed with the current permitting and regulatory situation.

For a competent, professionally recognized biologist to renew or slightly modify an "Endangered Species Permit" (e.g., simply adding a colleague's name), can take many months. Obtaining a new permit can take much longer. We endorse review and permitting of individuals and organizations requesting authorization for hands-on activities with wildlife. What we object to is duplication and unneeded repetitiveness of the exercise. Regulatory officials should review and investigate once and, assuming the applicant is qualified and the request(s) reasonable, issue with minimal delay a general "blanket" permit for all activities covering several years. Then, unless a problem arises or the permit needs amendment, only annual reports should be required. Walsberg (1994) and other professional ornithologists have come to the same conclusion.

Regulations are designed more to control the few potential abusers than to encourage the many individuals and organizations attempting to benefit nature. The current approach to permitting is to search for justification to deny requests and to exhaust applicants with excessive hurdles and requirements. Applicants are forced to expend their limited resources to accommodate these procedures rather than to conserve biological diversity. These complaints are not new and have their origin in a fundamental reorganization of the Law Enforcement Division of the Fish and Wildlife Service in 1974 from an agency of "conservation officers" to one composed of "special agents," including a task force for covert operations and "stings" (Cade 1985). Changes in permitting regulations and processing have been urgently needed for a long time, but federal administrators remain unresponsive.

Governments and international bodies also frequently attempt to impose their values and judgments on others—the "top down philosophy" in which decisions are made internationally or nationally and imposed locally (Western et al. 1989). It is difficult to generalize between cultures and "developed" and "developing" countries. A Greenlander at the Inuit Circumpolar Conference said of an IUCN proposal for a universal ethic of wildlife use, "unity only develops if all parties gain from the unity, if they accept their differences, if they recognize the necessity of understanding each other, and then if they find ways to refine means of communication and cooperation. To develop a universal ethic for use of wildlife will either result in an ethic dictated by dominant nations or will result in complete failure" (Egede 1994). He goes on to say that IUCN should focus on the operational goals expressed in the concepts of conservation, sustainability and ecology and allow the member regions, states and cultures to find their own ways to implement goals.

Economics

Economic and social well-being are critical to conservation of biodiversity and all natural resources. Programs to improve social stability, economic and agricultural production, and employment and personal income, including those in urban settings, in concert with reduction in human population, are the important actions needed for the conservation of nature. We need economic incentives and consumer restraints that support living with, rather than using up, natural resources. When social and economic reforms are required for resource sustainability, economic alternatives are important (Western et al. 1989). Business and private enterprise (large and small), more than governments, may have the best prospect for creating a steady-state economy if they will learn to take the long-range approach instead of opting for maximum, short-term profits. Corporate executives, shareholders, employees and customers must understand how sustainable resource use and conservation of life's diversity benefit them, their families and their descendants.

Professional Responsibilities

Public trust is not automatically awarded to governments, businesses or biologists but must be earned by substantive actions. The trust that wildlife biologists enjoy was earned primarily by the actions and accomplishments of our predecessors in the field. The public values and appreciates honesty (including admitting errors), accuracy (stating clearly what we know and do not know), productivity (working hard, meeting deadlines and disseminating results) and integrity (not allowing our results to be misrepresented or used in an unprofessional manner). As we combine science and conservation, write proposals for funding and deal with public information services, it is easy to fall into the traps of overstating results, relying too heavily on anecdotal information, obscuring contrary data and being anthropomorphic, although passion for our work and for nature is important. It is our job always to see that the public trust is not eroded, but instead enhanced by our actions. A recent editorial in *Conservation Biology* argues powerfully for the need to keep objective, unbiased science, however relevant to societal problems, free from political alliances (Brussard et al. 1994).

As professional resource managers, we also should be problem solvers. Solutions are seldom simple, black or white, yes or no, especially when trying to balance the needs of people and conservation of nature and short-term benefits and long-term costs. Cooperation is more productive and less expensive than litigation. Incentives are better than punitive activities (including trade bans). Solutions for the conservation of nature do not necessarily require legislative and Congressional mandates, nor are they necessarily found in courtrooms. Instead, rational discussion and equitable compromises among conflicting interests develop lasting solutions. To become better problem solvers and to benefit conservation, biologists should add knowledge of the humanities, social sciences, economics and even business techniques to their backgrounds. We also should ensure that we recognize the authority, rights and knowledge of native peoples and consider them as equals (Alcorn 1993). The same respect should be extended to private landowners. An aboriginal woman makes this clear: ''If you have come to help me you can go home again. But if you see my struggle as part of your own survival then perhaps we can work together'' (Sharma 1989).

Conservation of Nature

There is no simple way to conserve our natural world. Conservation cannot succeed by government fiat or by the action of special interest groups. To succeed, conservation must benefit humans spiritually and socially, but most importantly, economically. It must improve our quality of life. Only then will conservation be integrated into the fabric of our daily lives and thought processes. No single person, organization or industry can save nature, but many people working together can make an important difference. Then humanity will be able to live in harmony with the natural world.

Referring to the Conference theme, we would rephrase the theme as a goal for wildlife professionals, conservationists, and caring, informed human beings. The goal is to learn how to manage life and the global environment so that natural biological processes and species, including *Homo sapiens*, can be nourished and sustained through time.

Raptor Research and Conservation

Introduction

How do we work toward achieving the above goal through a concern for raptors? To begin—why study and conserve raptors? What are the reasons and justifications beyond our personal interests?

1. As predators at the tops of food webs, raptors are influenced by many factors and processes within nature. There also is increasing evidence that top predators, such as large raptors, may play key roles in maintaining biological diversity and normal ecological functions in tropical forest environments. They are, therefore,

excellent subjects to study for understanding ecological processes and for student education and training.

2. Measures that provide for the conservation of raptors frequently provide an "umbrella" of protection for entire ecological communities of which they are a part. Large raptors typically require large natural areas for survival. Each pair of eagles may require a territory of ten to hundreds of square kilometers of area (Newton 1979). Preserving an area of sufficient size and ecological integrity to maintain viable populations of such species provides justification of large rather than small protected areas. Reserves large enough to conserve raptors usually are large enough to conserve all the other organisms living there.

3. The kinds and numbers of raptors can reflect overall biological diversity and special attributes of the environment, indicating areas needing special attention.

4. Raptors have proven sensitivity to many forms of environmental change, such as chemical pollution (e.g., DDT) and habitat modification (e.g., deforestation), and probably are sensitive to climatic trends (e.g., global warming). Because of this sensitivity, raptor communities can be monitored as early warning systems for environmental pollution and other change. As predators, raptors also have been extensively killed to protect game and livestock, so that numbers in some areas still may be well below the level that the contemporary (often degraded) landscape could support. This is particularly true in Europe (Ian Newton personal communication: 1995).

5. Thorough knowledge of ecosystem structure and function is needed as a basis for conservation. By applying sound scientific research and understanding to raptors in the environment, we can build essential knowledge on which to base effective conservation action.

6. Birds of prey are among the most popular forms of wildlife in the world. They symbolize strength and courage and other important human values, but especially freedom and our natural environment and heritage. With this "charismatic" quality, they can be used as "flagship species" to focus human attention on needs for research and conservation.

Biogeographical Occurrence

Where do birds of prey occur? Following the classical division of the world into seven biogeographical regions, we have categorized the distribution of 296 species of diurnal birds of prey (Table 1). No Falconiformes occur in the eighth region, Antarctica. Two-thirds of all diurnal raptors are in the Tropics, a majority in tropical forests. Many raptors are restricted to single islands or localized continental areas. Only 33 species of diurnal raptors (11 percent) occur in the Nearctic region and the breeding ranges of only 9 species are restricted to this region. This compares with 91 species (31 percent) in the Neotropical region, of which 64 species occur only there.

Status

What is the biological status of raptorial species? Status can embrace population numbers and trends or inherent biological characteristics (White 1994). In the public view, most raptors and other species of wildlife that reproduce slowly and naturally occur at low density over large areas are considered to be in jeopardy. This notion and the popularity of raptors have caused birds of prey to become the tools of

Table 1. Zoogeographic distribution (breeding and wintering) and reported status of diurnal birds of prey (296 species) (Cade and Burnham 1990).

	Nearctic	Neo-tropical	Palearctic	Ethiopian	Oriental	Austral/ Asian	Oceanian	Total
Total species	33	91	51	93	75	58	4	
Breeding species restricted to region	9	64	22	60	27	38	2	222
Island species (and subspecies)	0	6 (3 ssp)	0 (2 ssp)	12 (2 ssp)	12	24	2	56 (7 ssp)
Total endangered	1	0	1–2	2[a]	3 (1 ssp)[a]	0	0	7–8 (1 ssp)
Total vulnerable	0	6	1	2	1	0	0	10
Locally vulnerable	3	10	9	11	7	21	4	65
Little-known and needing study	0	16+	7	13+	26	27+	4	93+

[a]All island endemics.
(Species range: Brown and Amadon 1968; species status: Chancellor and Meyburg 1986, King 1979, National Archives and Records Administration 1990.)

individuals and groups wishing to stop a particular activity, from natural resource use to building construction to fly-overs of aircraft. However, some raptor populations can occur at low densities and remain stable indefinitely, as we discuss later.

Globally, about one-quarter of all diurnal raptor species currently are considered to be in jeopardy throughout at least part of their range (Table 1). The present status of at least another third, however, is unknown, and the latter number continues to increase with the rapid environmental changes taking place in areas that are little studied. Island endemics (e.g., Philippine eagle, Madagascar serpent-eagle (*Eutriorchis astur*), Madagascar red owl (*Tyto soumagnei*)) and species with restricted continental distributions are especially prone to extinction owing to small population size and vulnerability of their entire habitats to destruction by humans and introduced plants and animals. Diamond (1989) reported that about one-quarter of the planet's species of island land birds are known to have been lost in the last 2,000 years because of human activities.

White (1994) examined the status of 48 species of western Nearctic raptors (including 18 owls). He found that 24 (50 percent) of the species (including 8 owls) are considered to be in jeopardy or potentially so, but he points out that the percentage has changed little over the past two decades.

The U.S. Endangered Species Act (ESA) lists 27 raptor species (6 owls) as threatened (2) and endangered (25). Of those, only 10 (2 threatened) occur naturally in the wild in the United States or its Puerto Rican commonwealth. They are the Audubon's crested caracara (*Polyborus plancus auduboni*), California condor (*Gymnogyps californianus*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), northern aplomado falcon (*F. femoralis septentrionalis*), Hawaiian hawk (*Buteo solitarius*), Everglade snail kite (*Rostrhamus sociabilis plumbeus*), northern spotted owl (*Strix occidentalis caurina*), Puerto Rican sharp-shinned hawk (*Accipiter striatus venator*) and Puerto Rican broad-winged hawk (*Buteo platypterus brunnescens*). We question why it is necessary to include non-native species in the ESA list since they are adequately protected by various international treaties and agreements (e.g., Convention on International Trade in Endangered Species [CITES]).

In Cade and Burnham's (1990) review of all diurnal raptors in the Nearctic, at the global species level the California condor was the only one that appeared to be in danger of extinction. We listed three additional raptor species (Audubon's crested caracara, aplomado falcon and Everglade snail kite) as locally vulnerable (Table 1); that is, although the range of the species is sufficiently large to make the extinction of the species in the short-term unlikely, a population may be vulnerable within a significant portion of the Nearctic region.

Habitat and Adjustment

Although some species adjust to habitat modification and even benefit from it, the greatest threat to the survival of raptors worldwide, and especially in the tropical forests, continues to be habitat alteration. Shooting, poisoning and other forms of persecution may be the second most important factor affecting raptors in Europe and Africa, having almost eliminated several species from huge areas (Newton 1979). Certainly, environmental contaminants (DDT/DDE and dieldrin) have been shown by their effects on the peregrine falcon, bald eagle and other species to be an important concern and should be monitored for the sake of raptors and humans.

In many tropical forest areas, habitat modification equates to removal of large segments of forest for farming and ranching, not the selective harvesting of individual trees. Typically, tropical deforestation creates a mosaic of habitats over large areas from bare eroded ground to primary forest. Some "forest raptors" utilizing these areas may exhibit different foraging behavior and prey by habitat type. For example, in Tikal National Park, Guatemala, nesting laughing falcons (*Herpetotheres cachinnans*) living in primary forest feed exclusively on snakes, while those nesting outside of the park in modified habitat capture lizards, rodents, fish and snakes (Megan Parker personal communication: 1994). Harpy eagles (*Harpia harpyja*) successfully nest in primary forest, selectively logged forests and near the forest edge (Eduardo Alvarez personal communication: 1994). These eagles seem to adjust to human activities on the forest floor. Assuming that adequate nesting trees and prey remain, unless direct persecution occurs, harpy eagles and most other tropical forest nesting raptor species may persist if areas are sufficiently large. On the other hand, habitat fragmentation resulting in isolated populations can cause population extinctions if local die outs exceed the rate of local recolonizations (Newton 1991).

Populations of some raptor species may benefit from human activities. Carefully grazed ranches appear to be excellent and possibly even preferred habitat for aplomado falcons (Sandfort 1994). Also, in part thanks to public education and increased human tolerance, some species of raptors are adjusting to exist in human-dominated environments. For example, at least 90 pairs of peregrine falcons now are breeding in 63 urban areas in North America (Cade et al. in press). Many of these peregrine falcons were not released in cities: although 11 pairs of peregrine falcons are known to nest in the greater New York City area, none of these falcons actually were released in the city. Merlins (*F. columbarius*) nest in Canadian city parks at high densities (Sodhi and Oliphant 1992). Cooper's hawks (*Accipiter cooperii*) nest in a busy park in Salt Lake City, Utah, and certainly, almost anyone feeding songbirds can attest to autumn and winter presence of accipiters in cities and suburbs (White 1994). Prairie falcons (*F. mexicanus*) and golden eagles (*Aquila chrysaetos*) use power transmission towers, and gyrfalcons (*F. rusticolus*) use oil pipelines for nesting (Roppe et al. 1989, Ritchie

1991). Harris' hawks (*Parabuteo unicinctus*) breed and accept beefsteak handouts in the suburbs of Tucson, Arizona (Richard Thorsell personal communication: 1988). In Europe, the sparrowhawk (*A. nisus*) breeds the most successfully in mid-successional forest stages and often uses city parks (Newton 1986). Goshawks (*A. gentilis*) in Europe breed in a variety of human-dominated forest environments (Cramp and Simmons 1980). One of the highest raptor nesting densities ever recorded was in Delhi, India, with 50 per square mile (19.3/km^2) (Galushin 1971). In certain instances, we may find that species that become overly abundant in human-altered environments affect and even eliminate more sensitive species, e.g., great horned owl (*Bubo virginianus*) depredation of released peregrine falcons on cliffs overlooking the Mississippi River (Garrott et al. 1993, Redig and Tordoff 1988).

Probably the best example of adjustment to habitat change is the Mauritius kestrel. This species once occupied a forested island environment and fed mainly on several species of arboreal day-geckos of the genus *Phelsuma*. As the native forest habitat diminished and many exotic species were introduced, the kestrel was reduced to only two known pairs in 1973 in the final habitat pocket. Through management of wild pairs and captive breeding and release of young into highly modified habitats, many of the kestrels changed their nesting and foraging habits in the new conditions. Today, there are more than 70 pairs in the wild, mainly in exotic or mosaic habitats, and the population is increasing without further management (Jones et al. 1995).

Management

Few places in the world have natural areas large enough to contain intact ecosystems with no need for management. Size and type of environments, as well as management goals, influence the methods to be used. Techniques for large areas may not be suitable for small areas. Species of special interest or requirements may influence management.

Although usually more cost effective and beneficial for conserving biodiversity, ''ecosystem management'' is difficult to apply to most raptor species because they occur at low density over large areas and different ecological communities. Woodruff (1989) recognized four levels of management for species. (1) The first level is management where the species occurs as part of ecosystem maintenance, the result from which benefits more than just the target species. These species typically would occur over large geographical areas, e.g., aplomado falcon and harpy eagle. (2) The next level is management of species that occur primarily in parks and reserves that may need to be protected or have habitat managed, e.g., Philippine eagle. (3) Level three includes species such as the California condor which depend heavily on captive breeding and release. (4) The final level of management and species conservation is use of cryopreservation and future advanced technology. The cost of a species conservation program is estimated to increase 10-fold to 10,000-fold at each of the first three levels of management (Conway 1986). The cost of the fourth level presently is incalculable for raptors. Obviously, it is much better to manage and conserve species at level one than level three. In that way, we maximize distribution and abundance with minimum cost and effort, thus giving the best chance of long-term persistence.

For effective raptor population management, the environmental factors that limit population size must be known (Newton 1991). There is no sense trying to improve reproduction or survival or add rehabilitated individuals if the habitat will not support more animals and the surplus must inevitably die or leave. Also, some habitats act as population "sinks," where mortality exceeds reproduction (Pulliam 1988). Habitat quality and quantity determine the maximum number of animals that can be supported in an area. Factors that influence reproduction and mortality determine whether animal populations will be at the maximum numbers set by the environment or below those levels. Habitats may deteriorate because of reduction in amount or quality of food, cover or breeding sites, and, thus, lead to reduced population levels. Mortality and reproduction may be affected by starvation, predation, disease, environmental contamination, human disturbance in nesting or foraging areas, weather (short-term and long-term), catastrophic events and other factors.

Species recovery plans are prescribed in the United States ESA for "threatened and endangered" species, but they too often are static rather than dynamic documents and may be outdated by the time they are adopted. Species recovery goals in many plans, e.g., American peregrine falcon and bald eagle (Craig 1985, Steenhof 1986), establish certain reproductive rates as criteria for recovery and down-listing or total delisting. As pointed out above, reproduction independent of information about mortality and carrying capacity of habitat is of limited value in evaluating a species' biological stability or status. Breeding peregrine falcon populations increased in France with a reported reproductive rate of only 0.70 young per territorial pair (Monneret 1988) but remained stable with a rate of 1.73 young in Spain (Heredia et al. 1988). The key questions for recovering jeopardized species are: (1) which resources or other factors are depressing the species or population (natural or human restraints); (2) where in the annual cycle does the limiting effect occur; and (3) how can the depressing factor(s) be removed or mitigated? For some species, we also may add a fourth question—can we help it adjust to survive in an altered world?

Mortality, including human persecution, of the potentially very long-lived, later maturing and slow-reproducing large raptors (and other birds) can contribute importantly to population declines. Shooting of harpy eagles may be an important factor contributing to population declines. Mathematical modeling of adult bald eagle and wandering albatross (*Diomedea exulans*) populations emphasizes the effect of mortality. Holding survival constant and reducing bald eagle reproduction by 75 percent led only to a negative population change of about 12 percent per year. Decreasing adult survival by 33 percent led to a 32-percent annual population decrease (Grier 1980). An albatross population went into decline with only about a 2-percent decrease in adult survival (from an annual average rate of around 96 to 94 percent), despite an increase in reproduction (Croxall et al. 1990). Even when the extra mortality has been removed, slow breeding rates may mean that such species take many years to recover their numbers.

Rehabilitation and release projects for injured raptors are much more likely to contribute meaningfully to conservation of populations by focusing on eagles, large vultures and condors. For medium and smaller raptors (hawks, falcons, owls, etc.), rehabilitation and release of single or even dozens of raptors provide very limited, if any, benefits to wild populations, unless the species are extremely rare and releases are focused geographically and accomplished expertly where available vacant habitat exists.

To maintain isolated populations, hands-on management such as repeated translocation of individuals may need to be considered. For example, the Philippine eagle has only been known to exist on 4 of the more than 7,000 islands of the Philippines. On these four islands, the eagle's habitat now is highly fragmented, and no single forest fragment may be large enough to maintain a self-sustaining population. Knowing the demography of these small populations and movements of individuals between fragments is important in assessing whether these populations can be maintained. For the Philippine eagle to survive, it may be necessary to manage isolated populations collectively on each island and in concert with a captive breeding population. In time, we could have the same situation for harpy eagles, and probably already do in the northern part of its range in Central America. Throughout the harpy eagle's range, well-managed, selectively logged, long-cycle, commercial forestry over large, contiguous forest concessions, combined with parks and reserves, as they occur, may provide the best chance for the eagle and the forest to survive. This scenario only is likely to occur, however, if local people benefit from timber harvest, the forest's current and probable future primary economic value, and are not left to scramble for minor economic forest products which ultimately result in no forest (Dove 1993).

Knowledge

How much knowledge is needed to ensure survival of a species? The ultimate answer probably is the more the better. The proximate answer may be an understanding of the organism's basic biological and ecological requirements, including density in certain habitats and, of course, for management, environmental factors limiting numbers. The minimal required knowledge may be having enough information to determine species' range and to estimate numbers. With such information in hand, subsets of the species population then should be monitored regionally for changes in density and long-term trends. Each population subset need not be visited every year, but instead every three to five years.

Biotic systems are not static but dynamic, and basing conclusions on limited temporal, spatial and numerical considerations can be misleading. The U.S. Fish and Wildlife Service received a petition in May 1991, to classify the ferruginous hawk (*Buteo regalis*) as an "endangered species" under the ESA. Although numbers of ferruginous hawks declined in certain local areas in the United States in the past decade, numbers of breeding ferruginous hawks located in Canada increased (White 1994). Only when a wide-ranging species experiences major regional reduction in numbers or where unique genes may be lost should "endangered" status be considered for particular intraspecific populations of a widespread species (see Hunter and Hutchinson 1994 for other reasons).

We have a wealth of knowledge on raptors of the Nearctic compared with those of other biogeographical regions; however, we do not recommend that raptor research cease in the Nearctic. There are many gaps in our knowledge, and personal or organizational interest, financial resources and societal concerns will limit and direct biologists' activities and opportunities for research. There is nothing wrong with conducting research just because we enjoy it or to satisfy our scientific curiosity. That is what basic science is all about; however, we do encourage biologists, as feasible, to consider focusing more on species that are "little known and needing study" (Table 1) and in geographical "hotspots." The term "hotspots" originally was used for plants by N. Myers (1988) to identify areas of high biodiversity and environmental degradation and later adapted by ourselves for raptors (Table 2, Cade and Burnham 1990) and for all birds by ICBP (Bibby et al. 1992). Although tropical rain forests contain a high diversity of raptors, tropical savannas and dry forest habitat should not be ignored (Table 2). In any habitat, long-term, in-depth studies on species can produce valuable and, many times, otherwise unattainable information, especially with keystone species. Alternatively, gathering as much information as possible on many little-known species may have a greater short-term benefit for realizing conservation needs (Ehrlich 1992).

Lack of knowledge, however, is not the major obstacle to more effective conservation. It is a trivial factor compared with human population growth and behavior. If the latter problems could be rectified, biodiversity could be preserved with existing knowledge. It is because they have not been rectified that more knowledge is essential in conservation.

Predictions and Recommendations

Species that are most likely to be or are soon to become jeopardized and that should be prioritized for research and possibly conservation management are: (1) species occurring in "hotspots"; (2) those occurring only on islands (including habitat islands, e.g., Sokoke scops owl (*Otus ireneae*) reported to be limited to a single 43-square mile [111 km^2] forest [Virani 1994]); (3) those that are likely to be rare based on large body size and large home range size; and (4) little-known or less-studied species.

Based on our current knowledge, much guessing would be required to make a list reflecting the status of all the world's raptor species in order to prioritize research and conservation. Lists based on limited data and guesswork can, through use, become fact and even the basis for law. For example, a potential result might be more raptor species being added to Appendix I ("endangered") of CITES. Not only would that add further confusion and frustration regarding endangered species, it would mean further permitting complications for systematists working internationally and wishing to return home with a minute sample of blood for DNA analysis or a whole specimen, or for a biologist desiring to import a live bird for captive breeding. CITES was developed to focus on international commercial traffic in endangered species, but its application has gone well beyond commerce. We are not aware that the survival of a raptor species ever has been threatened by commercial exploitation, nor have CITES regulations ever contributed positively to the conservation of a single raptor species, although 15 diurnal raptor species are included on Appendix I and all Falconiformes are included on Appendix II ("threatened species").

Building Local Capacity

Researchers, especially those working internationally, have a responsibility and opportunity beyond developing knowledge. They also should develop local capacity for conservation and science. Knowledge of a species, or even an ecosystem, does little good in-country if there are no capable people there to make use of it. In 1987, The Peregrine Fund established the *Maya Project* which uses raptors for conservation and ecological monitoring of biodiversity in the contiguous forests of northern Guatemala, southern Mexico and western Belize. Beyond inventory, monitoring and species-level research, more than 100 Latin Americans have received biological training and dozens of scholarships have been provided for high school through

Table 2 (part A). Some island "hotspots" for high biodiversity, including diurnal birds of prey (Cade and Burnham 1990).

Island	Total raptor species	Total endemics
Philippines	25	4
Borneo	27	1
Java	20	1
Sulawasi (Celebes)	24	6
New Guinea	25	7
New Britain	13	4
Madagascar	16	8

Table 2 (part B). Three megadiversity countries for comparison (Cade and Burnham 1990).

Country	Number of species	Percentage
Kenya	72	77.4 percent of all Ethiopian species
Mexico	56	61.5 percent of all Neotropical species
Costa Rica	53	58.2 percent of all Neotropical species

graduate degrees (Burnham et al.1994). The same blueprint combining science and conservation (including developing local capacity) also is being used successfully in Madagascar by The Peregrine Fund. In Kenya, conservationists combine human resource development with raptor conservation in human-dominated environments, "living with wildlife," through public education (Burnham and Cade 1994). In these projects, the ultimate goal is to conserve nature and eliminate the need for expatriate involvement.

Summary and Conclusion

A species is a unique form of life. Each biological species is made up of one or more populations of its own kind. A population is a demographic (and genetic) unit that interbreeds and is separated sufficiently from other interbreeding units of the species so that changes in its size do not necessarily affect other units and vice versa (Ehrlich and Daily 1993). To prevent extinctions of species, viable populations must be preserved. Threatened populations are of greater concern than vanishing species throughout much of the world, but especially so in the tropics. Preserving (and even restoring) habitat is the highest priority to conserve populations and all biodiversity, including raptors. Human persecution and environmental contamination are next in importance. Species isolated by geography or habitat are of special concern. To preserve populations of many raptor species we must work locally, regionally, nationally and internationally and consider their needs throughout the year, including during any seasonal movements. Public awareness and education demonstrating the value of raptors and nature are very important.

As parks and preserves are too small to maintain viable populations of many raptors, human-dominated environments probably are the best hope and greatest challenge for conserving raptors. Management decisions and options, including no management, should be made at the population and even species or community level (or higher) with a clear goal in mind. If the goal is to increase numbers, biologists should know what environmental factors restrict population size. For extremely rare, jeopardized species and/or those that are long-lived, working with individual birds or pairs of birds may benefit populations, but for more common species, intensive management, including rehabilitation of individuals, probably is insignificant to population maintenance. Management should include long-term monitoring of subsets of populations and communities for distribution, abundance and trends over as large a geographic scale as possible. Knowledge of each species is important for effective management action and conservation. Worldwide, the biology, ecology and status of many raptor species are little-known and need to be studied.

Options continually diminish for conservation of biological diversity and natural resources. Conservationists must be organized and opportunistic. Decisions about conservation of nature should be made expeditiously and be based on the best science available with realistic consideration of human needs, not on the sophistry and emotional rhetoric, or financial clout of special interests. Nature must be perceived to have value, especially by local people who should be involved in its care, if it is to continue to exist throughout much of the world. Possibly the most important thing society can do to conserve nature is to improve the socio-economic condition of people (urban and rural) while, at the same time, educating them about the need for human population reductions and the life (and death) processes required to maintain human, animal and plant societies and why conservation of nature and all natural resources benefits them and their families' well-being. Extreme viewpoints (preservation or overexploitation) can be disastrous.

The complexities of government, and especially wildlife regulations and laws, frequently discourage and hinder biologists. With necessary but minimal government regulation, private enterprise, even more than governments, can be instrumental in establishing sustainable use, conserving nature and biodiversity, and maintaining environmental health (ecological integrity) as part of responsible business practices.

Raptors are an integral part of our natural world and their conservation can contribute importantly to conserving the world's diversity of life and other natural resources. Although the biosphere is not just a collection of species, but instead a network of relationships, wildlife, including raptors, help sustain ecosystems (Perry 1993). With adequate knowledge, capable local scientists and managers, and realistic and effective management, we probably can preserve all raptor species and their necessary environments if we act soon enough. These short-range measures will not work indefinitely, however, without curbing human population growth and achieving a global, steady-state economy (James 1994).

Acknowledgments

We thank the following individuals for their constructive review of this paper: Frank Bond, Kent Carnie, Jeff Cilek, James Grier, Lloyd Kiff, Ian Newton, Richard Watson and Clayton White. We also thank Pat Burnham for her many improvements and contributions to the paper.

References

Acorn, J. B. 1993. Indigenous peoples and conservation. Conserv. Biol. 7: 424–426.

Bibby, C. J., N. J. Collar, M. J. Crosby, M. F. Heath, C. Imboden, T. H. Johnson, A. J. Long, A. J. Stattersfield and S. J. Thirgood. 1992. Putting biodiversity on the map: Priority areas for global conservation. Int. Coun. for Bird Preserv. 90 pp.

Brown, L. and D. Amadon. 1968. Eagles, hawks and falcons of the world. Vols. 1 and 2. McGraw-Hill Book Co., New York, NY. 414 pp.

Brussard, P. F., D. D. Murphy and C. R. Tracy. 1994. Cattle and conservation biology—Another view. Conserv. Biol. 8: 919–921.

Burnham, W. and T. Cade. 1994. Newsletter No. 24. The Peregrine Fund. Boise, ID. 20 pp.

Burnham, W. A., D. F. Whitacre and J. P. Jenny. 1994. The Maya Project; Use of raptors as tools for conservation and ecological monitoring of biological diversity. Pages 257–264 *in* B.-U. Meyburg and R. D. Chancellor, eds., Raptor conservation today. WWGBP/The Pica Press. 799 pp.

Cade, T. J. 1985. Statement of Dr. Tom J. Cade, Professor of Ornithology and President, The Peregrine Fund, Inc. Pages 497–503 *in* 'Endangered Species Act,'' hearings before the Subcommittee on Fisheries and Wildlife Conservation and the Environment. House of Representatives. Serial No. 99–100. Govt. Print. Off., Washington, D.C.

Cade, T. and W. Burnham. 1990. The Peregrine Fund's World Program. The Peregrine Fund, Boise, ID. 41 pp.

Cade, T. J., M. Martell, P. Redig, G. Septon and H. Tordoff. In press. Peregrine falcons in urban North America. *In* D. M. Bird, D. E. Varland and J. J. Negro, eds., Raptor adaptations to human influenced environments. Academic Press, London.

Chancellor, R. D. and B.-U. Meyburg, eds. 1986. Western Hemisphere meeting of the World Working Group on Birds of Prey. World Working Group on Birds of Prey and Owls. 211 pp.

Conway, W. 1986. The practical difficulties and financial implications of endangered species breeding programs. Intl. Zoo Yearb. 24/25: 210–219.

Craig, G. R., ed. 1985. American peregrine falcon recovery plan, Rocky Mountain southwest populations, first revision. U.S. Dept. Inter., U.S. Fish and Wildl. Serv. 105 pp.

Cramp, S. and K. E. L. Simmons, eds. 1980. The birds of the western Palearctic. Vol. II. Oxford Univ. Press, New York, NY. 695 pp.

Croxall, J. P., P. Rothery, S. P. C. Pickering and P. A. Prince. 1990. Reproductive performance, recruitment and survival of wandering albatrosses *Diomedia exulans* at Bird Island, South Georgia. J. Anim. Ecol. 59: 775–796.

Diamond, J. 1989. Overview of Recent Extinctions. Pages 37–41 *in* D. Western and M. Pearl, eds., Conservation for the twenty-first century. Oxford Univ. Press, New York, NY. 365 pp.

Dove, M. R. 1993. A revisionist view of tropical deforestation and development. Environ. Conserv. 20(1): 17–56.

Egede, I. 1994. Universal ethics and IUCN. The Conserv. Digest. 1(4): 7.

Ehrlich, P. R. 1992. Population biology of checkerspot butterflies and the preservation of global biodiversity. Oikos 63(1): 6–12.

Ehrlich, P. R. and G. C. Daily. 1993. Population extinction and saving biodiversity. Ambio 22(2–3): 64–68.

Galushin, V. M. 1971. A huge urban population of birds of prey in Delhi, India. Ibis 113: 522.

Garrott, R. A., P. J. White and C. A. Vanderbilt White. 1993. Overabundance: An issue for conservation biologists? Conserv. Biol. 7: 946–949.

Grier, J. W. 1980. Modeling approaches to bald eagle population dynamics. Wildl. Soc. Bull. 8: 316–322.

Heredia, B., F. Hiraldo, L. M. Gonzalez and J. L. Gonzalez. 1988. Status, ecology, and conservation of the peregrine falcon in Spain. Pages 219–226 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Inc., Boise, ID. 949 pp.

Hunter, M. I. and A. Hutchinson. 1994. The virtues and shortcomings of parochialism: Conserving species that are locally rare, but globally common. Conserv. Biol. 8:(4) 1,163–1,165.

James, P. O. 1994. On economic growth and ecological decay. Conserv. Biol. 8(4): 1,161–1,162.

Jones, C. G., W. Heck, R. E. Lewis, Y. Mungroo, G. Slade and T. Cade. 1995. The restoration of the Mauritius kestrel population. Ibis (suppl.). 137: 5, 173–5,180.

King, W. B., tech. coord. 1979. Red data book. Vol. 2. Int. Coun. for Bird Preserv., Morages, Switzerland. 501 pp.

Monneret, R.-J. 1988. Changes in the peregrine falcon populations of France. Pages 201–213 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Inc., Boise, ID. 949 pp.

Myers, N. 1988. Threatened biotas: ''Hotspots'' in tropical forests. The Environmentalist 8(3): 1–20.

National Archives and Records Administration. 1990. Code of federal regulations. Parts 1 to 199. U.S. Govt. Print. Off., Washington, D.C. 706 pp.
Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, SD. 399 pp.
———. 1986. The sparrowhawk. T.I.A.O. Poyser Ltd., Carlton, England. 396 pp.
———. 1991. Concluding remarks. pages 637–654 *in* C. M. Perrins, J.-D. Lebreton and G. J. M. Hirons, eds., Bird population studies. Oxford Univ. Press, New York, NY. 683 pp.
Parsons, R. 1994. Sustainable use guidelines not adopted by IUCN. The Conserv. Dig. 1(4): 2–3.
Perry, D. A. 1993. Biodiversity and wildlife are not synonymous. Conserv. Biol. 7: 204–205.
Redig, P. T. and H. B. Tordoff. 1988. Peregrine falcon reintroduction in the upper Mississippi valley and western Great Lakes region. Pages 559–563 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Inc., Boise, ID. 949 pp.
Ritchie, R. J. 1991. Effects of oil development of providing nesting opportunities for gyrfalcons and rough-legged hawks in northern Alaska. Condor 93: 180–183.
Roppe, J. A., S. M. Siegel and S. E. Wilder. 1989. Prairie falcon nesting on transmission towers. Condor 91: 711–712.
Pulliam, R. 1988. Sources, sinks and population regulation. Am. Natural. 132: 652–61.
Sandfort, C., ed. 1994. Northern aplomado falcon restoration. The Peregrine Fund, Inc., Boise, ID. 105 pp.
Schmidheiny, S., ed. 1992. Changing course: A global business perspective on development and the environment. MIT Press, MA. 374 pp.
Sharma, R. 1989. People's participation in sustainable development. Ecoforum. 14(1): 3.
Sodhi, N. S. and L. W. Oliphant. 1992. Hunting ranges and habitat use and selection of urban-breeding merlins. Condor 94: 743–749.
Steenhof, K., ed. 1986. Pacific bald eagle recovery plan. U.S. Dept. Int., U.S. Fish and Wildl. Serv. 163 pp.
Virani, M. 1994. Ecology of the endangered Sokoke scops owl. M.S. thesis. Univ. Leicister, England.
Walsberg, G. E. 1994. The use of wild birds in research. Condor 96: 1,119–1,120.
Western, D., M. C. Pearl, S. L. Pimm, B. Walker, I. Atkinson and D. S. Woodruff. 1989. An agenda for conservation action. Pages 304-323 *in* D. Western and M. Pearl, eds., Conservation for the twenty-first century. Oxford Univ. Press, New York, NY. 365 pp.
White, C. M. 1994. Population trends and current status of selected western raptors. Pages 161–172 *in* J. R. Jehle and N. K. Johnson, eds., Studies in avian biology, No. 15(161): 161–172.
Woodruff, D. S. 1989. The problems of conserving genes and species. Pages 76-88 *in* D. Western and M. Pearl, eds., Conservation for the twenty-first century. Oxford Univ. Press, New York, NY. 365 pp.

Raptors, Technological Tools and Conservation

Mark R. Fuller
U.S. National Biological Service
Raptor Research and Technical Assistance Center
Boise, Idaho

William S. Seegar
Edgewood Research Development and Engineering Center
Aberdeen Proving Ground, Maryland

John M. Marzluff
Greenfalk Consultants
Boise, Idaho

Brett A. Hoover
U.S. National Biological Service
Inventory and Monitoring
Laurel, Maryland

Introduction

Most owls, hawks, falcons, eagles and vultures, as top predators and scavengers, are widely dispersed across the landscape and use large areas through which they can fly quickly. Owls also commonly are crepuscular or nocturnal. These characteristics of raptors make them difficult to study. Technology such as radio telemetry provides tools and methods for overcoming some of these difficulties.

Radio telemetry is used widely for wildlife studies. Kenward (1987) provides a good basis for the topic. White and Garrott (1990) concentrate on study design and analytical methods. Samuel and Fuller (1994) provide a condensed overview of study design considerations, equipment, field procedures and analytical techniques. Herein, we present examples of how radio telemetry technology has been used to address raptor conservation issues. Then we review some innovations in technology and methodology, including examples from our recent research.

Traditional Radio Tracking

Southern (1964) apparently was the first to apply radio telemetry to raptors in his study of bald eagle (*Haliaeetus leucocephalus*) winter behavior. Nicholls and Warner (1972) were first to radio mark owls for their study of home range and habitat use. The most common uses of radio marking include finding the raptors to observe them, or gathering home range or habitat use data by repeatedly estimating their locations. Location estimates usually are obtained by homing toward the radio signal or by triangulating from two or more receiver positions with directional receiving antennae (Samuel and Fuller 1994). For example, data from radio-marked burrowing owls

(*Athene cunicularia*) allowed Haug and Oliphant (1990) to recommend conservation of open shortgrass prairie habitat for nesting and nearby denser foraging habitat in Saskatchewan. Bloom et al. (1993) radio tracked red-shouldered hawks (*Buteo lineatus*) in selected woodland habitats in an average home range of 1.2 square kilometers. The hawks showed adaptability to human activity in southern California, and the authors concluded that land-use planning could readily accommodate management for red-shouldered hawks.

California condors (*Gymnogyps californianus*) represent an extreme in ranging behavior. Meretsky and Snyder (1992) usually radio tracked California condors on daily foraging flights within 70 kilometers of a roost or nest, but occasionally the birds flew more than 200 kilometers. Radio tracking from prominent topographic features, cars and aircraft facilitated locating individual condors. Radio tracking was a supplemental tool to intensive observation of the last wild birds and helped to find injured or dead condors. Radio telemetry was used on Andean condors (*Vultur gryphus*) that were released in southern California (to learn about the effectiveness of release methods and about threats). California condors now are being released from the captive propagation program (Wallace and Toone 1992) and radio tracked.

Radio telemetry is an efficient technique for closely monitoring individuals in intensively studied or managed "populations." Radio tracking facilitated study of the behavior and causes of death of captive-bred peregrine falcons (*Falco peregrinus*) that were released in the species recovery effort in North America (Sherrod et al. 1981). It has been used to study released goshawks (*Accipiter gentilis*) in Great Britain (Kenward et al. 1981) and goshawks and prey in an intensively managed system in Sweden (e.g., Kenward et al. 1992). Hegdal and Colvin (1988) radio marked five raptor species to assess the potential for secondary poisoning from rodenticides. Buehler et al. (1991) learned that radio-marked bald eagles in the northern Chesapeake Bay made little use of developed shoreline or areas where human activity occurred. Andersen et al. (1990) used telemetry to study raptor movements in relation to military training in Colorado.

Telemetry also is being used to study raptors in relation to military training in the Snake River Birds of Prey National Conservation Area (SRBOPNCA) in Idaho (Marzluff et al. 1993). We radio marked about 120 prairie falcons (*Falco mexicanus*) during four breeding seasons and accumulated location estimates to relate to real-time military training, vegetation patterns, prey distributions and other environmental variables. The activity and home ranges of individual falcons will be analyzed in this context. Also, we are interested in the use patterns of our random sample of the local population. For this purpose, we use a splining subroutine in Arc/Info software (Arc/Info, Environmental Systems Research Institute, Inc., Redlands, California) to produce a contour map of prairie falcon spatial use of the study area (Figure 1). Our Geographic Information System enables us to identify areas of high to low use by falcons, and to relate them to land-use patterns and management options.

The conservation of forest raptors currently is receiving considerable attention. Hayward and Garton (1984) radio marked boreal (*Aegolius acadicus*) and screech owls (*Otus asio*) in the River of No Return Wilderness Area in northcentral Idaho. They homed to the radio signal to find the owls in roosts, then measured the roost and surrounding habitat. Hayward et al. (1993) gathered movement data to delineate home ranges (> 1,000 ha) and winter ranges ($\bar{x}$ 1,451 ha) of boreal owls in the western United States subalpine forests. Reynolds and Linkhart (1992) radio tracked

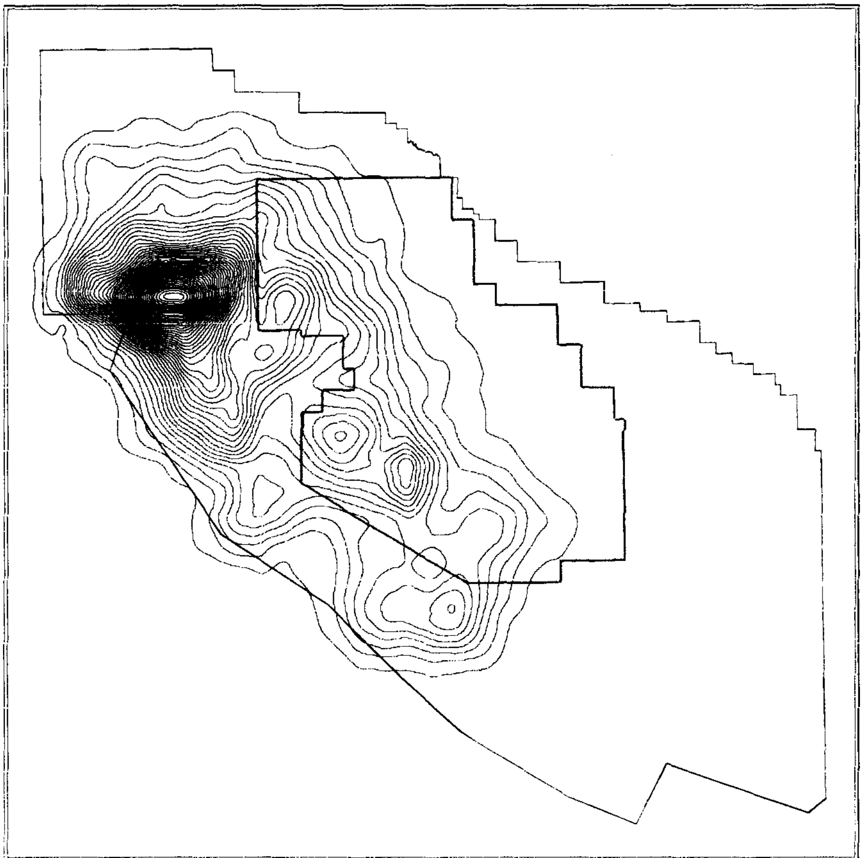


Figure 1. Prairie falcon use of the Snake River Birds of Prey study area and military Orchard Training Area (internal border), contours of use were created from a splining routine in a Geographic Information System.

flammulated owls (*Otus flammeolus*) in Colorado and found that they used several intensive foraging areas of only 1 to 4 hectares in which they hunted insects. Bull et al. (1988a, 1988b) radio tracked great gray owls (*Strix nebulosa*) across home ranges that averaged 67.3 square kilometers for adults and 139 square kilometers for juveniles during their first year in northeastern Oregon's forests. These radio telemetry results were used in the U.S. forest Service Technical Conservation Assessment (Hayward and Verner 1994) for flammulated, boreal and great gray owls.

The northern goshawk, a forest-dwelling species, is being considered for threatened or endangered status in the United States. There is a paucity of information about the home range requirements and foraging habitat of the secretive hawk, but some recent radio tracking revealed that in eastern California, northern goshawks range up to 3.5 kilometers from the nest to hunt from large trees with extensive canopy cover that occur among a diversity of habitat patches (Hargis et al. 1994). Radio-marked, male goshawks in northcentral New Mexico used an average of 2,106 hectares, females 569.3 hectares, and juveniles from 200 to 800 meters around the nest during an eight-week post-fledging period (Kennedy et al. 1994). These data are being incorporated in conservation assessment and strategy plans for the U.S. Forest Service (R. Reynolds and R. Rodriguez personal communication: 1995), and the Upper Columbia River ecosystem (R. Howard personal communication: 1995). Ongoing radio tracking of northern goshawks on the Tongass National Forest (K. Titus personal communication: 1995) provides data for the revised forest management plan (C. Iverson personal communication: 1995). In forested, mountainous landscapes, radio telemetry is the best way to obtain data about the area and habitats required by northern goshawks.

The spotted owl (*Strix occidentalis*) has been the focus of intensive management and policy making. Some birds have been radio marked to study home range size and habitat selection, especially in relation to forestry management practices (Carey et al. 1990, Call et al. 1992). Solis and Guiterrez (1992) described spotted owl habitat based on telemetry data. A subsequent study of nest and roost sites, found by using imitated calls, revealed similar results (Blakesly et al. 1992). However, the use of harnesses to attach backpack transmitters to spotted owls is not recommended by some biologists because their radio-marked birds had lower productivity than banded owls (Foster et al. 1992).

Potential Effects on Birds

Biologists should assume that radio marking effects birds. Some birds have obvious behavioral responses to transmitters and attachment devices (White and Garrott 1990); all birds expend energy to carry the extra mass (Pennycuick et al. 1989) and some radio marking increases aerodynamic drag (Obrecht et al. 1988) or otherwise affects energy expenditure (Gessaman et al. 1991). "High-tech" wind tunnels, measuring devices (e.g., strain gauge transducers), high-speed video, and computing have enabled measurements of these effects. Also, a model is available for estimating some potential effects (Pennycuick 1989). Tail-feather mounts and backpack harness attachments are used most commonly for radio marking raptors (Kenward 1987, Samuel and Fuller 1994). Careful selection of an attachment method, practice on live birds and, if required, some innovation and testing can minimize potential effects of radio marking raptors (Snyder et al. 1989, Kenward and Walls 1994, Wallace et al. 1994, Buehler et al. in press). The effect of radio marking can vary with weather of prey availability, making it difficult to assess effects on a raptor by season, year, or age or sex class (M. Vekasy, J. Marzluff, M. Kochert, K. Steenhof, and R. Lehman personal communications: 1995).

Innovations

Technology was the basis for innovative raptor telemetry methods such as automatic radio tracking systems used to study barred owls (*Strix varia*) (Nicholls and Warner 1972) and griffon vultures (*Gyps fulvus*) (Bogel 1991). Today's more reliable transmitters and sensors can be used to detect and estimate mortality (e.g., Kenward and Walls 1994). Sensors have been used to detect altitude (Bogel and Burchard 1992), gastric motility (Kuechle et al.1987), heart rate (Sawby and Gessaman 1974), temperature and movement (Kenward 1987). Individually coded transmitters (all the same frequency) and an automatic receiving station were used to sample the duration of stopover by migrating peregrine falcons (Howey et al. 1989). Cochran (1975) radio tracked migrant raptors, in part from aircraft. Aerial tracking can be very effective for locating wide-ranging raptors on their breeding areas, winter areas (Buehler et al. 1991) or on migration stopover areas (Hunt and Ward 1988), but it is difficult and expensive for following migrants.

Tracking Via Satellites

By the mid-1980s, serious development was underway to produce transmitters powerful enough to send signals to receivers in the Argos polar orbiting satellites, but small enough to be carried by birds (Fuller et al. 1984). The first field trial was conducted with a subadult bald eagle (Strikwerda et al. 1986). Additional field trials were conducted on bald eagles, a golden eagle and a gyrfalcon, as the transmitter was reduced in size and made more reliable (Howey 1992, Grubb et al. 1994). As the technology became available, other trials were conducted with griffon vulture (Griesinger et al. 1992), lesser spotted eagles (Meyburg et al. 1993 and a Steller's sea eagle (Meyburg and Lobkov 1994).

Now, tracking via satellite has been applied to several raptor conservation issues. In Glacier Bay National Park and Preserve, Mary Kralovec supplemented conventional telemetry data with location estimates from satellites (Kralovec 1994). She studied the seasonal movements of bald eagles in relation to streams and rivers that potentially could be affected by proposed mining activity. Near James Bay in Quebec, Serge Brodeur investigated the movements of breeding golden eagles with location estimates from satellites. This area is being developed for hydropower. Brodeur and DeCarie (1993) tracked the eagles from their breeding range, along their migratory routes to their wintering areas in the United States and their return to Quebec.

We have just completed study of winter range use by golden eagles in relation to land use in the SRBOPNCA. Here, resident birds are joined by migrants on the military Orchard Training Area. Tracking via satellite allowed us to document local use areas and follow the migrants' northward flights in the spring (Figure 2). Computing with analytical software, such as Ranges (Kenward 1990) and Arc/Info, exemplifies technology that facilitates telemetry data management, analyses and display (also see Chandler et al. 1994).

Currently, we are studying the migrations of peregrine falcons that breed in Greenland, Canada, Alaska and northwestern Russia. Tracking via satellite provides regular samples along flight paths regardless of the remoteness of an area or international boundaries. Computer technology and mapping software (Figure 3; Mapitt, Allison Software, Apollo, Pennsylvania) allow us to obtain data on-line from Argos and immediately plot locations. With these technologies, we readily can identify areas where birds are staging or "wintering." By integrating these technologies with other satellite technology, the Global Positioning System, personnel can go to the field location, observe the bird, measure habitat, etc.

Methodological Considerations

Radio-tracking technology must be used carefully. In particular, users must consider the error associated with location estimates, which is affected by: equipment, observ-

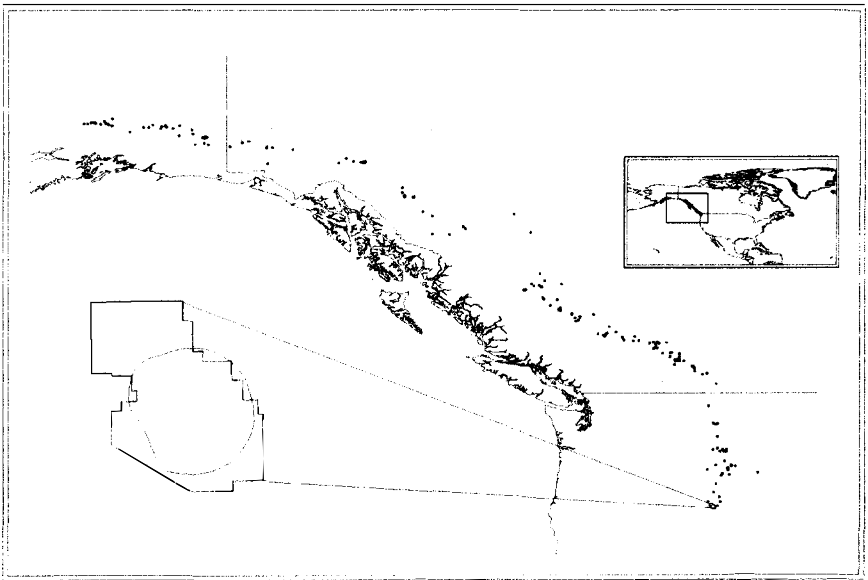


Figure 2. Golden eagle winter use of the military Orchard Training Area, Idaho, and spring migration path. Location estimates were obtained from a radio-marked bird, using the Argos satellite system.

ers, weather, electrical interference, topography, vegetation, animal movement and signal bounce (White and Garrott 1990). Location accuracy and precision within and among study areas can vary greatly.

Perhaps the most important factor affecting telemetry error in studies of raptors is their ability to quickly cover large areas. For a given angle of error (the difference of the observed bearing from the known bearing), the farther the distance from the transmitter to receiver, the larger the linear error (distance from estimated to known location). Our recent studies of prairie falcons in Idaho illustrate the problem. Six radio trackers were strategically positioned to surround and simultaneously triangulate (using directional antennae to obtain two or more bearings from receiver sites toward the transmitter) on falcons. Nevertheless, we typically could define a bird's location only within 1.5 square kilometers because falcons, on average, were 29 kilometers from receiver sites (Marzluff et al. 1993, B. Kimsey and J. Marzluff personal communications: 1995). Signal bounce is another important factor. Chu et al. (1989) reported point estimates (based on two bearing intersections) to be as far as 9 kilometers away from transmitters at known locations in forest habitat where signal bounce was common.

Precise location estimates can be obtained even when the distances between trackers and birds are great. However, researchers need to be able to assess the accuracy of each estimate as it is taken to be certain that a suitable number of accurate locations are obtained. This was done in our prairie falcon study by entering bearings from each tracker to each bird in the field on a laptop computer. A computer program, that we named OTA, facilitates data input, allows real-time analysis of telemetry data, and graphically displays location estimates and error areas on maps of the study

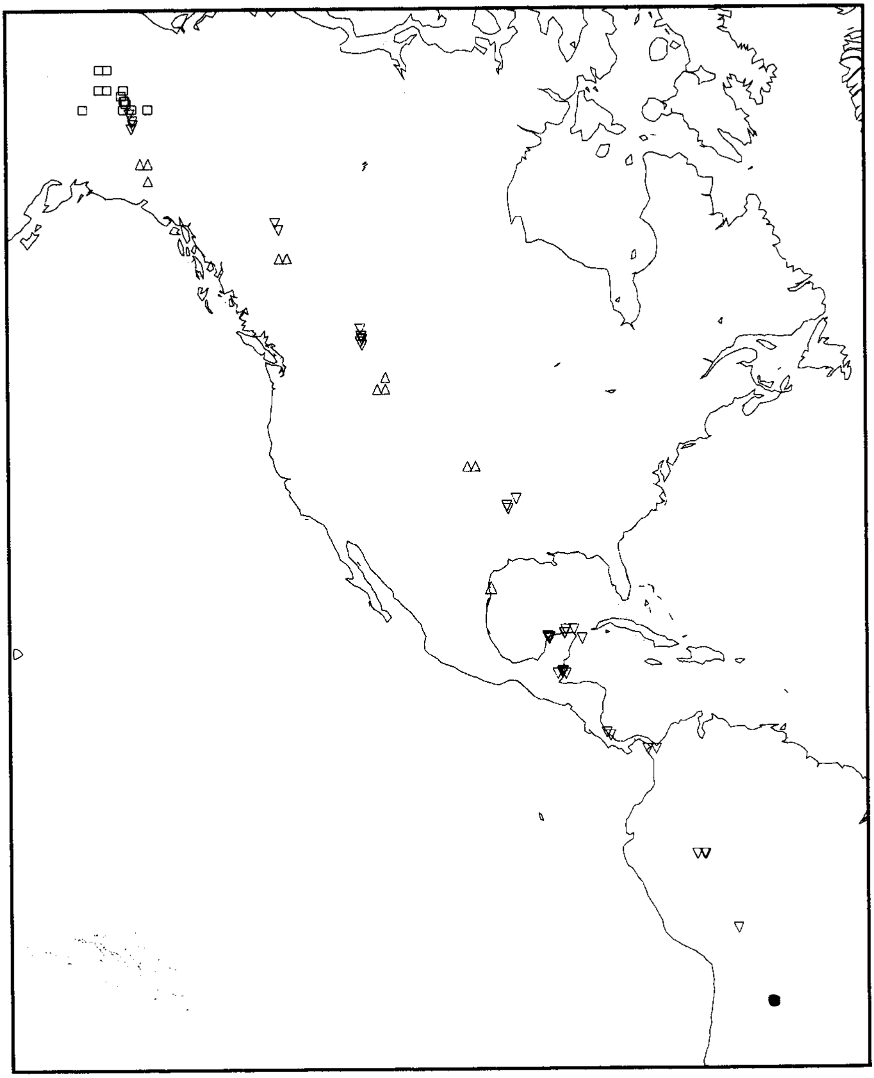


Figure 3. Female peregrine falcon spring migration (△), breeding season distribution (❑), and autumn migration (▽), and "winter" area (*). Location estimates were obtained from a radio-marked bird using the Argos satellite system.

area. We use two-way radio communication to coordinate the efforts of researchers taking the bearings, and determine, on the spot, if the estimate meets predetermined accuracy criteria. If it does not, the researchers can be directed to take additional bearings.

OTA is based on the commonly accepted method of using the maximum likelihood estimator or a modification that is robust to aberrant bearings (Lenth 1981, White and Garrott 1990). These estimators allow three or more receiving sites to be used in the estimation of an animal's position and provide a measure of precision. Recent tests suggest that Lenth's (1981) estimators do not always accurately represent the precision of an error estimate; error ellipse size correlates poorly with the distance between known and estimated locations (Kimsey and Marzluff personal communication: 1995). We advise researchers to quantify the factors that affect the precision of their error estimates by estimating the locations of transmitters at known sites throughout their study area. The results of such "beacon tests" allow refinement of Lenth's estimators and indicate the limitations of remote telemetry specific to a given study (Marzluff et al. 1994, Kimsey and Marzluff personal communication: 1995).

OTA has a routine for beacon (transmitters of known location) analyses providing statistics for accuracy and precision. OTA also has a triangulation routine for estimating locations and obtaining descriptive statistics for an animal's location. Both routines allow a choice for method of triangulation (least squares, maximum likelihood or robust maximum likelihood). In cases where only two bearings are provided, OTA provides the intersection of the two bearings as the location estimate.

OTA allows up to ten receiving sites per location estimate and each receiving site can have two bearings. OTA allows multiple coordinate files for receiver sites simplifying data management. OTA graphically displays the bearings, estimate and statistics. The user can optionally specify a map of the study area to be plotted with the estimate. Output of OTA is in ASCII (text) files that are imported easily into a database management system for further manipulation and analyses. OTA can be obtained from B.A. Hoover.

Radio telemetry and associated technology has been useful for conservation research of raptors. Advances in electronics and computing constantly provide new opportunities for biotelemetry. Biologists often can find the latest developments in wildlife biotelemetry technology and methods in proceedings from conferences (e.g., Priede and Swift 1992) and scientific journals. Also, Biotelem is a bulletin board available on Internet.

Acknowledgments

V. Hughes typed our manuscript and L. Schueck and T. Zarriello produced our figures. M. Kochert and W. Mattox provided useful comments on the draft manuscript.

References

Andersen, D. E., O. J. Rongstad and W. R. Mytton. 1990. Home range changes in raptors exposed to increased human activity levels in southeastern Colorado. Wildl. Soc. Bull. 18: 134–142.

Blakesley, J. A., A. B. Franklin and R. J. Gutiérrez. 1992. Spotted owl roost and nest site selection in northwest California. J. Wildl. Manage. 56: 388–392.

Bloom, P. H., M. D. McCrary and M. J. Gibson. 1993. Red-shouldered hawk home-range and habitat use in southern California. J. Wildl. Manage. 57: 258–265.

Bogel, R. 1991. Automatic radio tracking. Pages 115–125 *in* Acta du colloque international: Suivi des vertebres terrestres par radiotelemetrie. Principante de Monaco, 12–13 December 1988. Parc National Mercantour, Nice, France.

Bogel, R. and D. Burchard. 1992. An air pressure transducer for telemetering flight altitude of birds. Pages 100–106 in I. G. Priede and S. M. Swift, eds., Proc. 4th Eur. Conf. Wildl. Telem. Ellis Horwood, Chichester, U.K.

Brodeur, S. and R. Decarie. 1993. Etude telemetrique de l'Aigle royal (Aquila chrysaetos). Rapport Finale. G.R.E.B.E., Montreal. 109 pp.

Buehler, D. A., T. J. Mersmann, J. D. Fraser and J. K. D. Seegar. 1991. Effects of human activity on bald eagle distribution on the northern Chesapeake Bay. J. Wildl. Manage. 55: 282–290.
Buehler, D. A., J. D. Fraser, M. R. Fuller, L. S. McAllister and J. K. D. Seegar. In press. Captive and field-tested radio transmitter attachments for bald eagles. J. Field Ornithol.
Bull, E. L., M. G. Henjum and R. S. Rohweder. 1988a. Home range and dispersal of great gray owls in northeastern Oregon. J. Raptor Res. 22: 101–106.
Bull, E. L., M. G. Henjum and R. S. Rohweder. 1988b. Nesting and foraging habitat of great gray owls. J. Raptor Res. 22: 107–115.
Call, D. R., R. J. Gutierrez and J. Verner. 1992. Foraging habitat and home-range characteristics of California spotted owls in the Sierra Nevada. Condor 94: 880–888.
Carey, A. B., J. A. Reid and S. P. Horton. 1990. Spotted owl home range and habitat use in southern Oregon coast ranges. J. Wildl. Manage. 54(1): 11–17.
Chandler, S. K., J. D. Fraser, D. A. Buehler and J. K. D. Seegar. 1994. Using geographic information systems to analyze bald eagle habitat use in the Chesapeake Bay, USA. Pages 324–336 *in* B.-U. Meyburg and R. D. Chancellor, eds., Raptor conservation today. World Work. Grp. on Birds of Prey. Pica Press, East Sussex, U.K. 799 pp.
Chu, D. S., B. A. Hoover, M. R. Fuller and P. H. Geissler. 1989. Telemetry location error in a forested habitat. Pages 188–194 *in* C. J. Amlaner, ed., Biotelemetry X: Proceedings of the Tenth International Symposium on Biotelemetry. Univ. Arkansas Press, Fayetteville.
Cochran, W. W. 1975. Following a migrating peregrine from Wisconsin to Mexico. Hawk Chalk 14: 28–37.
Foster, C. C., E. D. Forsman, E. C. Meslow, G. Miller, J. Reid, F. Wagner, A. B. Carey and J. B. Lint. 1992. Survival and reproduction of radio-marked adult spotted owls. J. Wildl. Manage. 56: 91–95.
Fuller, M. R., N. Levanon, T. E. Strikwerda, W. S. Seegar, J. Wall, H. D. Black, F. P. Ward, P. W. Howey and J. Partelow. 1984. Feasibility of a bird-borne transmitter for tracking via satellite. Pages 375–378 *in* H. P. Kimmich and H.-J. Klewe, eds., Biotelemetry VIII. Proceedings of the Eighth International Symposium on Biotelemetry, Dubrovnik, Yugoslavia, May 6 to 12, 1984, Braunschweig.
Gessaman, J. A., M. R. Fuller, P. J. Pekings and G. E. Duke. 1991. Resting metabolic rate of golden eagles, bald eagles, and barred owls with a tracking transmitter or an equivalent load. Wilson Bull. 103: 261–265.
Griesinger, J., P. Bertold, U. Querner, C. Pedrocchi and E. Novok. 1992. Satellite tracking of a young griffon vulture in the north of Spain. Pages 199–200 *in* I. G. Priede and S. M. Swift, eds., Wildlife telemetry, remote monitoring and tracking of animals. Ellis Horwood, New York. 708 pp.
Grubb, T. G., W. W. Bowerman and P. H. Howey. 1994. Tracking local and seasonal movements of wintering bald eagles *Haliaeetus leucocephalus* from Arizona and Michigan with satellite telemetry. Pages 346–358 *in* B.-U. Meyburg and R. D. Chancellor, eds., Raptor conservation today. WWGBP, Pica Press, East Sussex, U.K. 799 pp.
Hargis, C. D., C. McCarthy and R. D. Perloff. 1994. Home ranges and habitats of northern goshawks in eastern California. Studies in Avian Biol. 16: 66–74.
Haug, E. A. and L. W. Oliphant. 1990. Movements, activity patterns, and habitat use of burrowing owls in Saskatchewan. J. Wildl. Manage. 54: 27–35.
Hayward, G. D. and E. O. Garton. 1984. Roost habitat selection by three small forest owls. Wilson Bull. 96: 690–692.
Hayward, G. D. and J. Verner, tech. eds. 1994. Flammulated, boreal, and great gray owls in the United States: A technical conservation assessment. Gen. Tech. Rept. RM–253. USDA For. Serv., Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 214 pp. 3 maps.
Hayward, G. D., P. H. Hayward and E. O. Garton. 1993. Ecology of boreal owls in the northern Rocky Mountains, U.S.A. Wildl. Monogr. 124: 1–59.
Hegdal, P. L. and B. A. Colvin. 1988. Potential hazard to eastern screech owls and other raptors of brodifacoum bait used for vole control in orchards. Environ. Toxicol. Chem. 7: 245–260.
Howey, P. W. 1992. Tracking of birds by satellite. Pages 177–184 *in* I. G. Priede and S. M. Swift, eds., Wildlife telemetry, remote monitoring and tracking of animals. Ellis Horwood, NY. 708 pp.
Hunt, W. G. and F. P. Ward. 1988. Habitat selection by spring migrant peregrines at Padre Island, Texas. Pages 527–535 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds.,

Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Inc., Boise, ID.
Kennedy, P. L., J. M. Ward, G. A. Rinker and J. A. Gessaman. 1994. Post-fledging areas in northern goshawk home ranges. Studies in Avian Biol. 16: 75–82.
Kenward, R. E. 1987. Wildlife radio tagging. Academic Press, London, U.K. 222 pp.
———. 1990. Ranges IV. Software for analysing animal location data. Inst. Terrest. Ecol., Wareham, U.K.
Kenward, R. E. and S. S. Walls. 1994. The systematic study of radio-tapped raptors: I survival, home range and habitat use. Pages 303–315 *in* B.-U. Meyburg and R. D. Chancellor, eds., Raptor conservation today. World Work. Grp. on Birds of Prey. Pica Press, East Sussex, U.K. 799 pp.
Kenward, R. E., V. Marcstrom and V. Karlbom. 1992. The goshawk as a predator and renewable resource. Gibier Faure Sauvage.
Kenward, R. E., M. Marquiss and I. Newton. 1981. What happens to goshawks trained for falconry? J. Wildl. Manage. 45: 802–806.
Kralovec, M. I. 1994. Movements and home range size of bald eagles from Glacier Bay National Park and Preserve, Alaska: With an analysis of satellite telemetry. M.S. thesis, Virginia Polytech. Inst. and St. Univ., Blacksburg. 167 pp.
Kuechle, V. B., M. R. Fuller, R. A. Reichle, R. J. Schuster and G. E. Duke. 1987. Telemetry of gastric motility data from owls. pages 363–366 *in* H. P. Kimmich and M. R. Neuman, eds., Biotelemetry IX. Proceedings of the Ninth International Symposium on Biotelemetry. Dubrovnik, Yugoslavia, October 26–31, 1986. Kimmich/Neuman, Braunschweig.
Lenth, R. V. 1981. On finding the source of a signal. Technometrics 23: 149–154.
Marzluff, J. M., M. S. Vekasy and C. Coody. 1994. Comparative accuracy of aerial and ground telemetry locations of foraging raptors. Condor 96: 447–454.
Marzluff, J. M., L. S. Schueck, M. Vekasy, B. A. Kimsey, M. McFadzen, R. R. Townsend and J. O. Mckinley. 1993. Influence of military training on the behavior of raptors in the Snake River Birds of Prey Area. Pages 40-125 *in*: K. Steenhof, ed., Snake River Birds of Prey National Conservation Area research and monitoring. Ann. rept., USDI Bur. of Land Manage.
Meretsky, V. J. and N. F. R. Snyder. 1992. Range use and movements of California condors. Condor 94: 313–335.
Meyburg, B.-U., W. Scheller and C. Meyburg. 1993. Satelliten-telemetrie bei einem juvenilen Schrieadler (*Aquila pomarina*) auf dem Herbstzug. J. Orn. 134: 173–179.
Meyburg, B.-U. and E. G. Lobkov. 1994. Satellite tracking of a juvenile Steller's sea eagle *Haliaeetus pelagicus*. Ibis 136: 105–106.
Nicholls, T. H. and D. W. Warner. 1972. Barred owl habitat use as determined by radiotelemetry. J. Wildl. Manage. 36: 213–224.
Obrecht, H. H., III, C. J. Pennycuick and M. R. Fuller. 1988. Wind tunnel experiments to assess the effect of back-mounted radio transmitters on bird body drag. J. Exp. Biol. 135: 265–273.
Pennycuick, C. J. 1989. Bird flight performance. A practical calculation manual. Oxford Univ. Press, New York, NY.
Pennycuick, C. J., M. R. Fuller and L. McAllister. 1989. Climbing performance of Harris' hawks (*Parabueto unicinctus*) with added load: Implications for muscle mechanics and for radiotracking. J. Exp. Biol. 142: 17–29.
Priede, I. G. and S. M. Swift, eds. 1992. Wildlife telemetry, remote monitoring and tracking of animals. Ellis Horwood, NY. 708 pp.
Reynolds, R. T. and B. D. Linkhart. 1992. Flammulated owls in ponderosa pine: Evidence of preference for old growth. Paper presented at the Workshop on old-growth forests in the Southwest and Rocky Mountain Region, Portal, Arizona, March 3–5, 1992.
Samuel, M. D. and M. R. Fuller. 1994. Wildlife radiotelemetry. Pages 370–418 *in* T. A. Bookhout, ed., Research and management techniques for wildlife habitats, Fifth ed. The Wildl. Soc., Bethesda, MD.
Sawby, S. W. and J. A. Gessaman. 1974. Telemetry of electrocardiograms from free-living birds: A method of electrode placement. Condor 76: 479–481.
Sherrod, S. K., W. R. Heinrich, W. A. Burnham and J. H. Barclay. 1981. Hacking: A method for releasing peregrine falcons and other birds of prey. The Peregrine Fund, Boise, ID. 61 pp.
Snyder, N. F. R., S. R. Beissinger and M. R. Fuller. 1989. Solar radio-transmitters on snail kites in Florida. J. Field Ornithol. 60: 171–177.

Solis, D. M. and R. J. Gutierrez. 1990. Summer habitat ecology of northern spotted owls in northwestern California. Condor 92: 739–748.

Southern, W. E. 1964. Additional observations on winter bald eagle populations: Including remarks on biotelemetry techniques and immature plumages. Wilson Bull. 76: 121–137.

Strikwerda, T. E., M. R. Fuller, W. S. Seegar, P. W. Howey and H. D. Black. 1986. Bird-borne satellite transmitter and location program. Johns Hopkins APL Tech. Digest 7: 203–208.

Wallace, M. P. and W. Toone. 1992. Captive management for the long term survival of the California condor. Pages 766–774 *in* D. R. McCallough and R. T. Barrett, eds., Proc. Wildlife 2001: Populations. Elsevier Applied Sci., London. 1,163 pp.

Wallace, M. P., M. R. Fuller and J. Wiley. 1994. Patagial transmitters for large vultures and condors. Pages 358–366 *in* B.-U. Meyburg and R. D. Chancellor, eds., Raptor conservation today. World Work. Grp. on Birds of Prey, Pica Press, East Sussex, U.K. 799 pp.

White, G. C. and R. A. Garrott. 1990. Analysis of wildlife radio-tracking data. Academic Press, Inc., San Diego, CA.

Population Changes in North American Peregrines

James H. Enderson
Department of Biology
The Colorado College
Colorado Springs

William Heinrich and Lloyd Kiff
The Peregrine Fund
Boise, Idaho

Clayton M. White
Department of Zoology
Brigham Young University
Provo, Utah

Our purpose is to summarize available data on the historical status, decline, management and increase of the peregrine falcon (*Falco peregrinus*) whose fate in North America and elsewhere was profoundly affected by DDT and other chlorinated pesticides (Risebrough and Peakall 1988). Primary sources of information include the proceedings of the 1965 and 1985 peregrine conferences convened in Madison, Wisconsin (Hickey 1969) and Sacramento, California (Cade et al. 1988a), respectively, and reports of North American peregrine surveys made in 1970 (Cade and Fyfe 1970), 1975 (Fyfe et al. 1976), 1980 (White et al. 1990), 1985–86 (Murphy 1990) and 1990 (Holroyd and Banasch unpublished). Recovery plans for the East (U.S. Fish and Wildlife Service [USFWS] 1979), Rocky Mountains and Southwest (USFWS 1984), Pacific population (USFWS 1982a), and Alaska (USFWS 1982b) provided historical records and early count results. The Canadian recovery plan (Erickson et al. 1988) provided data on nesting pairs through 1980. Kiff (1988) summarized early records providing a basis for this paper.

Most information after 1985 was obtained from unpublished records of state and federal wildlife agencies, The Peregrine Fund, The Santa Cruz Predatory Bird Research Group, The Raptor Center at the University of Minnesota, and from field workers nearly everywhere peregrines occur in North America.

Peregrines of three subspecies in North America presently breed from central Mexico to the middle Arctic, but counts were reported regionally rather than taxonomically. Surveys in Canada were extensive every five years from 1970 on, but those in the United States were more frequent wherever peregrines persisted. Geographic regions used in this analysis were: Canada—Arctic and sub-Arctic, Pacific coast, Southeast, Prairie and West; United States—Alaska (Interior, Arctic and Bering Sea coast, Pacific coast including Aleutian Islands), East, Midwest, West; and Mexico—Interior, Pacific coast (including Baja California).

Arctic and sub-Arctic peregrines are highly migratory and we reviewed the results of intensive migration counts, some dating back to the 1950s. However, most information on peregrine population changes was from counts of birds on breeding territories. The error in analysis of population change based on counts of territorial pairs was discussed by Fyfe et al. (1976) and Ratcliffe (1993). In most regions, historical baselines were poorly known. Count techniques were not standardized. Further, effort became far more extensive and intensive in the last two decades and contributed to higher counts in recent years.

Historical Records

Historical records were derived from early published checklists, specimen records, egg collectors, falconers and other sources. The early accounts of peregrines in the eastern United States by Hickey (1942) and in the western United States by Bond (1946) were based on these types of records. Because old records continually came to light, even into the period of the decline in the 1960s and 1970s, a perspective of pre-decline peregrine territories was difficult to achieve. Historical records seldom resulted from systematic surveys and were better indicators of distribution than of abundance.

Table 1 summarizes the historical records and, by this count, peregrines were reported at about 1,156 locations in North America prior to the advent of intensive searches, generally beginning in the mid-1970s. Doubtless, the published records in Table 1 do not include every nesting pair. For example, a pair nested on bluffs of the Mississippi River in Union County, in southern Illinois in 1957 (R. Brewer personal communication: 1994) but the record never was published.

The data in Table 1 are from reports that summarized historical records appearing prior to 1975, except for the western United States where a later summary included more accounts. The report of the 1975 North American survey (Fyfe et al. 1976) mentioned 280 historical territories for the western United States, but the recovery plans (USFWS 1982a, 1984) and other sources account for 304 historical territories. Bond (1946) knew of only 136. Table 2 provides a review of the historical records for the western United States, a region where recent archival work was extensive. Even if the highest totals for historical pairs are used, the result is only 366 territories.

These scant historical records created the perspective that peregrines generally were rare. This resulted in underestimates of pre-decline population sizes over large regions. Bond (1946) estimated roughly 310 pairs in temperate western North America, excluding British Columbia, and Hickey (1942) suggested 350 pairs occurred east of the Rocky Mountains from southern Canada southward, yielding a total of 660 pairs in temperate regions. This was not much above the 537 historical records that emerged from early summaries (Table 1). Conversely, estimates for Arctic and Subarctic populations greatly exceeded the actual number of known historical pairs. Fyfe (1969) estimated 7,548 pairs in northern Canada, where only about 200 historical accounts were known. Cade (1960) estimated about 1,000 pairs for all of Alaska when only about 157 records were available (Table 1).

More recently, Kiff (1988) ventured estimates of the actual pre-decline population, benefitting from more complete records and new surveys. The middle of his extremes for the Arctic and sub-Arctic was 6,500 pairs; he also estimated 850 pairs for the Pacific coast and Aleutians, and 1,425 pairs for temperate regions, a grand total of 8,775 historical pairs. We now believe these values were good estimates. Generally,

Table 1. Historical records of peregrine territories in North America based on early summaries and other sources. New accounts of early nestings still are appearing.

Region	Number of historical pairs	Approximate year of estimate	Sources
Canada			
Arctic/Subarctic	196	1965	(Fyfe 1969)
Pacific coast	80	1965	(Beebe 1969)
Southeast			
Maritime Provinces and southern Quebec	18	1970	(Hurry 1970)
Ontario	26	1970	(Gibbon et al. 1970)
Prairie and West			
Manitoba/Saskatchewan	3	1982	(Bechard 1982)
Southern Alberta	21	1965	(Enderson 1969)
British Columbia, interior	18	1965	(Beebe 1969, Cannings et al. 1987)
United States			
Alaska			
Interior	59	1959	(Cade 1960)
Arctic	70	1959	(Cade 1960)
Pacific coast	28	1959	(Cade 1960)
East	215	1942	(Hickey 1942)
Midwest	60	1942	(Hickey 1942)
West	(136)	1946	(Bond 1946)
	(280)	1975	(Fyfe et al. 1976)
	304	pre-1975	(USFWS 1982a, 1984, others)
Mexico			
Pacific coast	55	1965	(Banks 1969)
Interior	3	1965	(Ely 1962 and museum specimens)

temperate North America east of the Rocky Mountains probably held roughly 500 pairs, the west, including Mexico, surely had 1,000 pairs, the Pacific coast of Canada and Alaska 800, and at least 5,000 in the Arctic and Subarctic, a total for the continent of 7,300 pairs. Immature and other non-breeding birds probably amounted to at least 8,000 individuals in the post-breeding season, exceeding 22,000 total individuals.

The Decline of Populations

Normally, peregrines occupy 80–90 percent of all territories in any year (Enderson and Craig 1974, Ratcliffe 1993) and occupancy rates far below this first were obvious in the eastern United States by the early 1950s (Hagar 1969, Herbert and Herbert 1969, Rice 1969). Berger et al. (1969) found no peregrines at 143 territories in that region in 1964. A single adult male was at a Vermont eyrie in 1970, the last individual seen at a cliff in the eastern United States (Enderson and W. Spofford unpublished observation). By 1964, only 33 percent of surveyed territories in the Rocky Mountains were in use (Enderson 1969) and a maximum of only 35 pairs were known by falconers and others in California by 1965 (Glading 1969), about a third of the count of historical

Table 2. Historical records of peregrine territories in the western United States.

State	Estimate used in Table 1	Other estimates	Source
Arizona		33	(Ellis 1976)
	15		(USFWS 1984)
California	100		(Herman et al. 1970)
		120	(USFWS 1982a)
Colorado	27		(USFWS 1984)
Idaho	17		(USFWS 1984)
Montana	23		(USFWS 1984)
New Mexico	10		(Bond and Smylie 1976)
		20	(USFWS 1984)
Nevada	5		(USFWS 1982a)
Oregon	39		(Henny and Nelson 1981)
		40	(USFWS 1982a)
Texas		5	(Hunt 1976)
	7		(USFWS 1984)
Utah		42	(Porter and White 1973)
	29		(USFWS 1984)
Washington	13		(USFWS 1982a)
Wyoming		18	(White et al. 1990)
	19		(USFWS 1984)
Total	304		

sites. Less than five pairs were thought to be present in California in 1970 (Herman 1971) and only eight were found in 1975 (Thelander and Walton 1976).

The Queen Charlotte Islands, British Columbia, was the only region on the Pacific coast of Canada and Alaska where a decline was apparent (Blood 1968, Nelson and Myres 1967). About 60 percent of known sites remained in use in the mid-1970s (Munro and van Drimmelen 1988). In Arctic and Subarctic Alaska, occupancy was reported down by 65 percent and 55 percent, respectively, by the early 1970s (White and Cade 1975, Ambrose et al. 1988). The 1975 North American survey showed a mean occupancy rate of about 39 percent for 110 territories in seven regions of the Canadian Arctic. In two well-known regions in the taiga, the Mackenzie District and the Yukon Territory, 49 percent of known sites were in use (Fyfe et al. 1976).

The 1975 North American Survey best reflects the low point of count results because field work was far more extensive at that time than in the 1960s. In tundra regions, only 60 pairs were counted at 184 known sites. In the taiga, 97 pairs were found when 349 sites were known, and only 62 were found in more southerly regions where 557 territories were known. The actual low point in the number of falcons probably occurred then.

Overall, this species disappeared by the mid-1970s from temperate regions east of the plains and fell to below one-quarter of former numbers in the West where counts were rudimentary. The Pacific Northwest maritime population was little affected, especially in the Aleutians. In interior Alaska and northern Canada, we estimate that numbers fell to about a third or less of the pre-decline level. Apparently, numbers in temperate regions were depressed much lower than in the north, but it is possible that a few hundred pairs persisted in the southwestern United States and northern Mexico. Vast areas of suitable habitat were not surveyed.

The Recovery

Two events had favorable impacts on peregrine populations: (1) DDT was banned in the United States in 1972 and greatly restricted in Canada in 1969, and (2) by 1975, the feasibility of production of captive bred peregrines for release to the wild had been demonstrated by the Canadian Wildlife Service, The Peregrine Fund and others. The great reduction in DDT use after 1972 north of Mexico did not result in sudden lowering of DDE levels in peregrine eggs. Peakall et al. (1990) reported a gradual reduction in the proportion of Canadian eggs with more than 15–20 milligrams per kilogram DDE (wet weight) in the post-restriction era to the middle 1980s. This level was thought to correlate with eggshell thinning sufficient to affect hatchability. A similar decrease in residues occurred in Greenland between the 1970s and 1989 (Walker et al. 1973, Jarman et al. 1994).

Management of Peregrines

By the late 1960s, those who studied peregrines were convinced direct management of the species might reverse the decline or re-establish lost populations. Captive breeding was accomplished by falconers at four locations by 1969, beginning with R. Waller in Germany 1942–43 (Cade 1988).

Captive breeding. The Peregrine Fund was established by T. Cade at Cornell University in 1970 and was stocked with falcons from the wild and a few donated by G. Hunt, J. Oar, C. White and others. In 1973, 20 peregrines were produced from three pairs, one of which had produced young for H. Meng in 1971–72. Peregrines from the Rocky Mountain region were produced in 1973 by J. Enderson in Colorado. The Canadian Wildlife Service facility was founded in 1972 and headed by R. Fyfe. The initial stock was three nestling peregrines from southern Alberta and a few from the lower Mackenzie River, less than five pairs in all (R. Fyfe personal communication: 1994). Other young were produced in 1973 by J. Campbell and W. Nelson, and R. Fyfe, in Alberta, Canada. Three years later, the Santa Cruz Predatory Bird Research Group was formed by J. Roush and K. Norris. Subsequently, B. Walton became the director, beginning with less than 20 peregrines, some hatched from eggs taken from eyries.

In 1982, Redig and Tordoff (1988) developed the Midwest Peregrine Falcon Restoration Project in Minnesota after their earlier tests of releases with Peregrine Fund birds in 1976 and 1977. Unlike the other groups, the Minnesota program did not breed peregrines, but obtained them for release from other sources. In 1974, a second Peregrine Fund facility was built in Fort Collins, Colorado, with the cooperation of the Colorado Division of Wildlife. The facility was stocked with 13 peregrines bred by J. Enderson, and pairs donated by F. Bond, W. Burnham and T. Smylie, all falconers. In the mid-1980s, both Peregrine Fund facilities were consolidated in Boise, Idaho. In Canada, a breeding facility was built in 1976 in Saskatoon, at the University of Saskatchewan, by L. Oliphant, and at McGill University Science and Conservation Centre, near Montreal, by D. Bird in 1978. In 1975, nearly 200 peregrines were produced by these operations and other private breeders. By 1980, more than twice that number were produced annually, sufficient for a meaningful level of releases.

Releases. Hacking, an old technique used by falconers, involved releasing several fledglings at a protected site in a region where adults did not occur (Sherrod et al. 1981). The young learned to fly and hunt while under the care of concealed attendants. Hack boxes were placed on cliffs, special towers and buildings, and some received a second set of young after those in the first set learned to fly. About 80 percent of birds released survived to independence. A second release technique was fostering, where young were placed into nests of pairs whose eggs were incubated artificially and had been temporarily replaced with dummy eggs. Cross-fostering to prairie falcons (*Falco mexicanus*) in a similar way was infrequent (Burnham et al. 1978).

In the eastern United States, the Midwest, Montana, Idaho and Wyoming, hacking alone was used because no wild pairs remained. Elsewhere in the western United States, especially in Colorado and California, fostering also was important. In Canada, only 8 of 825 birds were fostered in the southeast, and 286 of 716 in the prairies and west; 1,247 were hacked in both areas (U. Banasch personal communication).

Table 3 shows the number of peregrines released since the first fostering of two birds in Colorado in 1974, a grand total of 6,221 individuals. Releases reached a maximum in the late 1980s, ceased in Colorado after 1989 and in California after 1992. In the East, releases were few after 1991; about 25 were released in Maine, Kentucky and Alabama in 1994. Only 24 young were released in the Midwest in 1994. In southern Canada, between 100–120 birds per year were released since 1992.

By 1990, about 1,155 peregrines had been released in 15 eastern states, from Maine to Georgia, and the District of Columbia (Peregrine Fund unpublished report). About 60 percent of these were in New York, Vermont, Maine, Maryland and Virginia; the last two included 316 individuals, most of which were released from coastal hack towers. In the Midwest, about 663 individuals were released in 1982–94. Of these, 63 percent were in Wisconsin, Michigan and Minnesota; in the last two states, about 217 releases were at non-urban sites (Redig and Tordoff 1994).

In the West, early releases were focused in California, Colorado and Utah, but in the late 1970s, about 28 peregrines were released in New Mexico. In all, at least 2,722 were released in the West (Table 3). Most of these were captive-bred birds, but 333 young from wild eggs, hatched in captivity, were released by the Santa Cruz facility (J. Linthicum and B. Walton unpublished report) and about 177 were released by the Colorado Division of Wildlife.

Establishment of populations by releases. No known pairs occurred in southeast Canada prior to releases; and the East, Midwest, and Wyoming, Montana and Idaho in the United States also had lost all known nesting pairs. In these regions, releases resulted in nesting populations including 62 pairs in 1994 in the three western states. The ratios of total releases (Table 3) to known pairs in 1994 (Table 4) are 11:1 for the East, 13:1 for the Midwest, 17:1 for the three western states (see Figure 4), and 36:1 for southeast Canada and the prairie and west. In the latter three cases, releases were ongoing in 1993–94, and some of these birds would not appear on territory until 1995. The inexplicably high ratio for Canada was apparent by 1985 (Peakall 1990).

Peregrines released in California and Colorado often became breeders, especially where releases were concentrated. In the late 1980s, at least one in five breeding

Table 3. Peregrine releases by all methods in North America. A few recent outlying releases are not included. About 80 percent of released individuals reached independence.

Region	Period	Number of individuals released
Canada		
Southeast	1976–94	825[a]
Prairie and West	1975–94	716[a]
United States		
East	1975–93	1,229[b]
Midwest	1981–94	729[c]
West	1974–94	2,722
Total		6,221

[a]U. Banasch personal communication: 1995, Alberta Fish and Wildlife Services, Ontario Ministry of Natural Resources, Fundy and Wood Buffalo National Parks (Department of Canadian Heritage), Canadian Wildlife Service Atlantic and Quebec Regions, Quebec Ministere de L'Environment et de la Faune, Saskatchewan Cooperative Falcon Project (University of Saskatchewan), Manitoba Wildlife Branch.
[b]Annual Report, The Peregrine Bund, Boise, Idaho, 1993.
[c]Redig and Tordoff unpublished report.

adults in California were released birds (B. Walton personal communication). In 1987 in Colorado, 16 of 38 breeding adults checked wore color bands placed earlier on hacked or fostered young (G. Craig personal communication).

Counts of Peregrines in Migration

Counts of migrants may be biased by changes in effort and other variables such as weather, trapping activities and observer competence. Ward et al. (1988) standardized counts made in 1970–84 on the basis of sightings per 10 person-hours of observation. They found counts in autumn on Assateague Island in Virginia and Maryland were about three individuals per 10 hours averaged for the five-year period 1974–78. In 1982–85, counts averaged 6.6 individuals, and 8.5 individuals per 10 hours in 1990–94, a three-fold increase (M. Yates and W. Seegar personal communication: 1994).

Counts of autumn migrants at Cedar Grove Ornithological Station on Lake Michigan near Milwaukee increased three-fold from about 15 sightings in the period September 16–October 12 1974–78 (five-year average) to about 46 in the same period in 1981–85 (Mueller et al. 1988). More recent data for 1983–1994 indicate a four-fold increase in 1993–1994 over the mid-1970s (D. Berger and H. Mueller personal communication: 1995).

Hawk Mountain Sanctuary in Pennsylvania has been the site of raptor counts since 1934, and data on counts of peregrines were standardized on the basis of 100 observer-hours. In 1971–1978, the mean count of peregrines was 1.5, in 1970–85 the count averaged 2.0, and in 1987–93 the count averaged 7.3 peregrines per 100 observer-hours (K. Bildstein personal communication: 1995).

Workers at South Padre Island, Texas, have counted north-bound migrant peregrines in spring. Their counts of adult peregrines observed in northward migration in spring (1989–94) vary between about 40 and 70 individuals per 100 observer-hours with no trend apparent in that recent period (T. Maechtle and W. Seegar personal communication: 1995).

Table 4. Counts of pairs of peregrines on territory in 1994 or most recent year counts were made, and projections of actual populations based on counts or conservative estimates.

Range	Number of pairs counted	Number of pairs estimated
Canada		
Arctic and Sub-arctic	376	4,125[d]
Pacific Coast	77	250[e]
Southeast	23	30
Prairie and West	20	25
Total	496	4,430
United States		
Alaska		
Arctic	158[a]	225[f]
Interior	183[b]	200[g]
Pacific Coast	149	600[f]
East	104	120
Midwest	55	60
West	673	914
Total	1,322	2,119
Mexico		
Pacific Coast	32	70
Interior	17	100
West Greenland	104[c]	450[h]
Totals	1,971	7,169

[a]T. Swem and R. Ritchie, personal communication: 1995.
[b]Includes middle and lower Yukon River not surveyed after 1991, R. Ambrose personal communication.
[c]Estimated from W. Mattox unpublished report 1993.
[d]Lowest estimate of Cade et al. (1988b) minus estimates for northern regions outside of Canada.
[e]Kiff (1988) minus estimate of Ambrose et al. (1988) for Alaska.
[f]Midpoint of estimate range by Cade (1960).
[g]Ambrose et al. (1988).
[h]Falk and Møller (1988).

Overall, counts of migrants generally were lowest in the 1970s. Counts at Cedar Grove were dramatically lower in that period than before or after (Mueller et al. 1988). Similarly, counts at Hawk Mountain declined from 1950 to the late 1970s (Bednarz et al. 1990). In the latter case, the decrease appears to have been to about one-third of the early counts.

Population Estimates from Counts of Migrants

A result of the increased survey work on peregrines in the Arctic and sub-Arctic was the banding of thousands of nestlings by 1985. Admittedly, crude estimates of the northern population (including Greenland) using the Lincoln Index equation were made by J. Sheppard (USFWS 1983) and Cade et al. (1988b). The equation involves the product of the number of nestlings banded times all those trapped in migration divided by the number trapped that were wearing bands. The latter authors suggested a near doubling of population in 1980–85, and a production of 10,000–20,000 young annually in that period. The index provides, perhaps, a maximum estimate because band recoveries are not all available in the first year; i.e., further recoveries still were possible at the time calculations were made. Considering the lower estimate of 10,000 young, and assuming 1.5 young per territorial pair, the estimate translates to 6,700 pairs in the north. Of these, 400–500 may be in Greenland (Falk and Møller 1988).

A more direct estimate can be based on sightings of juvenile birds in a single season. In autumn 1993 about 1,200 juvenile females were seen on Padre Island (T. Maechtle personal communication: 1994) and 175 at Assateague Island (M. Yates personal communication: 1994), a total of about 1,400. Assuming few of these females were counted twice, they represented about 2,800 juvenile migrants if the sex ratio in migration is 50:50. If a third of all juvenile peregrines was counted in that migration, an unlikely high proportion, and if a mean 1.2 young per pair survived to be counted, then the 1993 counts indicated 8,400 juveniles migrated, representing the production of about 7,000 pairs on territory.

Population Increase 1980–1994

By 1980, surveys in most regions resulted in higher counts of pairs on territory. Data are most complete in the years when the five-year surveys were organized to revisit previously discovered territories. However, these surveys were not systematic. For example, the 1985–86 surveys were focused in Canada, while uncoordinated surveys in the United States were done by government agencies and individuals.

Results from increasing counts. Table 5 shows a universal trend toward higher counts of pairs on territory in 1980–90. We used a few counts actually taken a year before or after the year shown. Higher counts were no doubt owing to both increased search effort and more birds. The relative importance of these effects cannot be estimated from the combined data in Table 5. The total known occupied territories tripled in one decade.

The data in Table 5 are not closely comparable. In Arctic and Subarctic Canada, the 1980 and 1985–86 surveys included northern Northwest Territories, a region omitted in the 1990 survey. The 1985–86 and 1990 results included the Coppermine River and Hope Bay, areas with many peregrines not surveyed in 1980. In arctic Alaska, after 1980, counts expanded from the Colville River to include major tributaries. Surveys in the central Brooks Range since 1990 have revealed about 30 previously unknown sites (R. Ritchie personal communication: 1995). The number of occupied territories for coastal Alaska reflects very inadequate surveys in terms of total population. For example, a dramatic increase was discovered in Norton Sound in the west; in 1987, 6 pairs were present but, in 1991, about 27 pairs plus 10 single adults were found (J. Hughes personal communication: 1995).

We believe the data for the East and Midwest United States reflected actual population changes because nesting peregrines were unlikely to remain unnoticed for long, especially because many of the territories were urban. The western United States has much unsurveyed peregrine habitat. Early counts clearly were rudimentary. Contributing to an apparent five-fold increase in numbers in 1980–90 was the gradual discovery, beginning in 1985, of a huge population on the Colorado Plateau (Enderson et al. 1988) and along the lower Colorado River (Brown et al. 1992).

Results from systematic inquiries and surveys. In most regions of North America a few surveys have been conducted nearly every year since the mid-1980s or earlier.

Table 5. Counts of nesting pairs of peregrines by region from the era of population increase. Data were compiled from many sources and reflect changes in awareness of peregrine nestings, as well as actual increases. Not all counts were made in the same localities in each year.

Region	1980[a]	1985–86	1990
Canada			
Arctic and Sub-Arctic	143[b]	252[g]	342[k]
Pacific Coast	66	70	77
Southeast	1	3	19
Prairie and West	0	3	5
Total	210	328	443
United States			
Alaska			
Arctic	24	44[c]	108[l]
Interior	76[c]	106[c]	161[l]
Pacific Coast	43[d]	91[h]	105[m]
East	5	40	84
Midwest	0	3	23
West	94	271[i]	490[j]
Total	242	555	971
Mexico			
Pacific Coast	26	32[j]	
Interior	7[e]	17[j]	
West Greenland	14[f]	38	77[n]
Total	499	970	1,540[o]

[a]Mainly from White et al. 1990.
[b]Erickson et al. 1988.
[c]Ambrose et al. 1988.
[d]Includes 13 pairs in the Aleutians (Early 1982).
[e]Estimate from 1979–82 (Hunt et al. 1988).
[f]Mattox and Seegar 1988.
[g]Bromley 1988, Bromley and Matthews 1988, Murphy 1990.
[h]Estimated from Ambrose et al. 1988.
[i]Current USFWS Rec. Team unpublished.
[j]J. Lewis (USFWS 1988).
[k]Mainly from Holroyd and Banasch unpublished data.
[l]Ambrose 1990.
[m]C. White personal communication.
[n]W. Mattox unpublished.
[o]Assumes 49 territories in Mexico from 1985–86 remained active.

These counts generally include searches of historical territories, sites found in previous years and visits to promising cliffs not known to have been used by peregrines. Although the accuracy of these surveys is uncertain, counts along rivers such as the Colville in Alaska probably closely reflect the number of pairs actually present. In systematically surveyed states, such as California and Colorado, searches inevitably expand, and surely not all pairs are discovered in the year they are established. In the Midwest, where banded, released peregrines apparently establish most territories in cities, about 10 percent of territorial pairs may be undiscovered, according to calculations based on banded adults on territory (Redig and Tordoff unpublished).

Figure 1 shows changes in counts for four well-studied areas in the tundra. Annual variation was pronounced for the Coppermine River and Hope Bay because of weather (G. Court personal communication). Peregrines on the Colville have grown steadily in numbers since the late 1970s (T. Swem unpublished), and now are about twice as abundant compared with the 1950s (Cade 1960).

The Yukon and the Mackenzie Rivers in the taiga, which had low occupancy during the 1970s, are the most thoroughly searched areas in the northern forest since 1985. The Yukon River from Eagle to Circle, Alaska, now has twice the number of pairs present in the 1970s (R. Ambrose unpublished) (Figure 2). The Mackenzie River is about 900 miles (1,440 km) long, and has hundreds of cliffs and cutbanks, some not easily searched from the river. Count results were subject in part to effort. Through 1990, numbers have increased dramatically and a massive search effort in 1995 surely would reveal more birds than in 1990 (C. Shank personal communication: 1995).

Populations in the East and Midwest United States, established entirely by released peregrines, grew at similar rates (Figure 3). Major releases were discontinued in the East in 1991, and those in the Midwest were curtailed from a high of 116 in 1989 to 24 in 1994. Through 1992, about 667 young were released in the Midwest and

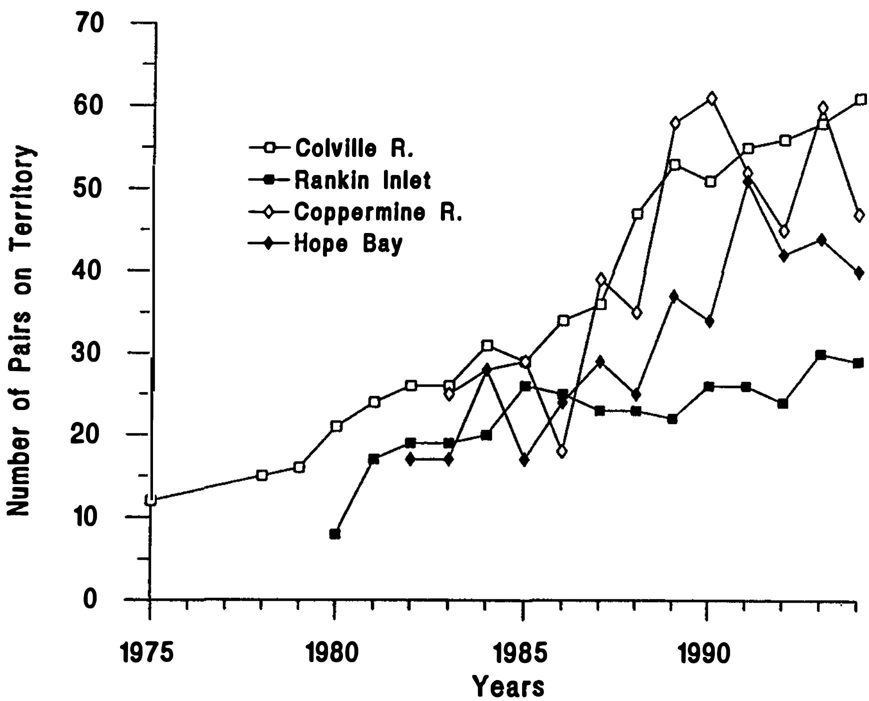


Figure 1. Increases in counts of peregrines in the Arctic where surveys were intensive. Sources were: Colville River, Ambrose et al. (1988), T. Swem unpublished data; Rankin Inlet, Court et al. (1988), G. Holroyd and U. Banasch unpublished data, R. Johnstone unpublished data; Coppermine River and Hope Bay, Shank et al. (1993), USFWS (1994), C. Shank personal communication.

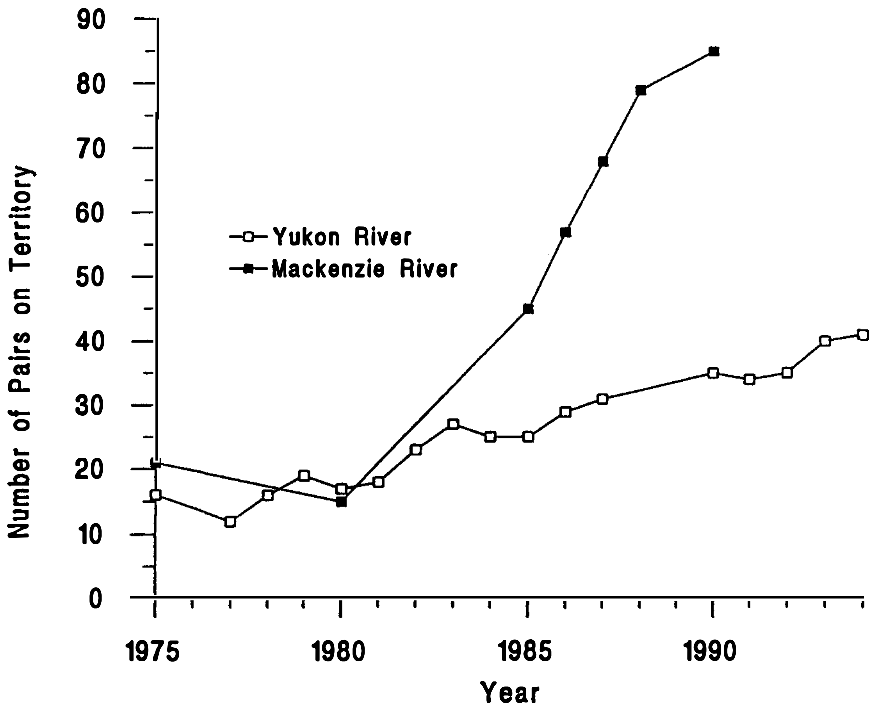


Figure 2. Increases in counts of peregrines in the taiga where surveys were intensive. Sources were: Yukon River, Ambrose et al. (1988), R. Ambrose unpublished data; Mackenzie River, Fyfe et al. (1976), White et al. (1990), C. Shank personal communication.

another 172 were fledged by natural reproduction, 839 in all. These young all would have been adults by 1994 and some were members of the 53 known pairs present that year, but the full impact of recent releases is yet to be seen.

Figure 4 shows increases in several states in the West where attempts were made to find as many pairs as possible each year. Hacking in Idaho, Montana and Wyoming no doubt caused in large part the increases from near zero. About 1,054 peregrines were released in these states. All nesting adults (n = 6) in 1984–85 wore bands given to released birds, and 77 percent (n = 22), 81 percent (n = 31) and 89 percent (n = 9) in 1988, 1989 and 1990, respectively, wore bands where checks were made (Heinrich and Oakleaf unpublished). Only one bird, a banded male, is known to have dispersed northward into the region.

Figure 5 shows the increase of counts for Colorado and California where augmentation by hacking and fostering was terminated after 1989 and 1992, respectively. Apparently, these increases are continuing. Despite intensive early survey efforts, increases in Colorado were not apparent until the late 1980s. The number of known pairs increased at a rapid near-constant rate, but we cannot discount the role of wild recruitments as a factor in these increasing counts. In Utah, there were no systematic state-wide surveys, but dense clusters of territories were discovered in 1985–87 and focused intensified counts. One of the highest densities for the continental United

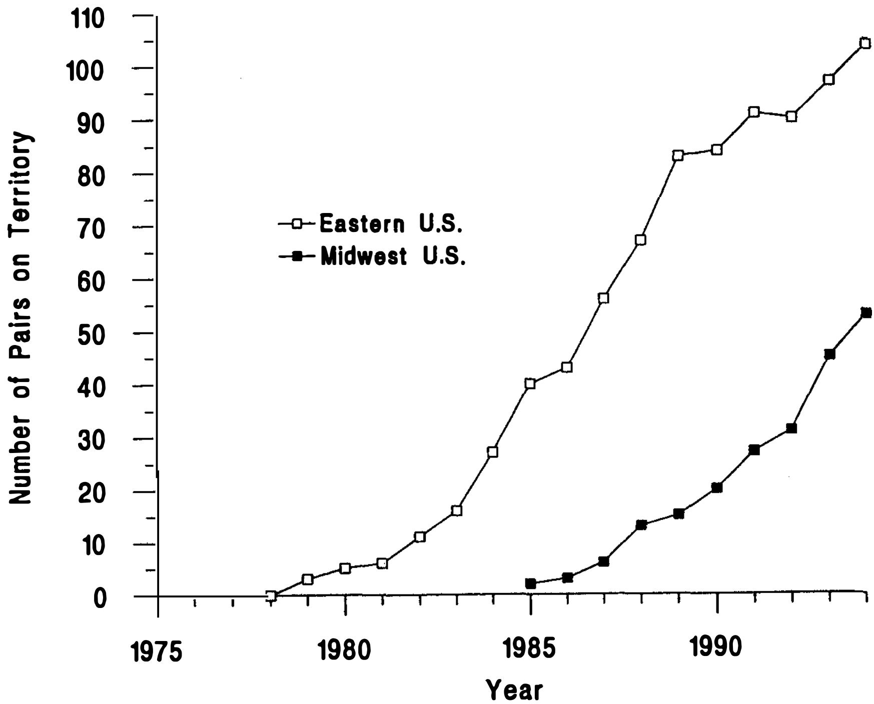


Figure 3. Increases in counts of peregrines resulting from reintroduction in the United States. Sources were: East, The Peregrine Fund, Inc., Boise, Idaho; Midwest, Redig and Tordoff (1988), P. Redig and H. Tordoff personal communication. Only a few peregrines were hacked in the East after 1991, and fewer than 25 per year in the Midwest after 1992.

States was reported there. Reproduction was very good; nine pairs in an 11-mile (18 km) radius fledged 2.8 young per pair and no pair failed (L. Hays personal communication: 1995).

There is some evidence that the recent increase included coastal Mexico. In a region on the west coast of Baja California visited by ornithologists since 1927, Banks (1969) was able to document only two records of nesting peregrines. Eight territories recently were discovered there (Massey and Palacios 1994).

Estimates and projections for 1994. We made two estimates for the current North American population (Table 4). One used only counts of pairs on territory for 1994 or the latest year for which such a count was available. The other included conservative projections and estimates made by workers from the actual regions. The first method is conservative because not all territorial pairs were found. Furthermore, the few counts we used for years prior to 1994 probably underestimate present pairs because of the continuing increase in numbers. The second method certainly is closer to the actual number of pairs now present because it extrapolates for vast areas not yet surveyed.

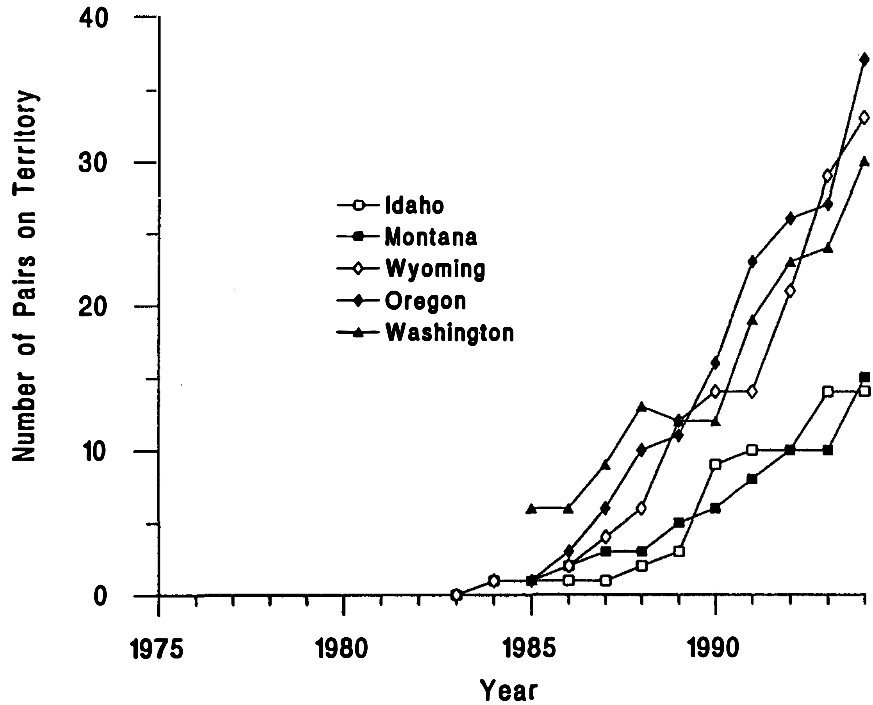


Figure 4. Increases in counts of peregrines in the northern tier of western states. Releases began in Idaho (1982), Montana (1981) and Wyoming (1980) at times when only one territorial pair was known in this region. Sources were: Idaho and Montana, The Peregrine Fund, Inc., Boise, Idaho; Oregon, B. Walton and J. Pagel personal communication; Washington, H. Allen personal communication; Wyoming, R. Oakleaf personal communication. About 270 peregrines were released in these states in 1993–94, too recent to contribute to territorial pairs in 1994.

Table 4 shows that recent counts for most regions are much lower than total population projections, especially for poorly surveyed areas. Counts total nearly 2,000 pairs, but estimates total nearly 7,200 pairs. The combined estimates for northern Canada of 4,125 pairs, 450 pairs for West Greenland, and 425 for Arctic and interior Alaska sum to 5,000 pairs of northern birds. The Pacific coast from Vancouver Island through the Aleutians surely has 850 pairs or more, but only a quarter of that number actually was counted because of difficult access. Peregrines in the southwest United States still are increasing and potential habitat is vast. In Arizona, much habitat on tribal lands and in the Colorado River drainage was not surveyed, and numbers probably were twice the 197 pairs seen on different territories in recent years (T. Tibbetts personal communication: 1995). As no total counts were made in New Mexico, we used 75 pairs as a projection of present pairs. This was less than midway between highest and lowest projections appearing in unpublished reports (S. Williams personal communication: 1994). Our least certain estimate was for interior Mexico, which, in regard to peregrines, was the most poorly known region in North America. About 100 pairs seems very conservative considering the enormous potential habitat.

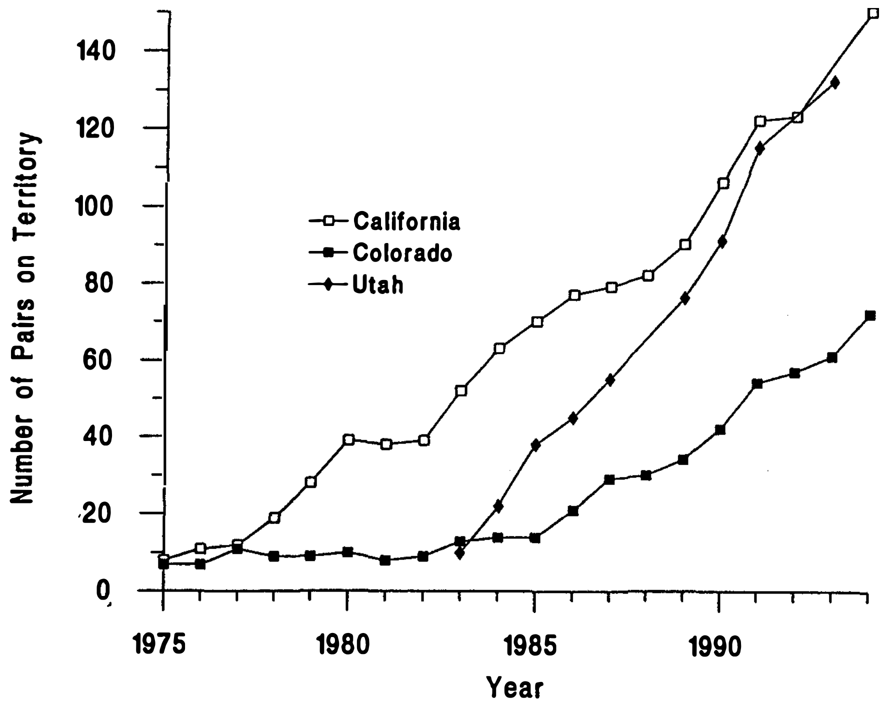


Figure 5. Increases in counts of pairs of peregrines on territory in California where population growth and increasing survey effort probably were factors, in Colorado where actual growth probably was the major factor, and in Utah where increasing survey effort probably was the major factor. Sources were: California, B. Walton personal communication; Colorado, G. Craig personal communication; Utah, R. Walters, Jr. and D. Bunnell personal communication. California value for 1994 is an estimate based on 90-percent occupancy of recently used territories.

Urban peregrines. By 1988, more than 30 pairs of peregrines were nesting in 24 cities across North America. These birds were mostly captively reared and released falcons (Cade and Bird 1990). In 1993, about 87 pairs were on territories in 60 cities, mainly in the northeastern seaboard, midwestern states and coastal southern California. Urban nest sites made up 58 percent of the regional population in the Midwest and 34 percent of the regional population in the eastern United States (T. Cade et al. in press).

Discussion and Conclusions

It is now clear that a severe decline in a very substantial, but unknown, population of peregrines in North America began in the 1950s and continued to a low in the 1970s, only 20 years ago. After the restrictions on DDT, numbers increased slowly at first. In 1980, at a time when little real increase was apparent, only about 500 pairs were known on the continent (Table 5). The four United States peregrine recovery plans actually were drafted during 1979–82 in this setting. The known United States population was only about 242 pairs, including Alaska. At that time, about 736 historical sites were known, including about 215 in the East (Table 1). The recovery plans, especially the criteria for recovery, were greatly influenced by historical records which were three times the known 1980 number of pairs.

What was the degree of the crash? Very few pairs, if any, persisted in temperate North America east of the Rocky Mountains. The loss also was nearly complete in interior western Canada and the northern states in the West. California had fewer than one-tenth of the known historical breeding pairs. No estimate of decline is possible elsewhere in the West because historical accounts are so scant, but fewer than 100 pairs were known in 1980 (Table 5). In the Arctic and sub-Arctic, the decline was massive. There were no pre-DDT surveys, but counts of migrants were roughly three times greater in the 1930s and early 1940s compared with the 1970s (Bednarz et al. 1990, Mueller et al. 1988, Ward et al. 1988).

In temperate United States from 1980, the number of known pairs (1980–90) or estimated pairs (1994) roughly doubled every five years (tables 4 and 5). The conservative 1994 number was 1,094 compared with 99 pairs in 1980. This remarkable change was owed substantially to the release of 4,680 peregrines in that region. If we accept a ratio of 13 releases for each pair appearing on territory in the United States, then 360 pairs were due to releases, more than a third of the 1994 estimate of pairs. We believe that effect was minor compared to the restocking of vast regions that would be devoid of peregrines without releases. Any effect of releases certainly would have been much reduced had DDT not been banned. Reproduction by both wild and released birds has been normal in most regions.

About 10 percent of all known peregrines in southern Canada and the coterminous United States hold urban territories. This results from a wide, if not total, acceptance of this predator by the public, ''peregrine fever'' by local conservation interests and remarkable adaptability by the falcon. In 1994, six peregrines were successfully released in Little Rock, Arkansas. The expansion of the urban component will continue with no end in sight.

Peregrines now are classified as endangered south of the tundra in Canada (excluding the Pacific coast), in interior Alaska and in the coterminous United States. In southern Canada, only 55 pairs were estimated in 1994 (Table 4), still well below the no doubt inadequate historical count of 86 (Table 1). In interior Alaska, a minimum of 200 pairs probably were present and still may be on the increase (Figure 2). In the East and Midwest United States, about 165 pairs were known and 180 pairs were estimated. Counts show continuing increase (Figure 3). The goal of the recovery plan, 175 pairs is at fruition (USFWS 1979: 14).

In the West, the two relevant recovery plans recommended a total of about 500 pairs for delisting from endangered or threatened status (USFWS 1982a, 1984). Both called for certain distributions based mainly on historical records. In 1994 or recent years, 673 pairs were known present, and a conservative estimate is 914 pairs (Table 4). There are roughly 300 historical locations for peregrines in the West (Table 1), including 100 in California (Table 2). Where systematic counts were made, trends were strongly upward, including those in the northern tier of states where releases are ongoing (figures 4 and 5). These results indicate the peregrine is no longer threatened with extinction in the West and should be delisted.

Acknowledgments

This summary really is a contribution of scores of field workers. Many generously shared their unpublished data, including H. Allen, R. Ambrose, U. Banasch, D. Berger, D. Bunnell, T. Cade, G. Court, G. Craig, L. Hays, G. Holroyd, J. Hughes, R. Johnstone, T. Maechtle, W. Mattox, B. McKinney, J. Negro, R. Oakleaf, J. Pagel, R. Ritchie, W. Seegar, C. Shank, P. Schempf, T. Swem, D. Varland, S. Williams and M. Yates. The draft manuscript was improved through editing by U. Banasch, B. Walton and L. Behrman. D. O'Brien and P. Beardsley helped with manuscript preparation.

References

Ambrose, R. E. 1990. Peregrine falcon surveys in interior and northern Alaska, 1990. Mimeo. U.S. Fish and Wildl. Serv., Fairbanks, AK. 7 pp.

Ambrose, R. E., R. J. Ritchie, C. M. White, P. F. Schempf, T. Swem and R. Dittrick. 1988. Changes in status of peregrine falcon populations in Alaska. Pages 73–82 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Banks, R. C. 1969. The peregrine falcon in Baja California and the Gulf of California. Pages 81–91 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.

Bechard, M. J. 1982. Further evidence for a historic population of peregrine falcons in southern Saskatchewan. Blue Jay 40: 125.

Bednarz, J. C., D. Klem Jr., L. J. Goodrich and S. E. Senner. 1990. Migration counts of raptors at Hawk Mountain, Pennsylvania, as indicators of population trends, 1934–1986. Auk 107: 96-109.

Beebe, F. J. 1969. The known status of the peregrine falcon in British Columbia. Pages 53–60 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.

Berger, D. D., C. R. Sindelar, Jr. and K. E. Gamble. 1969. The status of breeding peregrines in the eastern United States. Pages 165–173 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison.

Blood, D. A. 1968. Population status of peregrine falcons in the Queen Charlotte Islands, British Columbia. Can. Field-Natural 82: 169–176.

Bond, F. and T. Smylie. 1976. New Mexico. Page 268 *in* R. W. Fyfe, ed., The 1975 North American peregrine falcon survey. Can. Field-Natural 90: 228–273.

Bond, R. M. 1946. The peregrine population of western North America. Condor 48: 101–116.

Bromley, R. G. 1988. Status of peregrine falcons in the Kitikmeot, Baffin, and Keewatin regions, Northwest Territories, 1982–1985. Pages 51–57 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Bromley, R. G. and S. B. Matthews. 1988. Status of the peregrine falcon in the Mackenzie River valley, Northwest Territories, 1969–1985. Pages 59–63 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Brown, B. T., G. S. Mills, R. L. Glinski and S. W. Hoffman. 1992. Density of nesting peregrine falcons in Grand Canyon National Park, Arizona. Southwest Natural 37: 188–193.

Burnham, W. A., G. Craig, J. H. Enderson and W. R. Heinrich. 1978. Artificial increase in reproduction of wild peregrine falcons. J. Wildl. Manage. 42: 625–628.

Cade, T. J. 1960. Ecology of the peregrine and gyrfalcon populations in Alaska. Univ. California Publ. Zool. 63: 151–290.

———. 1988. The captive breeding of peregrines and other falcons in captivity: A historical summary. Pages 539–547 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Cade, T. J. and D. M. Bird. 1990. Peregrine falcons, (*Falco peregrinus*), nesting in an urban environment: A review. Can. Field-Natural 104: 209–218.

Cade, T. J. and R. Fyfe. 1970. The North American peregrine survey, 1970. Can. Field-Natural 84: 231–245.
Cade, T. J., J. H. Enderson, C. G. Thelander and C. M. White, eds. 1988a. Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Cade, T. J., J. H. Enderson, C. G. Thelander and C. M. White. 1988b. Migration statistics as peregrine population estimators? Pages 141–143 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Cade, T. J., M. Martell, P. T. Redig, G. Septon and H. B. Tordoff In press. Peregrine falcons in urban North America. *In* D. M. Bird, D. E. Varland and J. J. Negro, eds., Raptor adaptations to human-influenced environments. Academic Press, London.
Canadian Wildlife Service. 1988. Minutes of *Anatum* Peregrine Falcon Recovery Team meeting, Halifax, N.S., 18–19 November. Mimeo. Can. Wildl. Serv., Edmonton, 14 pp.
Cannings, R. A., R. J. Cannings and S. G. Cannings. 1987. Birds of the Okanagan Valley, British Columbia. Royal British Columbia Mus., Victoria.
Court, C. M., D. M. Bradley, C. C. Gates and D. A. Boag. 1988. The population biology of peregrine falcons in the Keewatin District of the Northwest Territories, Canada. Pages 729–739 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Early, T. J. 1982. Abundance and distribution of breeding raptors in the Aleutian Islands, Alaska. Pages 99–111 *in* W. N. Ladd and P. F. Schempf, eds., Raptor management and biology in Alaska and western Canada. U.S. Fish and Wildl. Serv., Anchorage.
Ellis, D. H. 1976. Arizona. Pages 268 *in* R. W. Fyfe, ed., The 1975 North American peregrine falcon survey. Can. Field-Natural 90: 228–273.
Ely, C. A. 1962. The birds of southeastern Coahuila, Mexico. Condor 64: 34–39.
Enderson, J. H. 1969. Population trends among peregrine falcons in the Rocky Mountain region. Pages 73–79 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.
Enderson, J. H. and G. Craig. 1974. Status of the peregrine falcon in the Rocky Mountains in 1973. Auk 91: 727–736.
Enderson, J. H., G. R. Craig and W. A. Burnham. 1988. Status of peregrines in the Rocky Mountains and the Colorado Plateau. Pages 83–86 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Erickson, G., R. Fyfe, R. Bromley, G. L. Holroyd, D. Mussop, B. Munro, R. Nero, C. Shank and T. Wiens. 1988. Anatum peregrine falcon recovery plan. Can. Wildl. Serv., Ottawa, 52 pp.
Falk, K. and S. Møller. 1988. Status of the peregrine falcon in South Greenland: Population density and reproduction. Pages 37–43 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Fyfe, R. W. 1969. The peregrine falcon in northern Canada. pages 101–114 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.
Fyfe, R. W., S. A. Temple and T. J. Cade, eds. 1976. The 1975 North American peregrine falcon survey. Can. Field-Natural. 90: 228–273.
Gibbon, R. S., C. C. Gates and S. M. Teeple. 1970. Peregrines in Ontario, southern Quebec and Labrador. Pages 236–237 *in* T. J. Cade and R. Fyfe, eds., The North American peregrine survey, 1970. Can. Field-Natural 84: 231–245.
Glading, B. 1969. The peregrine falcon in California. Pages 96–97 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.
Hagar, J. A. 1969. History of the Massachusetts peregrine falcon population, 1935–57. Pages 123–133 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.
Henny, C. J. and M. W. Nelson. 1981. Decline and present status of breeding peregrine falcons in Oregon. Murrelet 62: 43–53.
Herbert, R. A. and K. S. Herbert. 1969. The extirpation of the Hudson River peregrine falcon population. Pages 133–154 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.

Herman, S. G. 1971. The peregrine falcon decline in California. Amer. Birds 25: 818–820.
Herman, S. G., M. N. Kirven and R. W. Risebrough. 1970. The peregrine falcon decline in California. Aud. Field-Notes 24: 609–613.
Hickey, J. J. 1942. Eastern populations of the Duck Hawk. Auk 59: 176–204.
———, ed. 1969. Peregrine falcon populations: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.
Holroyd, G. L. and U. Banasch. 1990. The reintroduction of the peregrine falcon (*Falco peregrinus anatum*) into southern Canada. Can. Field-Natural 104: 203–208.
Hunt, W. G. 1976. Peregrines in western Texas and northeastern Mexico. *In* R. W. Fyfe, ed., The 1975 North American peregrine falcon survey. Can. Field-Natural 90: 228–273.
Hunt, W. G., J. H. Enderson, D. Lanning, M. A. Hitchcock and B. S. Johnson. 1988. Nesting peregrines in Texas and northern Mexico. Pages 115–121 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Hurry, N. 1970. Newfoundland and the Maritime Provinces. Page 235 *in* T. J. Cade and R. Fyfe, eds., The North American peregrine survey, 1970. Can. Field-Natural 84: 231–245.
Jarman, W. M., S. A. Burns, W. G. Mattox and W. S. Seegar. 1994. Organochlorine compounds in the plasma of peregrine falcons and Gyrfalcons nesting in Greenland. Arctic 47: 334–3340.
Kiff, L. F. 1988. Commentary—Changes in the status of the peregrine in North America. Pages 123–139 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Kirven, M. N. and B. J. Walton. 1992. The peregrine falcon population recovery in California from 1981 to 1992. Bur. of Land Manage., Sacramento, CA. 25 pp.
Mattox, W. G. and W. S. Seegar. 1988. The Greenland peregrine falcon survey, 1972–1985, with emphasis on recent population status. Pages 27–36 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Massey, B. W. and E. Palacios. 1994. Avifauna of the wetlands of Baja California, Mexico: Current status. Studies in Avian Biol. 15: 45–57.
Munro, W. T. and B. Van Drimmelen. 1988. Status of peregrines in the Queen Charlotte Islands, British Columbia. Pages 69–72 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Mueller, H. C., D. D. Berger and G. Allez. 1988. Population trends in migrating peregrines at Cedar Grove, Wisconsin, 1936–1985. Pages 497–506 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Murphy, J. E. 1990. The 1985–1986 Canadian peregrine falcon, (*Falco peregrinus*), survey. Can. Field-Natural 104: 182–192.
Nelson, R. W. and M. T. Myres. 1976. Declines in population of peregrine falcons and their seabird prey at Langara Island, British Columbia. Condor 78: 281–293.
Peakall, D. B. 1990. Prospects for the peregrine falcon (*Falco peregrinus*) in the nineties. Can. Field-Natural 104: 168–173.
Peakall, D. B., D. G. Noble, J. E. Elliott, J. D. Somers and G. Erickson. 1990. Environmental contaminants in Canadian peregrine falcons, (*Falco peregrinus*): A toxicological assessment. Can. Field-Natural 104: 244–254.
Porter, R. D. and C. M. White. 1973. The peregrine falcon in Utah, emphasizing ecology and competition with the prairie falcon. Brigham Young Univ. Ser. 18: 1–71.
Porter, R. D., M. A. Jenkins, M. N. Kirven, D. W. Anderson and J. O. Keith. 1988. Status and reproductive performance of marine peregrines in Baja California, Mexico. Pages 105–114 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.
Ratcliffe, D. A. 1993. The peregrine falcon. Academic Press, San Diego, CA. 454 pp.
Redig, P. T. and H. B. Tordoff. 1988. Peregrine falcon reintroduction in the upper Mississippi Valley and western Great Lakes region. Pages 559–564 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Redig, P. T. and H. B. Tordoff. 1994. Midwest peregrine falcon restoration, 1993 report. Midwest Peregrine Restoration Project, The Raptor Center, Univ. Minneapolis, St. Paul. 85 pp.

Rice, J. N. 1969. The decline of the peregrine falcon in Pennsylvania. Pages 155–163 *in* J. J. Hickey, ed., Peregrine falcon populations: Their biology and decline. Univ Wisconsin Press, Madison. 596 pp.

Risebrough, R. W. and D. B. Peakall. 1988. Commentary—The relative importance of the several organochlorines in the decline of peregrine falcon populations. Pages 449–462 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Shank, C. C., R. G. Bromley and K. G. Poole. 1993. Increase in breeding population of tundra peregrine falcons in the central Canadian arctic. Wilson Bull. 105: 188–190.

Sherrod, S. K., W. R. Heinrich, W. A. Burnham, J. H. Barclay and T. J. Cade. 1981. Hacking: A method for releasing Peregrine Falcons and other kinds of prey. The Peregrine Fund, Boise, ID.

Thelander, C. G. and B. Walton. 1976. California. Pages 268–269 *in* R. W. Fyfe, ed., The 1975 North American peregrine falcon survey. Can. Field-Natural 90: 228–273.

U.S. Fish and Wildlife Service. 1979. Eastern peregrine falcon recovery plan. 147 pp.

———. 1982a. Pacific Coast recovery plan for the American peregrine falcon (*Falco peregrinus anatum*). 87 pp.

———. 1982b. Recovery plan for the peregrine falcon—Alaska population. 69 pp.

———. 1983. Proposal to reclassify *F.p. tundrius* from endangered to threatened. Fed. Reg. 48: 8,796–8,801.

———. 1984. American peregrine falcon Rocky Mountain/Southwest populations recovery plan. (Revised.) 105 pp.

———. 1988. Summary of western states peregrine falcon recovery meeting, Las Vegas, Nevada, August 23–25, 1988. U.S. Fish and Wildl. Serv. Region 1, Portland, OR. 26 pp.

———. 1994. Endangered and threatened wildlife and plants; Removal of the Arctic peregrine falcon from the list of endangered and threatened wildlife. Fed. Reg. 59: 50,796–50,805.

Ward, F. P., K. Titus, W. S. Seegar, M. A. Yates and M. R. Fuller.1988. Autumn migrations of peregrine falcons at Assateague Island, Maryland/Virginia, 1970–1984. Pages 485–496 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Walker, W., W. G. Mattox and R. W. Risebrough. 1973. Pollutant and shell thickness determinations of peregrine eggs from west Greenland. Arctic 26: 256–258.

White, C. M. and T. J. Cade. 1975. Long term trends of peregrine populations in Alaska. World Conf. on Birds of Prey. Vienna. Pages 63–72.

White, C. M., R. W. Fyfe and D. B. Lemon. 1990. The 1980 North American peregrine falcon, (*Falco peregrinus*), survey. Can. Field-Natural 104: 174–181.

The Effect and Value of Raptor Rehabilitation in North America

Patrick T. Redig and Gary E. Duke
The Raptor Center at the University of Minnesota
St. Paul

Since very early in its inception, the underpinnings of raptor rehabilitation (RR) (and other forms of wildlife rehabilitation) have consisted of medical treatment (including convalescence and preparation for return to a free-living environment), research and education. All of these elements are necessarily integrated and important to the effective conduct of a rehabilitation program. The effectiveness of any program is greatly diminished if any one of these elements is not present and maintained. The effects and value of RR can be regarded in terms of direct and indirect impacts. The direct impacts are those that derive from (1) the contribution to raptor populations by the restoration of individual birds back to the wild, (2) medically supported research which identifies causes of morbidity and mortality as defined by birds admitted for rehabilitation, and (3) legislation and regulatory changes that are formulated on the basis of problems identified by rehabilitation. The direct effects are tangible and quantifiable within the limits of data collection abilities. The indirect effects are those that derive from (1) public and professional education about various facets of wildlife that come to light through the process of conducting wildlife rehabilitation, (2) avenues for hands-on involvement by people with wild animals, and (3) the public education efforts that accompany most rehabilitation efforts. These effects are less amenable to quantification and assessment. The purpose of this paper is to examine the direct and indirect effects in order to draw a conclusion about the role played by RR in raptor conservation.

It typically is argued in any analysis of rehabilitation that the number of birds released back to the wild is so small that it has no impact on wild populations. Allowances are made, however, for endangered species of birds such as peregrine falcons (*Falco peregrinus*) or long-lived birds, such as bald eagles (*Haliaeetus leucocephalis*) and California condors (*Gymnogyps californianus*), where adult survivorship has a major impact on population dynamics (Grier 1980). It also has been stated that if rehabilitation were to occur on a large enough scale, the numbers of birds returned to the wild could indeed have an impact on wild populations, particularly where adult, breeding-age birds are returned (Duke et al. 1981). Several attempts have been made to assess the scope and impact of raptor rehabilitation. No recent survey has been undertaken to determine present and past impact of raptor rehabilitation. For the purposes of this paper, we prepared a questionnaire which was sent to 65 of the approximately 250 rehabilitation facilities in the U.S. Participants were selected on the basis of their focus on raptors, longevity and organizational size. Questions were based, in part, on a questionnaire sent to members of the National Wildlife Rehabilitator's Association in 1986 (Horton 1987). Thirty-two questionnaires were returned. Questions were designed to obtain an overall picture of the number of different species of raptors handled in 1994 and in the total aggregate since program inception, release rate, post-release information, recognition of special morbidity and mortality causing factors, training and educational programs affiliated with the rehabilitation operation, and impacts on policy and regulation at various levels of government organization. The data from these surveys was combined with similar data from The Raptor Center at the University of Minnesota (TRC) to generate a window by which to gain a broad overview of the present scope and nature of rehabilitation operations. The effort also identified areas in which improved record keeping and further analysis would lead to improved results in any future endeavors of this type.

Results

The first question dealt with the number of raptors treated in 1994 and over the total time each organization had been operational. The range of operational time was 2 to 26 years, with the mean time being 11.5 years for the 32 respondents. Species of raptors about which information was sought included high-profile and endangered species (bald eagle, golden eagle, [*Aquila chrysaetos*]), peregrine falcon), common, widely distributed species (great-horned owl [*Bubo virginianus*], red-tailed hawk [*Buteo jamaicensis*], American kestrel [*Falco sparverius*]) and species finding urban environments well-suited to their existence (coopers hawk [*Accipiter cooperi*]). The data is presented in Table 1.

The second question dealt with the causes of injury. Respondents were asked to list and rank the top five or six causes. More than half listed vehicle collisions as the most common cause of injury. Other causes, in order, were miscellaneous trauma, especially windows and powerlines, followed closely by orphaned birds encountered by the public at fledging time or birds whose nests had been destroyed by storms or human activity. Shooting and toxicity were the remaining categories in the top five, except for one respondent who reported that shooting injuries accounted for 70 percent of their admissions.

Post-release Survival and Reassimilation of Rehabilitated Raptors

Few respondents had data about post-release survival rates among rehabilitated raptors. Time, expense and lack of other resources were the major hindrances to any large-scale and conclusive studies utilizing telemetry. Additionally, the Bird Banding

Table 1. Numbers of raptors rehabilitated in 1994 and cumulative by 32 centers in the U.S.

Species	1994	Total[a]
Golden eagle	37	198
Bald eagle	183	1,242
Red-tailed hawk	541	3,229
Great-horned owl	506	3,579
Barred owl	157	1,263
American kestrel	520	3,372
Peregrine falcon	55	330
Cooper's hawk	120	522
Total	2,119	13,735

[a]Number of years for totals ranged from 2 to 26 (average = 11.5 years).

Laboratory and many state regulatory agencies have not allowed banding of rehabilitated raptors. The longest-standing and largest database derived from banding is held by The Raptor Center at the University of Minnesota and with information on about 140 returns from bands placed on about 900 birds since 1985. We previously published information on rehabilitated and released raptors from the period 1974 through 1979 (Duke et al. 1981).

Examples of several cases of long-term survival of eagles and other raptors are as follows:

1. A bald eagle first banded as a nestling on 6/1/83 was admitted to TRC on 10/3/85 with a gunshot fracture of its right ulna and a near-lethal case of lead poisoning (1.5 ppm in the blood). It recovered from both of these problems and was released. It was recovered again on 3/31/90, four years and three months after its previous release, this time with shotgun injuries to its left metacarpus. It was not recoverable the second time.
2. Another documented case involved an adult bald eagle photographed and identified by band number in 1989 and again in 1990 in Michigan's Upper Peninsula by a wildlife photographer operating out of a blind. The band number was read from a photograph and it was learned that this particular bird had been admitted to TRC in the autumn 1981 with a rifle bullet injury that had fractured its right humerus. It was released along the Mississippi River in the winter of 1982 and was not seen again until encountered at the photographer's blind seven years later.
3. Another documented case involved an adult bald eagle recovered near Grantsburg, Wisconsin in spring 1994 with organophosphate poisoning. Released four weeks later at a refuge near Fargo, North Dakota, it was found a year later within 1–2 miles of the site of the original poisoning in Wisconsin, poisoned again, this time dead.
4. An adult bald eagle was released on 2/6/88 near St. Paul, Minnesota and was resighted on 9/24/89 at Cheyenne Bottoms Refuge near Great Bend, Kansas.
5. A great-horned owl admitted in 1984 after being tangled in a fence and sustaining a fractured digit and corneal abrasion, was released the following June. It was recovered eight years later after a fatal collision with a car.
6. The Wildlife Center of Virginia reported one rehabilitated bald eagle nesting and fledging young the year following its release and still present three years later (Porter personal communication).
7. The Raptor Trust in Millington, New Jersey reported a red-tailed hawk, Eastern screech owl (*Otus asio*) and barn owl (*Tyto alba*), all known to have survived two, three, and four years, respectively, following release.
8. Treehouse Wildlife Center in Brighton, Illinois reported a red-tailed hawk and a barred owl (*Strix varia*) to be still surviving five and seven and a half years, respectively, after release.
9. A center in New York reported a great horned owl, blind in one eye, still surviving after four and a half years.
10. Tufts Wildlife Clinic reports a bald eagle still surviving seven years after release.
11. An adult bald eagle had been recovered in Arkansas on January 15, 1995 (K. Yaich personal communication) with a U.S. Fish and Wildlife Service marker that had been attached to a former patient at TRC. This bird had been admitted as an adult in July 1988 from St. Louis County in Minnesota with a severe,

debilitating bacterial infection (*Edwardsiella tarda*). It was released on August 19, 1988 near the site from which it had been recovered. It most recently had become caught by the halux in a steel-jawed trap. The injury was successfully treated and the bird was released on February 16, 1995.

Further information about survival is gained from marked and monitored peregrine falcons that have been rehabilitated and released. Four peregrines belonging to the captively propagated and hacked founder population in the Midwest have been injured and released. Two are members of active pairs and each has produced two or more clutches of offspring since release. Additionally, a female in Colorado was injured, released and alive for three years, producing young in two of those years.

Despite the lack of large-scale follow-up on the success of released birds, there is good evidence of survivability among birds that have been radio-tagged and/or banded, suggesting that post-release survivorship of a rehabilitated raptor is a reasonable expectation provided strict criteria for performance ability are observed prior to release (Redig et al. 1988, see also Appendix). Whether such survivorship is on par with that of raptors which have not sustained injury or other life-threatening events hasn't been examined, however, urban environments might provide an opportunity for such comparative studies.

Discussion of Direct Impacts of Rehabilitation

Critics maintain and proponents, lacking evidence to the contrary, are compelled to agree that the rehabilitation and release of the relatively small number of individuals of a species may have little or no impact on a population and some maintain that it might be detrimental (Cooper 1987). Fraser and Moss (1985) give three conditions by which rehabilitation could alter substantially the dynamics of a population: (1) the number of animals released must be a large fraction of the total population; (2) the increased survival rate of treated animals must not be offset by increased mortality among the untreated part of the population; and (3) any change in mortality rate caused by rehabilitation must not result in changes in natality, immigration or emigration rates that compensate for the survival of rehabilitated animals. These conditions are likely to be met only in small populations with low natural mortality rates.

We would have to agree that rehabilitation may not meet these criteria and, thus, no argument is made *a priori* that rehabilitation alters population dynamics. Even with endangered species, Fraser and Moss (1985) indicate that there is no documentation of actual enhancement of such populations by rehabilitation. It could be argued, however, that the release of domestically reared falcons differs little from releasing orphaned raptors or rehabilitated birds and, in this regard, populations of endangered species have been enhanced by a technique closely allied to rehabilitation. Importantly, however, documentation suggesting that rehabilitation is detrimental to dynamics of wild populations is equally lacking.

These comments notwithstanding, the question of whether rehabilitated birds can be released in sufficient numbers to impact populations bears redress in light of a growing volume of data. Ingram (1986) reported on band returns from 41 birds released in a seven-year period out of 1,289 admitted (9 percent). Duration of survivorship exceeded three years in some instances and this surviving group included some partially handicapped birds.

Duke et al. (1981) concluded on the basis of limited data available then (648 released of 1,693 admitted band returns on 23 or a 4 percent return rate) that properly rehabilitated raptors had normal longevity and reassimilated into the pool of breeding birds. Noteworthy among their data were eight bald eagles seen more than two weeks after release, two of which were seen again between six months and two years after release and were tending nests. Additionally noted were a rough-legged hawk (*Buteo lagopus*) that survived nine months and traversed a distance of 1,625 kilometers from its release site in Minnesota to its summer nesting grounds in the arctic of northern Quebec, and a great-horned owl that survived more than three years and was found 80 kilometers from the release site.

The most conclusive data about post-release survival of rehabilitated raptors was reported by Martell et al. (1991). They profiled 18 successfully released bald eagles, all of which were monitored via telemetry, using both tail-mounts and backpacks. Two mortalities were recorded, but neither was attributed to any factors associated with their previous injury and rehabilitation. One bird was caught in a steel-jawed trap, 29 days after release and 130 kilometers from release site; it had to be euthanized. The second mortality occurred 11 months after release and 800 kilometers from the release owing to lead poisoning. All others were tracked for up to six months before radio contact was lost. All birds appeared to engage in seasonally appropriate behavior. One bird was known to nest for three years subsequent to release and produced four offspring. Proper veterinary care, pre-release conditioning and release site selection were credited as factors accounting for the high rate of success seen in these cases.

Such known rates of survivorship allow us to extrapolate and speculate on the survivorship of other eagles similarly treated. Of the 1,029 bald eagles admitted to TRC in 20 years, about 463 have been released. If mortality is on the order of 1 per 20 (5 percent), as predicted by our telemetry study, then 25–30 have perished, leaving more than 425 eagles that have survived. While we can't make unfounded statements about the possible significance of these birds within the eagle population of the Midwest, so large a number of eagles is impressive to contemplate. Until more banding or radio telemetry can be done, our knowledge base about the survivorship of rehabilitated raptors will grow very slowly.

Various authors using various means have substantiated that rehabilitated raptors have a reasonable prospect for survival upon release and may, therefore, contribute to the populations of their species. Duke et al. (1981) estimated that the 250 licensed rehabilitators had the capacity to release about 7,000 birds per year back to the wild. Based on our questionnaire results and introspective analysis of the rehabilitation field, we believe of 7,000–8,000 birds per year to be a reasonable estimate of the annual effort at the present time.

There is a possible added benefit due to the bias introduced by the special character of many of the raptors that have been submitted for rehabilitation. The primary causes of injury and debilitation of raptors are the result of events occurring when they come in contact with human activity—vehicle impacts, powerline and window collisions, poisons, and shootings. As human encroachment on wildlife habitats continues unabated, and populations of various threatened and endangered raptors recover, the probability of such adverse encounters increases (Marion 1989). But, at the same time, it is these very individuals that collectively represent a portion of their respective populations that are attempting to survive in a human-altered environment (Frink

1986). Giving them a second chance increases the rate and likelihood of establishing individuals whose behavioral characteristics are compatible with this type of human-dominated environment. Such a level of adaptation already is important for peregrine falcons, ospreys (*Pandion haliaetus*) and bald eagles, and may become more so for other species in North America and elsewhere as habitat is altered by urban development (Duke 1987).

Considered in the light of the human factor in wildlife management, rehabilitation of raptors and wildlife is an inevitable consequence of our present day society. With all of the promotion and public awareness aimed at raptors and endangered species over the last 20 years, it is inconceivable that the public would tolerate a situation wherein the available medical technology of the present day could not be applied to injured birds, especially when those injuries occur, for the most part, because of human defilement of their environment.

A parsimonious assessment still must conclude that rehabilitation is neutral with regard to raptor populations (i.e., does not harm). However, if an egalitarian and comprehensive assessment is made, numerous benefits derive from the rehabilitation process that benefit people, raptors and natural resources as a whole, without any cost to agencies or the public, given the nearly pervasive condition of private funding for these efforts.

Research, Legislative and Policy Changes

Causes and rates of morbidity and mortality factors are important elements in population dynamics and in attempts to model them. However, much less is known about these important factors than most other aspects of raptor ecology (Newton 1979). Rehabilitation provides a means of identifying and semi-quantifying sources of mortality. Several major problem areas affecting raptors have been identified via rehabilitation efforts and management and monitoring in the wake of such realization is underway. Examples occur in the areas of (1) lead, mercury, fenthion and carbofuran poisoning, and (2) trapping and roost site preservation.

Lead Poisoning

Lead poisoning is a frequently occurring event among bald eagles and other raptors (Coon 1970, Craig et al. 1990). Between 1980 and 1989, blood samples were analyzed for lead residues from 203 bald eagles admitted to TRC for rehabilitation. Twenty-three of these birds were admitted specifically for treatment of lead poisoning, while the remainder were admitted for a variety of common injuries, but were found to have elevated blood lead residues when sampled. Forty-seven of the latter had elevated lead levels in their blood that were sufficiently high to compromise hemoglobin synthesis and other physiological functions. Thus, a total of 70 eagles out of 203 (34 percent) were directly or indirectly impaired by exposure to lead. These data confirmed suspicions about lead poisoning as a cause of mortality among bald eagles and was used by the National Wildlife Federation to forge regulatory changes. In 1991, the use of steelshot on all federally owned waterfowl hunting areas became mandatory, although many states implemented such regulations ahead of time. Despite the implementation of steel shot requirements, current information would suggest that the problem has not been solved (Table 2). Of further concern is that lead

Table 2. Listed rates of incidence of lead poisoning admitted to TRC between 1990 and 1994. The first data column lists number of bald eagles with any detectable lead greater than the number sampled. The second data column list rates of clinical lead poisoning (defined as greater than 0.2 ppm in blood).

Year	Detectable lead	Percentage	Lead greater than 0.2 ppm	Percentage
1990	33/49	67	18/49	29
1991	18/41	44	13/41	32
1992	29/51	57	16/51	31
1993	23/57	40	11/57	19
1994	20/41	49	14/41	34

continues to be a problem for raptors not only in North America, but elsewhere in the world (Pain 1993, Pain and Newton 1995).

Carbofuran

Carbofuran, a potent cholinesterase inhibiting compound in the carbamate class of pesticides, was incriminated as the cause of death in raptors and other species of birds by the Wildlife Center of Virginia (Porter 1993). This work led to restrictions on the use of the granular form of carbofuran in Virginia and, ultimately, nationwide.

Fenthion

Fenthion is another cholinesterase inhibiting compound with extremely toxic properties. It is used as an avicide to kill starlings and sparrows by painting the toxic material on perching surfaces. Rehabilitators in Illinois demonstrated this poison to be causing secondary or relay toxicity in raptors. Through investigation, documentation and petitioning, a three-year moratorium on the use of this compound was declared in Illinois. Regrettably, the moratorium expired at the end of 1994 and it is probable that this deadly toxin again will be employed. During the autumn and winter 1994 in Minnesota, two peregrine falcons died from fenthion poisoning acquired when they killed and ate pigeons that were succumbing to the toxic effects of fenthion (Redig unpublished).

Leg-hold Traps

In the period 1980–1989, injury by capture in leg-hold traps accounted for 23.6 percent (87 eagles) of the bald eagles admitted to TRC, making this cause the second most common identified source of injury after shooting (Redig and Martell in preparation). While shooting, vehicle collisions and electrocution have been identified by others examining carcasses of dead birds (Franson 1990), only the data from admissions to a rehabilitation facility has illuminated trapping as a significant cause of morbidity and mortality. Consequently, several midwestern states including Minnesota, Wisconsin and South Dakota have regulations restricting the use of open-bait leg-hold trap sets (thought to be attractive to eagles) for the trapping of fur-bearing mammals. Regulations specify that baits must be set a minimum distance away from the trap. In New Jersey and Massachusetts, a complete ban on the use of the leg-hold trap was implemented, in part, due to the evidence presented by rehabilitation programs documenting damage to raptors (Soucy personal communication).

Education and Public Relations

In our survey, 80 percent of the respondents reported having an educational program integrated with their rehabilitation activities. These programs consisted of formal tours of the facility, onsite prepared programs and off-site programs, all involving the use of live raptors in the presentation. These results compare favorably with those of a much larger survey of the 600+ member National Wildlife Rehabilitator's Association in which 74 percent of the 372 respondents indicated that an educational program was associated with rehabilitation (Marion 1989).

Public Education

Estimates of the number of people that come into contact with raptors and learn of related environmental issues through the medium of these rehabilitation education programs indicate that as many as a quarter million people participated in onsite tours in 1994 at various raptor rehabilitation facilities. These tours cut across all segments of society from preschoolers to senior citizens. Twenty-nine species of raptors were used in program presentations, with about 200 individual birds involved. The most commonly utilized were great-horned owls (17), red-tailed hawks (20), American kestrels (23) and screech owls (14). Bald eagles (6) and peregrine falcons (5) also were used by some. Off-site programming, primarily involving schools, also was conducted but the number of people contacted could not be estimated from our survey. However, another survey indicated that as many as 7 million people may have been so contacted in 1992 (Thrune 1992). TRC conducted 365 off-site programs in 1994, reaching an estimated audience of 90,000 people. Natural history, human impact on raptors and conservation of raptors and natural resources were the main themes stressed in these presentations. About 70 percent reported conducting public releases of rehabilitated raptors. TRC conducts two such releases annually, each attracting between 2,000 and 3,000 people. Clearly, rehabilitation is an effective tool for drawing people's attentions to wildlife concerns (Horton 1986, Marion 1989).

Professional Education

A few of the larger facilities have formal programs for training veterinary and wildlife interns. Our survey results indicated that 22 of 32 respondents had technical training programs for wildlife rehabilitators, and have provided training for a minimum of 378 individuals. Additionally, 18 of 25 veterinary colleges in the U.S., plus three in Canada, have raptor/wildlife rehabilitation programs through which veterinary students rotate. Since 1981, TRC has provided four- to six-week training internships involving 122 veterinarians and senior veterinary students. Many of these individuals have gone on to assume career positions involving wildlife health and management.

Research

Beyond the research done on diagnosis and treatment for toxins alluded to above, rehabilitation programs have made great advances in developing techniques for diagnosing and treating all of the major diseases of raptors. Within the last ten years, such heretofore deadly problems such as aspergillosis (the number one cause of death of captively held birds) and malaria have become manageable. Sophisticated techniques for anesthesia, orthopedic surgery, fluid therapy and critical care have been developed (Redig et al. 1993). Without the impetus of rehabilitation, few of these advances would have been possible.

An important point about this research, both in medical techniques and the recognition of problems, is the need for centralization of data collection and, in the case of complex medical problems, the need for centralization of facilities and staff, particularly in managing endangered species. In this way, maximum benefit can be attained from training and research opportunities, as well as having the ability to commit the necessary resources to medical care. However, since many people derive a recreational benefit from rehabilitation (Fraser and Moss 1985), it is desirable to develop a networked system wherein many people can contribute at their particular level of expertise but, at the same time, forward information and patients to centralized facilities when the best interests of both resources will be served.

Public Relations

Public relations is an important tool in wildlife management, for it is a potent means of interfacing with people and garnering support for programs (Marion 1989). Rehabilitators have learned well the power of the media and many use it extensively to educate and raise money for their operations. All but three of the respondents to our survey indicated use of both electronic and printed media. The effect is not quantifiable from the information available. With the recent implementation of on-line services and the internet (TRC has had more than 20,000 log ons to our World Wide Web Server in just two months), there is going to be a virtual explosion in the dissemination of information to the public by rehabilitation programs.

Volunteerism

Most centers reported reliance on volunteers to carry out their missions. TRC, for instance, maintains a corps of more than 200 volunteers and has an extensive training program for these people. Annually, they contribute the equivalent of 10 staff positions. Other centers reported similar situations, but the overall numbers couldn't be quantified. These people become skilled in handling birds and assisting in a variety of activities associated with rehabilitation while acquiring a good working knowledge about raptors. Motivated by the hands-on experience they enjoy, they become effective ambassadors for the cause of raptors within their own social circles.

Whether agencies should ever get involved in raptor rehabilitation as a management tool is an unanswered question. What is clear, however, is that there should be recognition that a valuable resource for management of raptors exists among the community of people involved with integrated rehabilitation and it is available at virtually no cost to the agency. Rather, it is available on the basis of cooperation, respect and joint participation in projects of importance to raptors and can be particularly potent in the areas of, but not exclusively, education and public relations (Fraser and Moss 1985, Marion 1989).

To suggest that rehabilitation has no value ignores the direct and indirect benefits described in this paper that go far beyond the return of rehabilitated birds to the wild. To suggest it may be harmful in some way is unsubstantiated and ignores the benefit that may derive from saving individuals that have been injured by non-natural modes of selection, e.g., hit by cars, powerlines, poisons, etc. Rehabilitators are encouraged again to obtain as much information about their patients as possible, keep accurate records and share this information with others. The most benefit for the most raptors and the most people will be derived from a close working relationship among all who are involved with raptors (Cooper 1987).

Acknowledgments

The authors are grateful to the individuals at various institutions who took the time to respond to our survey. We also express great thanks to the staff at The Raptor Center at the University of Minnesota for helping with questionnaire preparation, summarization, data retrieval and analysis, in particular, Barb Talbot, Jane Goggin and Mark Martell. We also thank the many individuals, foundations and corporations, as well as state and federal agencies throughout the U.S. and Canada which support rehabilitation of raptors. Lastly, we thank the staffs and volunteers of rehabilitation centers everywhere for their untiring devotion to these incredible creatures.

Appendix

Basic guidelines for management and release of rehabilitated raptors to the wild.

1. All birds should be subjected to a period of *active* physical conditioning in the three to four weeks preceding release. Chaplin (1989) described the procedure and provided performance levels to be met before raptors should be released. These cannot be met by housing raptors, even in large flight cages.
2. Any recognizable visual deficiency is grounds for retaining a raptor in captivity and ultimately denying its release unless the defect can be corrected. Unilaterally blind birds should not be released. A visual system evaluation should be part of a pre-release examination. This check should include examination of the interior of the eye with an ophthalmoscope. Owls are prone to have detached retinas from head injuries.
3. No raptor should be released to the wild if missing an entire foot.
4. No raptor should be retained in captivity if missing an entire foot without an extremely good reason, such as rarity. Personnel responsible for the management of the bird should be aware of the inevitability of the development of bumblefoot in the remaining foot and the difficulty in successfully treating such a condition.
5. Raptors should be released with good feathers. Broken feathers should be replaced by molting or imping.
6. Medical and surgical procedures, as well as long-term convalescence of raptors should occur where the chances for success are optimized. This may require the birds completing parts of their recovery at different facilities depending on the need.
7. Because of their continuing endangered and/or threatened status and the need to collect information about injury, toxicity and mortality, along with the more complex medical and surgical problems encountered in them, peregrine falcons and bald eagles should be cared for at larger centers that have a wide range of facilities, equipment and highly experienced personnel available to care for them.

8. Good record keeping is essential. Rehabilitation records are the only source of information available that even approaches giving dimension to the various kinds of injuries and problems that raptors encounter.

References

Chaplin, S. B. 1989. Guidelines for exercise in rehabilitated raptors. J. Int. Wildl. Rehab. Coun. 12(2): 17–20.

Coon, N. C., L. N. Locke, E. Cromartie and W. L. Reichel. 1970. Causes of bald eagle mortality 1960–65. J. Wildl. Dis. 6: 72–76.

Cooper, J. E. 1983. The conservation and captive management of raptors: An overview. Int. Zoo Yb. 23: 1–7.

———. 1987. Raptor care, and rehabilitation: Precedents, progress and potential. J. Raptor Res. 21(1): 21–26.

Craig, T. H., J. W. Connelly, E. H. Craig and T. L. Parker. 1990. Lead concentrations in golden and bald eagles. Wilson Bull. 102: 130–133.

Dawson, J. W. and R. W. Mannan. 1994. Electrocution as a mortality factor in an urban population of Harris' Hawks. Raptor Res. Found. Ann. Meet., abstract book.

Duke, G. E. 1987. Raptor rehabilitation: Is it significant? Pages 141–144 *in* D. J. Mackey, ed., Wildlife Rehabilitation. Vol. 6: Coconut Creek Publ. Co., Coconut Creek, FL.

Duke, G. E., P. T. Redig and W. Jones. 1981. Recoveries and resighting of released rehabilitated raptors. J. Raptor. Res. 15(4): 97–107.

Franson, J. C. 1990. Causes of mortality. *In* D. A. Best, M. Gilbertson and H. Hudson, eds., Proceedings of the expert consultation meeting on bald eagles. Int. Joint Commiss., Windsor, Ontario. 33 pp.

Fraser, J. D. and M. B. Moss. 1985. Comment: A need for agency policies on wildlife rehabilitation. Wildl. Soc. Bull. 13: 202–204.

Frink, L. 1986. Philosophy of wildlife rehabilitation: The wildlife rehabilitator's pocket guide to self-defense. Int. Wildl. Rehab. Counc. J. Winter 1986.

Grier. 1980. Modeling approaches to bald eagle population dynamics. Wildl. Soc. Bull. 8: 316–322.

Horton, R. H. 1987. Public education by the National Wildlife Rehabilitators Association: A survey report. Pages 127–140 *in* D. Mackey, ed., Wildlife rehabilitation. Vol. 6. Coconut Creek Publ. Co., Coconut Creek, FL.

Ingram, K. 1986. Survival and movements of rehabilitated raptors. *In* R. L. Glinski et al., eds., Proceedings of the Southwest Raptor Management Symposium and Workshop. Nat. Wildl. Fed., Inst. Wildl. Res., Tech. Ser. No. 11.

Marion, W. R. 1989. Wildlife Rehabilitation: Its role in future resource management. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 54: 476.

Martell, M. S. and P. T. Redig. In prep. Causes of injury and incidence of lead poisoning in bald eagles.

Martell, M. S., P. T. Redig, J. Nibe and G. Buhl. 1991. Survival and movements of released rehabilitated bald eagles. J. Raptor Res. 25(3): 72–76.

Newton, I. 1979. Population ecology of raptors. T and A D Poyser, Berkhamsted. 399 pp.

Pain, D. J. 1993. Lead toxicity in raptors in France. Ecotoxicol. Environ. Safety 25(2): 183–192.

Pain, D. J. and I. Newton. 1995. Lead in raptors in Britain. Environ. Pollution 87(2): 173–180.

Porter, S. L. 1993. Pesticide poisoning in birds of prey. *In* P. T. Redig et al., eds., Raptor Biomedicine. Univ. Minnesota Press, Minneapolis. 265 pp.

Redig, P. T., L. Degernes and M. Martell. 1988. The release of one-eyed, one-footed and otherwise physically impaired raptors. Proc. Nat. Wildl. Rehab. Assoc. Ann. Meet., Foster City, CA.

Redig, P. T., J. E. Cooper, R. D. Remple and B. Hunter, eds. 1993. Raptor Biomedicine. Univ. Minnesota Press, Minneapolis. 265 pp.

Thrune, E. 1994. Member survey report. The NWRA Quarterly 12(1): 8. St. Cloud St. Univ., St. Cloud, MN.

Conservation of Prairie Raptors

Geoffrey L. Holroyd
Canadian Wildlife Service
Edmonton, Alberta

Introduction

A wide variety of raptors occur on the Great Plains of North America. Most raptors migrate between two or more countries. The conservation of prairie raptors today is by adaptation; the raptors must adapt to the landscapes that humans create. Although raptors benefit from formally protected areas, most raptors occur outside these lands. Most raptor management activities focus on protection of the individual raptor and only rarely on conservation of their habitat.

Raptors are particularly vulnerable to changes in the environment. As predators at the top of the prairie food chain, they depend on the health of the prairie ecosystem. Likewise, raptors are sensitive biological indicators of the chemical environment. As agriculture becomes more intensive, use of pesticides increases and land conversion continues. The World Conservation Strategy identifies the Great Plains of North America as an ecosystem whose ecological processes are in jeopardy (International Union for the Conservation of Nature and Natural Resources [IUCN] 1980). More species will be at risk and become threatened or endangered unless advice on the mitigation of these land-use activities is discovered and transferred to the agricultural community.

The migration of raptors connects the prairie habitats to the Arctic and Latin America. Yet, little or no interjurisdictional communication and cooperation occurs to incorporate raptor habitat needs into this diversity of land-management practices throughout the hemisphere. This paper provides Canadian examples of how raptor habitat needs can be identified and incorporated into land management at the landscape level and proposes ways that their conservation can be enhanced internationally.

Background

The Canadian prairies support a major agricultural economy which feeds millions of people and earns important export dollars. These same lands are productive wildlife habitat for a wide diversity of birds and mammals, including waterfowl, migratory shorebirds and 26 species of raptors. The drainage of prairie wetlands is well known. Forty percent of Canadian prairie wetlands have been drained and waterfowl numbers are down from the 1950s. In response to these declines, governments in Canada and the U.S., in partnership with non-government groups, initiated the 15-year North American Waterfowl Management Plan (NAWMP). While the wetlands of the prairies are in crisis, the uplands are in even worse shape!

Most of the Canadian prairies are upland or dry land. More than 75 percent of the prairies were converted from native vegetation to urban and agricultural land, transportation corridors, and other economic activities (World Wildlife Fund 1988). Almost all (99 percent) tallgrass prairie and 90 percent of the fescue grasslands in Canada are gone. Much of the remaining native prairie is marginal agricultural land.

Soil and water conservation programs dictate that some areas be left in permanent cover to protect soil and improve water table conditions (Agriculture Canada 1990).

Habitat conservation efforts can be classified into two simple categories. Habitat can be preserved in designated reserves such as parks and wildlife refuges, or wildlife habitat needs can be integrated into other land-use activities (World Wildlife Fund 1988, Hummel and Pettigrew 1991). While reserves have an important role to play in wildlife conservation, migratory wildlife and wide-ranging species such as raptors depend on various habitats over a large area. Thus, their habitat needs must be incorporated into other land-use activities if they are to survive.

Half of the bird species on the 1994 list of the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) occur on the prairies. Most are upland not wetland species. Five are raptors. The Prairie Conservation Action Plan (PCAP), which was endorsed by the Alberta, Saskatchewan, Manitoba and federal governments, is a multiagency plan to address the decline of prairie wildlife (World Wildlife Fund 1988). This plan included 10 goals to conserve both upland and wetland prairie wildlife through reserves and landscape management. Although the plan lacked dedicated funds, its regional nature increased its profile and effect on the conservation of biological diversity in the Canadian prairies (Holroyd 1993, in press).

Because the federal Migratory Bird Convention Act of 1917 omits raptors, the provincial and territorial governments are constitutionally responsible for their welfare. Their raptor related activities focus almost exclusively within their borders. The federal government work on raptors focuses on endangered species and toxicology within Canada. Little Canadian effort is made on raptors outside of Canada, even though most species migrate to the U.S. and Latin America. In Canada, raptors would benefit from a national raptor conservation strategy and clarification of government responsibilities (Holroyd 1993).

The next sections discuss examples of the integration of raptor habitat needs into landscape management to conserve these habitats.

Prairie Falcon Habitat Needs in Southern Alberta

In prairie Canada, the prairie falcon (*Falco mexicanus*) nests along most prairie rivers. A recent study determined how nesting prairie falcons use foraging habitat in an area of intense agriculture and cattle grazing rangeland adjacent (within 30 km) to the Bow River, south of Brooks, Alberta. The field investigations determined diet using prey remains and nest watches, home ranges and foraging areas with radio telemetry techniques, and the location of prey habitat by remote sensing (Hunt 1993, Usher et al. 1992).

The diet of nesting prairie falcons in southern Alberta was dominated, both numerically (68 percent) and in biomass (94 percent), by Richardson's ground squirrels (*Spermophilus richardsonii*) (Hunt 1993). Passerines, most frequently western meadowlark (*Sturnella neglecta*), horned lark (*Eremophila alpestris*) and European starling (*Sturnus vulgaris*), dominated the bird portion of the diet numerically (27 percent). However, ducks were more important than passerines in terms of percentage of biomass (14 percent versus 6 percent).

The most important foraging habitats for nesting prairie falcons were ground squirrel colonies. Ground squirrel colonies only occurred on native range in this study area, although solitary squirrels, presumably males, were seen along roadsides. Almost half (45.4 percent) of the study area was classified as native prairie on a 1989 LANDSAT Multispectral Scanner image (Usher 1993). Irrigated cropland (34.3 percent) was the second most abundant land-use type identified. Other land-use types were tame rangeland (11.2 percent), dryland crop (1.2 percent), bare ground (4.2 percent, mostly summer fallow) and water (3.6 percent).

Ground squirrel colonies occurred sparsely scattered within native range. A partially supervised classification of the LANDSAT image found a spectral signature of known colonies which comprised 2.9 percent of the study area. The ground squirrel habitat patches were small and scattered within the native prairie. Prairie falcons foraged at least 12.5 miles (20 km) from their nest and used all of these prey habitat patches during the nestling stage. After fledging, the young use habitats further from their nests, but details of their dispersal after fledging are unknown.

Ground squirrels are considered an agricultural pest and poison grain is readily available to control their numbers. Fortunately, ground squirrels occur primarily on cattle rangeland and ranchers appear less inclined to control ground squirrels than farmers where ground squirrels are adjacent to and eat crops.

Prairie falcon populations declined in Canada. Between 1959 and 1969, Fyfe and Armbruster (1977) noted a 34-percent reduction in the number of occupied territories in Alberta and Saskatchewan. Since the cliff nest sites appear intact, this decline may be due to the absence of suitable hunting areas on the adjacent uplands. In our study area, the population declined 15 percent from 1972 to 1988, while agricultural land-uses increased 25 percent within 4 miles (6 km) of the Bow River (Hunt and Holroyd unpublished data). The trends on other rivers is unknown, but native prairie still is being converted to cultivated agricultural uses in prairie Canada. In southwestern Alberta, the Oldman Dam was completed recently and additional land is being brought under irrigated agriculture.

In summary, 94 percent of the prairie falcon's diet in the Bow River study came from 2.9 percent of the landscape. The critical minimum number and dispersion of ground squirrels around nesting falcons is unknown. The implication of this study is that all or some of the ground squirrel colonies that occupy only 2.9 percent of the landscape should be maintained if prairie falcons are going to continue to nest here. Since the prairie falcon population already has declined, the minimum area of ground squirrels likely should be higher, by at least 5 percent.

The prairie falcon is ideally suited as an indicator of the health of dryland agricultural ecosystems. Its cliff nest sites along rivers are relatively secure, but the foraging areas on the uplands are potential areas for agriculture, particularly when supported by irrigation. As a top predator and a large, fast bird of prey, the prairie falcon has the potential to be a high-profile indicator species for focusing wildlife conservation along prairie river systems. This example of prairie falcon habitat use covers only the nestling stage of their annual cycle. Many other habitats are used by prairie falcons during the rest of the year. Since some banded prairie falcons from Canada were recovered in the U.S. during winter (Schmutz et al. 1991), the falcons are dependent on habitats in two countries.

Burrowing Owl Conservation

The burrowing owl (*Athene cunicularia*) is another species that uses specific habitats during the breeding season and migrates outside Canada for the winter.

COSEWIC designated the burrowing owl as threatened. Its foraging habitats in the breeding season are uncultivated pastures and roadsides. The maximum foraging distance is 1.1 miles (1.7 km), with a minimum average foraging area of 0.9 square miles (2.4 km^2) (Haug and Oliphant 1990).

However, the foraging efficiency of nesting owls may be declining due to habitat fragmentation. Wellicome and Haug (1995) summarize three specific effects of fragmentation. Owls that occupy smaller fragments require larger home ranges and increased foraging distances; owls in smaller fragments with larger edge ratios experience higher predation; and more isolated pastures are less likely to be occupied by nesting owls than pastures close to already occupied pastures.

Productivity is low in the Regina plains. Wellicome (personal communication) found fledging rates could be increased 250 percent by supplementing the nests with dead lab mice every three days. The incidence of cannibalism also decreased. The low productivity may be the consequence of the highly fragmented, agricultural landscape. The population of burrowing owls on the Regina plains is declining and expected to be extirpated within a decade (James personal communication). Fragmentation on the Canadian prairies is most obvious on the Regina plains in Saskatchewan and Manitoba, where population declines of nesting owls have been most extreme.

The decline in the number of breeding pairs of burrowing owls in Canada is shown by the three population estimates: 3,000 in the mid-1970s (Wedgewood 1978), 2,500 in 1990 (Huag and Didiuk 1991) and 1,015–1,695 in 1994 (Wellicome and Haug 1995). While the techniques that were used to derive these estimates changed, the trends of all monitored populations are the same, declining. Other data on population trends come from 748 members of Operation Burrowing Owl (OBO) who protect 93,000 acres (37,700 hectares) of suitable habitat. OBO is a voluntary program for landowners who agree to leave native pastures where burrowing owls nest. In 1993, 68 percent of the OBO pastures that were occupied in 1986 were unoccupied.

In addition to low productivity and habitat fragmentation and loss, the burrowing owl decline may be due to death by vehicles, toxic chemicals, shootings, and unknown factors on migration and in winter. Burrowing owls that breed in Canada migrate through the western U.S. to an unknown wintering area (James 1992). The habitats used on migration are unknown. However, throughout most of their North American range, burrowing owls are associated with burrowing mammals for roost and nesting sites. One of the most common burrowing mammals, the prairie dog, was greatly reduced in abundance during the past century (Miller et al. 1994). Prairie dog towns once covered 100 to 250 million acres (40 to 100 million hectares) but, by 1960, barely covered 1.5 million acres (600,000 hectares), only 2 percent of their historic range. Most or all of this range overlaps with that of the burrowing owl. Since owls breeding in Canada are at the edge of their northern distribution and likely migrate to Mexico at the southern edge of the prairie dogs' distribution, they then are likely to be drastically affected by a 98-percent reduction of the prairie dogs' primary habitat. Thus, prairie dog control in the U.S. and Mexico may be having a dramatic effect on this Canadian breeding population. If the burrowing owl is to continue as a breeding species in Canada, its habitat requirements must be determined, and its migration and winter habitats conserved.

Migration and Winter Habitats

All of the species of raptors that breed in prairie Canada migrate into the U.S. and many (17) continue into Latin America. Other species breed in the arctic and winter on the Great Plains or migrate through the prairies and winter to the south. Their welfare is contingent on the suitability of breeding habitat, staging habitat and winter habitat in two or more countries.

Ferruginous hawks (*Buteo regalis*) are a prairie raptor that uses prairie dog towns during the winter time. The ferruginous hawk populations in Canada are stable after a decline prior to 1980 (Schmutz personal communication). However, they are classified as threatened by COSEWIC. In the summer, the density of ferruginous hawks increases with cultivation up to 20 percent, then declines (Schmutz 1989). This response to cultivation may be due to an increase in their primary prey in Alberta, Richardson's ground squirrels. Ferruginous hawks that breed in Canada winter in Texas (Schmutz and Fyfe 1987). Their migration and winter range includes much of the historic prairie dog range. The effect of the decline of prairie dogs on winter survival of these hawks is of concern in Canada (Schmutz 1987a, 1987b).

Some merlins (*Falco columbarius*) winter in Alberta while others winter in the western U.S., south to New Mexico (Schmutz et al. 1991). One merlin that was banded in Yukon was recovered in Costa Rica. Peregrine falcons (*Falco peregrinus*) migrate from Canada as far south as Peru and Columbia (Schmutz et al. 1991). Little is known about the winter habitat requirements of these falcons and conflicts with human land uses. One spring and autumn staging area for migrating peregrine falcons near Edmonton is well documented (Dekker 1984) but not well protected.

Bald eagles (*Haliaeetus leucocephalus*) are another migratory raptor. Bald eagles that stage in Montana in autumn, winter as far south as northern California and east to Colorado (McClelland et al. 1994). They migrate north through Alberta and breed in the Northwest Territories near Great Bear and Great Slave Lakes. To the east, bald eagles that winter in Colorado summer in northern Saskatchewan and Manitoba (Harmata et al. 1985). These eagles clearly require a network of suitable foraging areas throughout the year in both countries if they are to continue to prosper. Local management of habitat and conflicting human activities needs to recognize the international character of this migratory species.

Landscape Solutions

Raptors need landscape solutions for habitat conservation throughout their range. In many cases, these needs are compatible with some human land uses. Merlins will nest in urban areas and shelterbelts. Prairie falcons and other raptors will hunt in cattle rangeland. In some cases, the nest sites must be free of human disturbance to avoid abandonment. Although raptors will benefit from protected areas, prairie raptors are capable of using a patchy environment created by the continuing agricultural conversion and irrigation of dryland prairies. The interspersion of habitat with suitable prey within a land-use area will determine the foraging strategy and success and, ultimately, the breeding success of raptor populations.

Raptors are high-profile predators that can be used to promote the conservation of upland or dryland habitats to benefit many species. Since their habitat needs often include habitat fragments, not a total area, their needs can be readily incorporated into human land uses (Holroyd et al. 1995). Raptors can be used to integrate multi-species wildlife conservation needs with agriculture. They can be used as an indicator to monitor the health of prairie habitats. Most of the threatened and endangered wildlife on the prairies survive on dryland habitats. The ultimate objective is to protect habitat for a broad diversity of wildlife, including native plants, while recognizing that landowners must make a living on the same land base. The integration of the habitat needs of prairie raptors with current and future agricultural land-use practices in southern Canada will help to ensure that these internationally migratory species continue to exist.

International Conservation

Because many raptors breed in one country and winter in another, some form of international conservation effort is needed to enhance the implementation of landscape management. Since at least some species have specific winter and summer ranges, the raptors need suitable habitat maintained in both areas, as well as staging habitats between. The management of these habitats is more likely to happen within an international context. The solution to local problems concerning raptors will take on a new perspective when the participants realize that the wildlife is shared with another country.

There are many other examples of habitat needs of raptors on the breeding grounds, on migration and in winter throughout Canada, the U.S. and Latin America. However, there are few examples of international cooperation to manage and protect these habitats for raptors as they exist to protect other species. Flyway councils and NAWMP are two examples of international cooperation to manage waterfowl populations and their habitat in Canada, the U.S. and Mexico. The Western Hemispheric Shorebird Reserve Network protects habitat for shorebirds on the prairies and throughout the hemisphere (Dickson and Smith 1991). More recently, the Partners in Flight program profiled the need for international cooperation in the conservation of neotropical migrant birds and their habitats, including some migratory raptors. However, it is primarily a U.S. initiative, with no equivalent in Canada or most Latin American countries.

Raptors are omitted from the Migratory Bird Treaty between Canada and the U.S., but were included in the treaty between the U.S. and Mexico. Whereas other species benefitted from international treaties and agreements, raptors have no cooperative ventures to protect them or their habitats. An international framework for raptor conservation should facilitate assistance, training and formal education opportunities between developed and developing nations, in this case, between Canada and the U.S. and Latin American countries. In Latin America, raptor conservation will depend on trained biologists, suitable solutions to land-use activities that affect raptor habitat and the desire to implement these solutions. All these require assistance from Canada and the U.S.

Currently, at least two international agreements exist which can be used to develop raptor conservation strategies: the Biodiversity Convention and the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere. The Biodiversity Convention is relatively new and has not yet developed specific instruments for developing and implementing multinational agreements. The Western

Hemisphere Convention is old (1942) (Lyster 1985) and has had five technical meetings concerning conservation of marine mammals, major ecosystems, migratory animals, education and training relevant to protected areas, and the legal implementation of the above. However, the convention currently is inactive without a specific secretariat within the Organization of American States, its administrative umbrella. While most nations in the western hemisphere ratified the Biodiversity Convention, all but Canada and Cuba ratified the Western Hemisphere Convention.

Raptors need a hemispheric technical meeting under one of these conventions to promote their conservation. The technical meeting should develop a list of raptor conservation needs, priorities and specific actions in the many countries involved in the species' ranges. The scope of the meeting becomes large with the inclusion of intratropical migrants, as well as temperate migrants from Canada and the U.S.

Conclusion

Many prairie raptor habitats are compatible with some human land uses. A better understanding of their habitat needs and the interspersion of these habitats in modified landscapes will provide a basis for managing the landscape to benefit landowners, raptors and other wildlife. An international agreement to conserve raptors would increase the opportunities to implement the conservation of raptor habitats.

Acknowledgments

The Prairie Falcon Project was jointly funded by Alberta Sports, Recreation, Parks and Wildlife Foundation; Canadian Wildlife Service; Concordia College; North American Waterfowl Management Plan; Edmonton Natural History Club; Summer Temporary Employment Program (S.T.E.P.); Alberta Remote Sensing Center of Alberta Forestry, Lands and Wildlife; and World Wildlife Fund Canada. I thank Laurie Hunt, Paul James, Joe Schmutz and Troy Wellicome for access to unpublished data; Ursula Banasch for comments on a draft of this manuscript and Vi Jespersen for assistance in preparation of the manuscript.

References

Agriculture Canada. 1990. Growing together. Rept. to Minister of Ag., Fed.-Prov. Ag. Comm. on Environ. Sustain. Ottawa.

Dekker, D. 1984. Spring and fall migration of peregrine falcons in central Alberta, 1979–83, with comparisons to 1969–1978. Raptor Res. 18: 92–97.

Dickson, H. L. and A. R. Smith. 1991. The western hemisphere shorebird reserve network and the prairie shorebird program. Pages 152–162 *in* G. L. Holroyd, H. L. Dickson, M. Regnier and H. C. Smith, eds., Proceedings of the Third Prairie Conservation and Endangered Species Workshop. Natur. Hist. Occas. pap. No. 19. Provincial Mus. of Alberta, Edmonton.

Fyfe, R. W. and H. J. Armbruster. 1977. Raptor research and management in Canada. Pages 282–293 *in* Proceedings of the ICBP World Conference on Birds of Prey, Vienna, 1975.

Harmata, A. R., J. E. Toepfer and J. M. Gerrard. 1985. Fall migration of bald eagles produced in northern Saskatchewan. Blue Jay 43: 232–237.

Haug, E. A. and A. B. Didiuk. 1991. Updated status report on the burrowing owl in Canada. Prepared for the Committee on the Status of Endangered Wildlife in Canada, Can. Wildl. Serv., Ottawa.

Haug, E. A. and L. W. Oliphant. 1990. Movements, activity patterns, and habitat use of burrowing owls in Saskatchewan. J. Wildl. Manage. 54: 27–35.

Holroyd, G. L. 1993. Toward a Canadian conservation strategy for raptors. Pages 195–200 *in* Holroyd, G. L., H. L. Dickson, M. Regnier, and H. C. Smith, eds., Proceedings of the Third Prairie Conservation and Endangered Species Workshop. Natur. Hist. Occas. paper. No. 19. Provincial Mus. of Alberta, Edmonton.

———. In press. Conservation of spaces and species on the Canadian prairies. Proceedings of the 1993 annual meeting of the Canadian Council on Ecological Areas. Min. of Natur. Resour., Toronto, Ontario.

Holroyd, G. L., I. Shukster, D. Keith and L. Hunt. 1995. A landowner's guide: Prairie raptors. Can. Wildl. Serv., Environ. Can. 48 pp.

Hummel, M. and S. Pettigrew. 1991. Wild hunter, predators in peril. Key Porter Books Ltd., Toronto, Ontario.

Hunt, L. E. 1993. Diet and habitat use of nesting prairie falcons (*Falco mexicanus*) in an agricultural landscape in southern Alberta. Unpubl. M.S. thesis, Univ. Alberta, Edmonton.

International Union for the Conservation of Nature and Natural Resources. 1980. World conservation strategy, living resource conservation for sustainable development. IUCN–UNEP–WWF. Gland, Switzerland.

James, P. C. 1992. Where do Canadian burrowing owls spend the winter? Blue Jay 50 (2): 93–95.

Lyster, S. 1985. International law. Grotius Publications Ltd., Cambridge. 470 pp.

McCelland, B. R., L. S. Young, P. T. McClelland, J. G. Crenshaw, H. L. Allen and D. S. Shea. 1994. Migration ecology of bald eagles from autumn concentrations in Glacier National Park, Montana. Wildl. Mono. 125: 1–61.

Miller, B., G. C. Ceballos and R. Reading. 1994. The prairie dog and biotic diversity. Conserv. Biol. 8(3): 677–681.

Schmutz, J. K. 1987a. An estimate of population size and probably causes of population stability in ferruginous hawks in southeastern Alberta. Unpubl. rep., Alberta Fish and Wildl. Div., Recreation Parks and Wildl. Found., World Wildl. Fund Canada, Special Areas Board, Can. Wildl. Serv., and Univ. Saskatchewan. 45 pp.

———. 1987b. Population size, distribution and survival of ferruginous hawks in N.W. Texas. Unpubl. rept., World Wildl. Fund Canada and Univ. Saskatchewan. 36 pp.

———. 1989. Hawk occupancy of disturbed grasslands in relation to models of habitat selection. Condor 91: 362–371.

Schmutz, J. K. and R. W. Fyfe. 1987. Migration and mortality of Alberta ferruginous hawks. Condor 89: 169–174.

Schmutz, J. K., R. W. Fyfe, U. Banasch and H. Armbruster. 1991. Routes and timing of migration of falcons banded in Canada. Wilson Bull. 103(1): 44–58.

Usher, R. G. 1993. Assessment of critical prairie falcon foraging habitat in southern Alberta using landsat imagery and GIS technology. Unpubl. rept., Can. Wildl. Serv., Edmonton, Alberta.

Usher, R. G., J. A. Dechka and G. L. Holroyd. 1992. Assessment of critical prairie falcon foraging habitat in southern Alberta using satellite imagery and GIS technology. Pages 3–6 *in* Hornsby, J. K., D. J. King and N. A. Prout, eds., Proceedings of the 15th Canadian Symposium on Remote Sensing. Toronto, Ontario. 504 pp.

Wedgwood, J. A. 1978. The status of the burrowing owl in Canada. Prepared for the Committee on the Status of Endangered Wildlife in Canada. Can. Wildl. Serv., Ottawa.

Wellicome, T. I. and E. A. Haug. 1995. Updated report on the status of the burrowing owl in Canada. Unpubl. rept., COSEWIC, Can. Wildl. Serv., Ottawa.

World Wildlife Fund Canada. 1988. Prairie conservation action plan. Toronto, Ontario. 84 pp.

A Profile of Falconers in the United States: Falconry Practices, Attitudes and Conservation Behaviors

R. Ben Peyton, Joseph Vorro and Lisa Grise
Michigan State University
East Lansing

Rick Tobin
Strategy Research Corporation
Miami, Florida

Roger Eberhardt
Michigan Department of Natural Resources
Lansing

Introduction

Falconry has enjoyed varying degrees of popularity during its long history as the 4,000-year-old art of taking game with a trained bird of prey. Following the advent of firearms, the need for and popularity of falconry waned and the practice became relegated to leisure-time activity and recreation. As a result, many of the training and arcane aspects of falconry were almost lost between the 17th and 20th centuries. An increasing interest in this form of hunting has existed for the past 75 years in the United States. Recent advancements by modern falconers in the area of domestic raptor propagation have provided important contributions to reintroduction efforts to protect these valuable species from ultimate demise (Cade 1982: 52).

Falconry is authorized and regulated by rules of the United States Fish and Wildlife Service (USFWS) and currently is permitted by 46 states. The federal government sets minimum standards to be used by states for issuing falconry permits. The number of licensed falconers has increased by an average of 153 new permits annually since 1986 (Brohn et al. 1986). The requirements for conduct in the sport are particularly detailed. Included are a written examination, facilities and equipment standards and inspection, stringent raptor marking and reporting guidelines, apprenticeship and progressive classes of falconry permits. Federal and state laws also establish standards to ensure the health and welfare of the raptor resource, and specify those species which may be used in the sport (U.S. Fish and Wildlife Service 1989).

The rigorous regulation of falconry and the population dynamics of the species involved, make this a unique form of recreation with potential for both benefits and costs to the raptor resource. Despite a long history in the United States as a recreational form, no comprehensive study has been conducted on U.S. falconers. The study of licensed falconers reported here was intended to establish baseline data on selected demographics and falconry practices, and to explore the recreational dynamics of this unique group. The study also explored the conservation attitudes and behaviors of falconers as a basis for preliminary assessments of the group's overall impact on conservation of raptors and other resources.

Methods

A questionnaire was designed to solicit information regarding falconers' demographics, consumptive and nonconsumptive wildlife practices, and contributions towards environmental resources. Drafts were revised after being reviewed by panels of experts in falconry and survey design. The survey was pretested using 50 names and addresses selected randomly from a 1990 list of licensed U.S. falconers provided by the USFWS. Returns were analyzed for clarity of response, comments by respondents and appropriate use of survey instructions. Modifications resulted in a final 12-page questionnaire. Format of the items included open-ended questions (e.g., information regarding species of raptors in possession), checklists and adaptations of Likert scale responses.

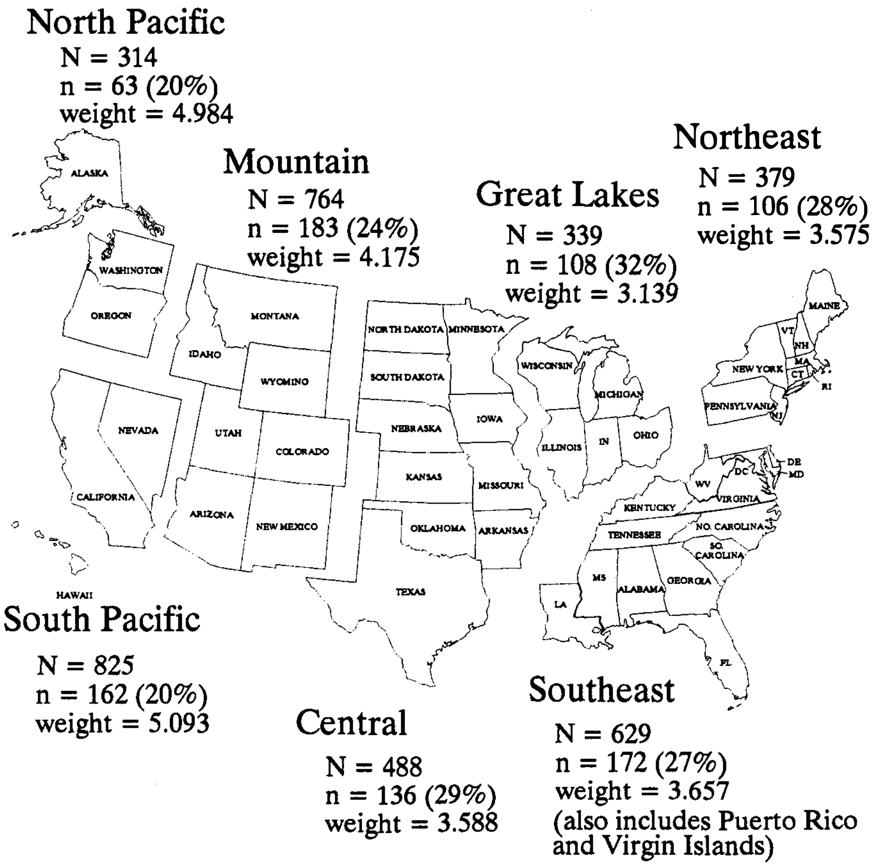
A 1991 USFWS list of 3738 licensed falconers was used to draw a sample of 2,100 names and addresses. Unusable addresses (n = 28) were removed from the list before sampling. Each individual received an announcement letter explaining the survey one week before questionnaires were sent with cover letters and pre-addressed, stamped, return envelopes. Recipients were told the purpose of the survey and assured that any information they provided would remain confidential. A second mailing with the same questionnaire package was sent out approximately 45 days later by first-class mail to those who had not yet responded. No study of nonrespondents was conducted.

Returned questionnaires were entered into a computer using a typical data entry package with 100-percent key verification. Regions of the U.S. defined by the North American Falconers Association (Figure 1) were used to assess the extent to which returned questionnaires represented the distribution of falconers. All data were coded with the state of origin and weights were calculated using the total number of individuals issued permits by the USFWS (weight = number of issued permits in region/number of returned questionnaires in that region). All regional analyses used unweighted (actual respondent) data. Unless otherwise identified as unweighted, all other analyses are presented here with weighted data which project the findings from 930 respondents to the population of 3,738 permit holders. Statistical analysis was performed with Statistical Package for the Social Sciences (SPSS, version 6.1). For statistical significance, alpha was set at 0.05.

Results

Of the 2,100 questionnaires mailed, 188 were undeliverable and 930 usable questionnaires were returned, producing a response rate of 49 percent. Most falconers were male (88 percent), married (69 percent), with at least some college education (83 percent) and grew up in an urban area of 50,000 or more (45 percent). Most (82 percent) reported being registered voters and 86 percent of these reported voting in the most recent (1988) election. Only 4 percent belonged to a nonwhite ethnic group. The median age was 38.3 years; 73 percent were between the ages of 24 and 45 (Table 1). Few (12 percent) grew up in rural areas (versus small cities or urban environments). Only 29 percent had an annual household income of less than \$30,000 (the 1991 median household income for the U.S.) (U.S. Department of Commerce 1992).

Some statistically significant differences (alpha = .05) in demographic and other descriptive characteristics existed between regions. Female respondents were most



N = number of licensed falconers in the region (1992)

n = number of respondents from the region (% of licensed falconers in the region)

weight = assigned weight for region respondents

Figure 1. Definitions of U.S. regions used in weighting the sample of falconers for analysis. The number of falconers licensed in each region, the number of surveys returned from each region and the weights assigned to each are included.

abundant in the South Pacific region (18 percent) and least represented in the Southeast region (6 percent) (Pearson Chi-square = 13.25; df 6; P = 0.04). The South Pacific region also had the highest percentage of nonwhite ethnic groups represented (7 percent compared with 1 to 5 percent for the other regions) (Pearson Chi-square = 46.97; Df 6; P = 0.03). While the proportion of respondents registered to vote did not vary significantly across regions, Great Lakes respondents were most likely to have reported voting in the 1988 election (93.8 percent) and North Pacific respondents

Table 1. A comparison of selected variables between the 1992 sample of U.S. licensed falconers and hunters in the 1991 National Survey of Fishing, Hunting, and Wildlife Associated Recreation (U.S. Fish and Wildlife Service and U.S. Bureau of the Census 1993).

	Sample of U.S. licensed falconers (1992) (weighted n = 3,738)[a]	Sample of U.S. hunters who purchased licenses in 1991 (weighted n = 11,986,000)
Age (percentage)		
16–24 years	5.5[b]	18.6
25–44 years	73	53.8
45–54 years	14	15.6
55+ years	6.5	12
Household income		
percentage above $30,000	71	59
Education		
percentage beyond high school education	83	40
Gender		
Percentage female	12	8
Percentage who hunted		
Big game in 1991	31 (Average: 5.6 days)	76 (Average: 12 days)
Small game in 1991	28 (Average 6.6 days)	34 (Average: 10 days)
Migratory birds in 1991	20 (Average: 3.3 days)	21 (Average: 7 days)
Median days spent hunting per year	36 (with falcon)	< 10 days (general)
Percentage engaging in primary nonconsumptive wildlife activities[c]	85	33

[a]Weighted to reflect regional representation of the sample.
[b]Includes 0.2 percent who were aged 15.
[c]Defined by the USFWS as traveling more than 1 mile from home for the primary purpose of observing, feeding or photographing wildlife.

least likely (74 percent) (Pearson Chi-square = 12.70; Df = 6; P = 0.048). There were no regional differences found for respondent age, marital status, education level or household income.

Nearly all respondents (97 percent) reported they possessed a U.S. falconry permit in 1992. Some falconers (30 percent) also had other permits including non-U.S. falconry permits (less than 1 percent), raptor propagation permits (10 percent), wildlife/raptor rehabilitation permits (9 percent), bird banding permits (5 percent), educational/special purpose permits (5 percent) or some other type of wildlife possession permit (2 percent). More respondents reported having raptor propagation permits from Northeast, Southeast and Mountain regions (13, 12 and 14 percent, respectively), and fewest held these permits from Great Lakes and South Pacific regions (4 and 5 percent, respectively) (Pearson Chi-square = 15.20; Df 6; P = 0.018). Fewer than 4 percent of the respondents from South Pacific, Central, Great Lakes and Southeast regions reported bird banding permits, compared with 12, 8 and 8 percent of Northeast, Mountain and North Pacific respondents, respectively (Pearson Chi-square = 20.76; Df 6; P = 0.002). Northeast respondents also reported a much higher number of education/special purpose permits (13 percent compared with less than 6 percent for all other regions) (Pearson Chi-square = 18.85; Df 6; $P = 0.004$).

Most falconers (67 percent) were members of the North American Falconers Association (NAFA). NAFA membership was lowest among South Pacific, Southeast and Mountain regions (56, 65 and 66 percent, respectively). In other regions, 73 to 79 percent were members of NAFA. Falconers also were members of regional, state or local falconry clubs (67 percent). Membership in regional, state or local clubs ranged from 91 percent of the North Pacific respondents to 57 percent of the Southeast respondents and for other regions varied between 63 and 73 percent (Pearson Chi-square = 26.91; Df 6; $P < 0.001$). Membership also was reported for the Peregrine Fund (24 percent), Raptor Research (8 percent) and the North American Raptor Breeders Association (NARBA) (6 percent). No regional differences existed in NARBA or Raptor Research membership, however, 24 to 33 percent of the western and central region respondents were members of the Peregrine Fund, compared with 16 to 19 percent of the Great Lakes and eastern region falconers. In addition, 27 percent of the respondents were members of one or more sportsman's organizations, with the National Rifle Association having the highest rate (19 percent) of membership of eight sportsman's organizations listed in the questionnaire. This pattern did not vary among regions.

The majority of falconers (59 percent) also hunted with methods other than falconry and 63 percent purchased a 1991 fishing license. Those who hunted other than with raptors reported that, in 1991, they had hunted big game (53 percent), small game (55 percent), migratory birds (35 percent), and other types of game (13 percent) (Table 1).

Most falconers also engaged in nonconsumptive wildlife recreation (Table 1). Eighty five percent of the falconers spent a mean of 41 days (S.E. 1.41) traveling more than a mile from their homes for the primary purpose of viewing, photographing or feeding wildlife (i.e., primary nonresidential, nonconsumptive wildlife activity). In contrast, the 1991 USFWS National Hunting and Fishing Survey reported that 39 percent of the total U.S. population (16 years or more) spent an average of 1.1 days in this form of activity (U.S. Fish and Wildlife Service and U.S. Bureau of Census 1993). Thirty-three percent of U.S. hunters traveled for the primary purpose of nonconsumptive use of wildlife. Residential nonconsumptive activities also were practiced by 89 percent of the falconers (mean days = 122; S.E. 2.47).

Falconry Practices

Virtually all (99.4 percent) respondents had practiced falconry at some time. The average experience in falconry was 15.3 years; the median was 14 years and 25 percent had 4 years experience or less. Attempts to take quarry during the past (1991) season were reported by 75 percent, and 68 percent reported they were working with one or more birds for falconry purposes at the time of the survey. Falconers averaged 38 days (S.E. .478) in a typical year hunting with a raptor.

Falconry-related expenditures reported by falconers for 1991 included the care, feeding and health of birds (mean $253 per year; S.E. 7.55), and the construction of mews (mean $191 in 1991; S.E. 9.022). For the 14 percent who reported they purchased a bird in 1991, the average cost was $1,010 (S.E. = $106; range = $10–$8,500).

The average age reported by respondents for their first interest in falconry was 17 years (unweighted S.E. .297), and for working with their first raptor, 23 years (unweighted S.E. .350). When they first worked with a raptor, Mountain, South Pacific and North Pacific region falconers were youngest (mean 20.2, 22.2 and 21.8 years, respectively) and Northeast and Southeast region falconers oldest (mean 25.9 and 25.1 years) ($F = 5.43$; Df 6, 912; $P < 0.001$).

Respondents were asked to identify major factors (if any) which initiated their participation in falconry. "Reading about falconry" influenced 45 percent of the falconers, 22 percent indicated they had been introduced by a friend and 8 percent had been introduced by a relative. Seeing someone working with a raptor influenced 21 percent.

Federal law requires that individuals serve two years as an apprentice before becoming a general class falconer, and gain an additional five years experience or equivalent before advancing to the master class falconer level. We estimated the number of falconers in each class by analyzing the number of years of experience in falconry reported by individuals. These estimates indicate 15 percent of the falconers were apprentices ($n = 560$), 20 percent were general class falconers and 65 percent were master class falconers in 1992. However, based on numbers of apprentices reported by survey respondents, 21 percent of the falconers had a total of 1,079 apprentices serving under them in 1992.

A majority of falconers (62 percent) reported that the red-tailed hawk (*Buteo jamaicensis*) was the species of raptor first possessed. American kestrels (*Falco sparverius*) were the first raptor for another 28 percent. Federal law restricts apprentices to these two species except in Alaska. No other species was named as their first bird by more than 2 percent of the remaining respondents.

Respondents were asked to list the individual raptors they had in their possession during the 12 months preceding the survey, how each was obtained and the total years each bird was in their possession (Table 2). Hybrids constituted 16 percent (weighted $n = 795$) of the birds reported in possession in 1991, with the most common hybrids being crosses of peregrine (*Falco peregrinus sp.*) with prairie falcons (*Falco mexicanus*) (weighted $n = 314$), and gyrfalcon (*Falco rusticolus*) with peregrine falcons (weighted $n = 276$). Excluding hybrids and exotic species, 14 species of birds were listed by respondents. More red-tailed hawks were possessed by falconers than any other species of raptor in the 12 months prior to the survey in 1992 (Table 2). The majority (84 percent) of red-tails were taken as wild passagers (subadults captured during their first migration) and had been in possession for an average of 1.8 years. Harris' hawks (*Parabuteo unicinctus*) were the next most common species; however, unlike red-tailed hawks, most Harris' hawks (86 percent) were captive bred. The prevalence of captive bred Harris' hawks is largely because only Arizona, Texas and New Mexico permit the removal of this species from the wild. Falconers had Harris' hawks in their possession for an average of 3.1 years. Of the 14 North American species reported to be in possession in 1991, 47 percent had been captive bred, 35 percent taken as wild passagers and 18 percent taken as wild eyases (nestlings). Respondents also were asked how many North American birds they personally had removed from the wild on their own falconry permit during the past five years. All species in Table 2 were listed for the respondents except the red-shouldered hawk (*Buteo lineatus*) and great-horned owl (*Bubo virginianus*). A total of 5,996 birds (1,200 per year) of these species and 94 of "other" species were reported removed from the wild by falconers during that five-year period.

Table 2. The number, source and years in possession of the most common birds reported to be in possession during the 12 months preceding the 1992 survey.

Species	Actual number reported[a]	Weighted number[b]	(Weighted) Percentage taken as: Wild eyas[c]	Wild passage[d]	Captive bred	Years possessed mean (S.E.)
Red-tailed hawk *(Buteo jamaicensis)*	352	1,347	15	84	1	1.8 (0.053)
Harris' hawk *(Parabuteo unicinctus)*	221	900	6	8	86	3.1 (0.087)
Peregrine falcon *(Falco peregrinus)*	118	502	0	0	100	1.9 (0.083)
Goshawk *(Accipiter gentilis)*	76	302	77	20	2	1.8 (0.096)
Kestrel *(Falco sparverius)*	55	222	30	64	5	0.96 (0.055)
Cooper's hawk *(Accipiter cooperii)*	50	202	72	28	0	1.2 (0.113)
Prairie falcon *(Falco mexicanus)*	49	207	47	37	16	1.7 (0.116)
Gyrfalcon *(Falco rusticolus)*	33	145	4	22	75	1.9 (0.120)
Merlin *(Falco columbarius)*	26	105	7	90	3	1.1 (0.123)
Golden eagle *(Aquila chrysaetos)*	10	41	24	11	65	4.4 (0.653)
Sharp-shinned hawk *(Accipiter striatus)*	8	33	72	28	0	1.3 (0.234)
Great-horned owl *(Bubo virginianus)*	8	33	100	0	0	1.7 (0.286)
Ferruginous hawk *(Buteo regalis)*	4	16	75	0	25	3.9 (0.660)
Red-shouldered hawk *(Buteo lineatus)*	3	11	64	36	0	.5 (0.273)
Exotic species	32	127	NA	NA	NA	NA
All hybrids	194	795	0	0	100	NA
Total	1,239	4,988				

[a]The number of birds reported in possession during 1991 by 930 respondents.
[b]The number projected to be in possesion by the population of 3,738 falconers using weighted data to reflect regional differences in the sample.
[c]Wild eyas is a nestling removed from the wild.
[d]Wild passage refers to wild subadult birds taken during their first migration.

Attitudes About Falconry

A list of motivations was presented and respondents were asked to rate the importance of each as a reason they began participating in falconry (Table 3). Motivations to work with the birds (e.g., training, taking care of and hunting with raptors) were very important early motivational factors. The excitement and/or challenge of capturing a wild raptor, companionship of other falconers and getting away from work or stress were important, but less so. However, eating or displaying game and displaying the raptors themselves were rated very low in importance.

Table 3. A comparison of the importance of potential motivations for practicing falconry at the time of initiating participation into falconry (recruitment) and at the time of the survey (current) using unweighted data. (Scale ranges from "Extremely Important" = 5 to "Not At All Important" = 1.)

Motivation Item: *"How would you rate each of the following as a motivation . . . [at recruitment] [for current participation]"*	Importance: recruitment mean (S.E.)	Importance: current mean (S.E.)	Paired differences (S.E.)	*t*-value	df	Sign.
Excitement . . . challenge of capturing a wild raptor	3.36 (0.05)	3.11 (0.05)	–0.24 (0.04)	5.45	878	<0.001
Training a raptor	4.41 (0.03)	4.25 (0.03)	–0.16 (0.03)	5.24	876	<0.001
Taking care of a raptor	4.27 (0.03)	4.07 (0.04)	–0.20 (0.03)	6.57	868	<0.001
Hunting with a raptor	4.43 (0.03)	4.54 (0.03)	+0.11 (0.03)	–3.77	872	<0.001
Experiencing a rewarding association with a wild animal	4.49 (0.03)	4.50 (0.03)	+0.01 (0.03)	-0.41	878	0.68
Eating the game taken	1.76 (0.04)	1.74 (0.04)	–0.02 (0.03)	0.55	864	0.58
Displaying or talking about the game taken	1.66 (0.03)	1.70 (0.03)	+0.04 (0.03)	–1.50	870	0.13
Displaying or talking about your raptor(s)	2.37 (0.04)	2.40 (0.04)	+0.03 (0.03)	–0.98	862	0.33
Enjoyment of improving falconry skills and knowledge	4.31 (0.03)	4.40 (0.03)	+0.09 (0.03)	–3.17	879	0.002
Compaionship of other falconers	2.77 (0.04)	3.03 (0.04)	+0.26 (0.03)	–7.88	877	<0.001
Need to get away from work and other stresses	2.79 (0.05)	3.22 (0.05)	+0.43 (0.04)	–11.10	867	<0.001

Respondents rated the importance of the same items as motivations for their current participation in falconry (Table 3). The importance of each motivation at recruitment and current stages of participation was compared using pair-wise statistical tests (Table 3). The desire to train and take care of a raptor became less important, and hunting with a raptor and improving skills and knowledge became more important; however, all remain important motivations for falconers. The challenge of capturing a wild raptor became less important as a motivation for current participation than it was as a recruitment motivation, while companionship of other falconers and getting away from stress became more important as current motivations. The importance of a rewarding association with a wild animal, displaying raptors and eating game was unchanged.

Respondents were asked how important falconry was to them in comparison with all other forms of recreation in which they participated. Six response options ranged from "most important" to "not at all important." The majority (55 percent) of falconers considered falconry their most important recreational activity and 33 percent indicated it was more important than most other recreation activities. When asked whether their interest in falconry had increased, decreased or stayed the same over the past five years, nearly half (46 percent) reported that their interest in falconry had increased over the past five years, and another 40 percent said it remained about the same. The remaining 14 percent felt their interest had declined because falconry required too much time (41 percent), they did not have enough opportunities to hunt with their raptors (41 percent), other interests were becoming more important (35 percent), there had been changes in their family situation (30 percent) and/or there were too many regulations (32 percent). The least commonly selected reasons for diminishing interests were age and/or declining health (16 percent), the expense involved in falconry (11 percent) and the expense/difficulty of obtaining raptors (7 percent). However, even for those whose interest in falconry was diminishing, 58 percent indicated it still was their most important recreation or more important than most other recreational activities they were involved in. Only 10 percent of this group indicated falconry was slightly or not at all important. Interest was more likely to be decreasing with older falconers. Average ages of those reporting increased interests, stable interests and decreasing interests were 36.4, 39.5 and 41.2 years, respectively ($F = 65.8$; df 2, 3659; $P < 0.001$).

Contributions of Falconers

Most falconers (80 percent) had contributed to at least one raptor-related rehabilitation, reintroduction, management or education effort.

Rehabilitation and reintroduction practices. The majority of falconers (57 percent) had, at some time, worked to rehabilitate at least one raptor for release to the wild. Some falconers (23 percent) contributed money in 1991 to support raptor rehabilitation projects. Reported contributions (for 1991) ranged from $10 to $4,000 with a median of $50.

A small percentage of falconers (14 percent) reported having donated, sold or voluntarily released a raptor for purposes of reintroduction. Time and/or skills were donated to a raptor reintroduction project in the 25 years prior to the survey by 35 percent of the falconers (median = 5 instances). When asked whether they had voluntarily performed each of several listed tasks involved in reintroduction projects during the past three years, falconers reported organizing reintroduction projects, locating release sites, release site preparation, attending hack sites or serving as media information contact (4, 9, 7, 5 and 6 percent, respectively). Participation in "other" (not listed) reintroduction project tasks was indicated by 14 percent. Of 15 percent who reported contributing money to raptor reintroduction projects in 1991, 56 percent gave $50 or less. Five percent had given money toward purchasing land to protect raptor habitat.

Management and education. A third of the falconers indicated they had provided time or skills at least once to a wildlife management agency or private organization on raptor management matters. Falconers reported working more with private organizations and state agencies than with federal agencies, primarily by providing technical information or assisting in field estimates of raptor populations. Some falconers (22 percent) also contributed money for raptor research projects in 1991 (median = $50).

A mean of $58 (S.E. 7.30) reportedly was contributed for educational projects in 1991 by 16 percent of the falconers. In addition, nearly half (47 percent) of the falconers reported providing educational programs to school-aged children or adults at least once a year. Of those, 81 percent provided programs or informational material on raptors at least once in 1991 to public or private schools or universities. The falconers also addressed nonformal audiences in nature centers, zoos, etc. (62 percent), and in conservation and hunting organizations (23 percent). They reported working with an average of 63 school-aged children (S.E. 4.01) and 44 adults (S.E. 3.37) in 1991. Most of these falconers (87 percent) reported that they always presented programs on raptors as an unpaid volunteer. Based on averages of individual respondent estimates, a third of this educational effort in 1991 focused on the sport of falconry (e.g., training, hunting, care of birds), one third dealt with associated science (e.g., ecology, predator niche, habitat needs of raptors) and the remaining efforts covered endangered species, management of raptors and other topics.

Environmental Attitudes and Behaviors

Several items used in a national survey to assess public environmental attitudes and behaviors (The Roper Organization 1990) were adapted for this study. Most falconers (80 percent) disagreed that economic security and well-being should be given priority over environmental problems. In contrast, only 42 percent of a national sample of the general public disagreed. Similarly, only 15 percent of falconers compared with 70 percent of the general public agreed that they did *not* ''have the scientific and technical knowledge to understand environmental problems'' (The Roper Organization 1990).

Falconers also were more likely than the general public to regularly read product labels to see if contents were environmentally safe (47 versus 26 percent), sort trash for recycling (66 versus 24 percent), boycott environmentally unsafe products (37 versus 16 percent) and reduce use of their automobile for environmental reasons (11 versus 8 percent). Falconers also reported more political involvement than did the general public. More falconers had written their senator or congressman (39 versus 14 percent), attended public meetings (40 versus 19 percent), served as officers of clubs or organizations (25 versus 9 percent) and written articles for magazines or newspapers (24 versus 2 percent).

A third of the falconers reported being members of at least one environmental or conservation organization. The highest rate of membership (15 percent) was with the National Wildlife Federation, 13 percent belonged to the Nature Conservancy and 11 percent were members of the National Audubon Society. Fewer than 5 percent were members of any of the remaining organizations listed.

Discussion

The survey response rate of 49 percent is considerably lower than that to be expected from surveys of specialized hunting or angling groups (Brown et al. 1989, Brown and Wilkins 1978). Typically, nonrespondents are found to be less active, less interested and, often, older members of the recreational community. This appears to be the case here, based on a comparison of membership in NAFA reported by our 1992 sample with actual membership determined from NAFA records. Our survey results indicate that 67 percent of licensed falconers (n = 3,738) are NAFA members (n = 2,514). The NAFA membership list of 1,962 individuals would be 52 percent of the U.S. licensed falconers. (However, NAFA membership probably includes an unknown number of members who are not licensed falconers and the difference in membership may be even larger.) It appears that our sample is somewhat biased towards more active, interested falconers and, thus, results may represent an overestimate of most participation variables, such as the number of birds possessed in 1991, days of hunting activity, conservation efforts on behalf of raptors, etc.

However, bias may be minimal. A large portion (25 percent) of the licensed falconers actually were interviewed. If we assume that the randomly selected sample of 2100 represents the entire population, the 930 respondents would be representative of nearly half of the licensed falconers in the U.S. In addition, our estimate that 1,200 birds were removed from the wild in 1991 by falconers is acceptably close to an estimate of the USFWS that falconers were removing "approximately 1000" birds in 1988 (U.S. Fish and Wildlife Service 1988). For those species listed in Table 2, 0.26 birds per permit were removed from the wild in 1985 (Brohn et al. 1986, U.S. Fish and Wildlife Service 1988). This rate predicts a removal of 950 birds annually for the 3,738 falconers with permits in 1992, compared with our survey estimate of 1,200 birds. The 1993 results show considerably higher annual rates of removal than predicted by the USFWS 1985 results for some species (e.g., Cooper's hawk, 117 versus 75 birds; red-tailed hawk, 554 versus 362 birds; American kestrel, 155 versus 71 birds). Removal was substantially lower for the prairie falcon (115 versus 213 birds).

Even though it appears that our sample is biased toward more active and specialized falconers, extent of the bias appears small. If findings are applied cautiously with potential bias in mind, the data do provide some useful insights and suggest an interesting profile of falconers.

The profile which emerges from the analysis of respondents in the study is one of an affluent, middle-aged, well-educated group of hunting specialists with an intense interest in their sport. An overwhelming majority of the falconers participated in primary nonresidential, nonconsumptive wildlife activity as well as falconry. Many are environmentally concerned and active, and the majority are involved in conserving and managing raptors and/or educating the public about raptors. The strongest motivations for falconers involve training, caring for and hunting with a raptor; i.e., it is the relationship and interaction with the raptor that is important. Falconers are much less interested in benefits related to the harvest of game or in displaying their birds.

There is some regional diversity among falconers. For example, some falconry related activities may vary by region based on differences found in numbers of permits held for propagation, banding, education and other special purposes. Membership in the primary falconry association (NAFA) also varied by regions and was especially low for the South Pacific respondents. Respondents from western regions appear to have been recruited into falconry at younger ages than those from other regions.

Potential nonresponse bias makes prediction of the future growth of falconry participation uncertain. However, falconers report working with nearly twice as many apprentices currently as there are potential dropouts (assuming those with declining interests represent potential dropouts). This suggests that the past trend of small annual increases might continue.

Falconers exhibited many characteristics of a highly specialized, recreational subgroup proposed by Ditton et al. (1992). The large number who indicated that falconry was their most important form of recreation suggests the central role of falconry in the lives of most respondents. This is true even of those respondents who reported their interest was declining. In addition, falconry requires a daily investment of time for those possessing birds, and the median number of days reportedly spent hunting with raptors (36) is triple the median number of hunting days reported by a national sample of hunters. This rate of activity also is higher than the minimum of 30 days used to define an "avid hunter" in that report (U.S. Fish and Wildlife Service and U.S. Bureau of the Census 1993; D–3). Falconry certainly is the most important form of hunting for falconers, as evidenced by the relatively small number who participated in nonfalconry hunts. Furthermore, those falconers who did sometimes hunt without raptors reported far fewer days than were reported by the national sample of hunters.

Although the rate of membership in nonfalconry outdoor sports organizations is low, a large majority (86 percent) of falconers belong to falconry-related organizations. This reflects the strong tendency for increased communication within recreational groups associated with an increasing degree of recreational specialization (Ditton et al. 1992). In contrast, only 14 percent of the national sample of sportsmen (anglers and hunters) reported expenditures for membership dues and contributions.

The appropriation of raptors from the wild for use by falconers appears to be well below the total allowable take of wild birds per year (6,845). Apprentice class falconers are allowed one bird (of specified legal species) from the wild each year, and general and master class falconers each may take two birds. Thus, in 1992, 555 birds could be taken yearly by apprentices, 1,480 birds by general class and 4,810 by the master class falconers. Our estimate of 1,200 birds removed annually represents 18 percent of the total allowable annual take. This low estimate of harvest and evidence that wild populations of these birds have increased nationwide since the 1960s and 1970s to current satisfactory levels (White 1994), support the position of the USFWS that current removal of wild raptor species by falconers poses no threat to the resource.

References

Brohn, A., C. Cushman, T. Juelson, J. Salyer and G. Taylor. 1986. Report of the subcommittee on falconry rules. Int. Assoc. of Fish and Wildl. Agen., Washington, D.C. 7 pp.

Brown, T. L. and B. T. Wilkins. 1978. Clues to reasons for nonresponse, and its effect upon variable estimates. J. Leisure Res. 10: 226–231.

Brown, T. L., D. J. Decker and N. A. Connelly. 1989. Response to mail surveys on resource-based recreation topics: A behavioral model and an empirical analysis. Leisure Sci. Vol. 11: 99–110.

Cade, T. J. 1982. The falcons of the world. London Ed. Ltd., London, England, 192 pp.

Ditton, R. B., D. K. Loomis and S. Choi. 1992. Recreation specialization: Re-conceptualization from a social worlds perspective. J. Leisure Res. Vol. 24, No. 1, pages 33–51.

The Roper Organization. 1990. The environment: Public attitudes and individual behavior. Report of The Roper Organization, Inc., Racine, WI. 87 pp.

U.S. Department of Commerce. 1992. 1990 Census of population: General population characteristics. U.S. November issue. U.S. Govt. Print. Off. 621 pp.

U.S. Fish and Wildlife Service. 1988. Final environmental assessment: Falconry and raptor propagation regulations. July. U.S. Fish and Wildl. Serv., Washington, D.C. 44 pp.

———. 1989. Migratory bird permits, 50 code of federal regulations 21.28, 21.29 Fed. Reg. Vol. 54 (177).

U.S. Fish and Wildlife Service and U.S. Bureau of the Census. 1993. 1991 national survey of fishing, hunting, and wildlife-associated recreation. U.S. Govt. Print. Off., Washington, D.C. 124 pp.

White, C. M. 1994. Population trends and current status of selected western raptors. Studies in Avian Biol. 15: 161–172.

Availability and Suitability of Bald Eagle and Osprey Nesting Habitat in the Northern Prairie Region

Robert E. Usgaard
South Dakota State University
Brookings

Kenneth F. Higgins
South Dakota Cooperative Fish and Wildlife Research Unit
National Biological Service
Brookings

Introduction

Historical information on bald eagles (*Haliaeetus leucocephalus*) and ospreys (*Pandion haliaetus*) nesting in South Dakota is sparse. Agersborg (1885) listed the bald eagle as a rare summer resident and breeder in southeastern South Dakota and documented one osprey nest along the Vermillion River in Clay County in 1883. References to nesting bald eagles and ospreys were lacking in journals and bird lists from explorations on the Missouri River prior to 1850 (Audubon 1898, Duke Paul Wilhelm of Wurttemberg 1938, Thwaites 1904–1905), in the eastern part of the state (Chilson 1968, Nicollet 1976, Youngsworth 1935) and in western South Dakota (Hayden 1863, Visher 1909). Prior to 1991, no osprey or bald eagle nesting attempts were documented in South Dakota in this century.

In 1991, one osprey pair nested in the Black Hills of South Dakota (Dowd 1992). In 1993, one bald eagle pair nested along the Missouri River on the Karl Mundt National Wildlife Refuge (NWR) (B. Wilson personal communication: 1993), and one bald eagle pair nested near Sand Lake NWR in 1994 (B. Schultz personal communication: 1994). Recent bald eagle nesting attempts in predominantly prairie areas in South Dakota, southwest Minnesota (Miller 1990), Nebraska (Farrar 1991) and North Dakota (Mayer and Collins 1988) likely are the result of increasing and expanding bald eagle populations. For example, in the Upper Midwest from 1988 to 1992, nesting bald eagle pairs increased 33 percent (882 to 1,176), and osprey nesting pairs increased 12 percent (745 to 837) (L. D. Frenzel personal communication: 1994). Ospreys, however, currently do not nest in Nebraska, North Dakota or eastern South Dakota.

If bald eagle and osprey populations continue to expand, it is probable that nesting pairs of both species will continue or begin to occupy suitable nesting habitat in predominantly prairie states such as South Dakota. However, nesting habitat in prairie areas where bald eagles and ospreys formerly nested (Roberts 1932) has been altered dramatically by development and agriculture in this century and little is known about the current suitability of habitat available. During 1991–1993, we assessed the suitability of potential bald eagle and osprey nesting habitat in South Dakota as part of a study to determine the feasibility of re-establishing bald eagle and/or osprey nesting populations through hacking. In this paper, we review the methods and criteria used to assess the suitability of potential bald eagle and osprey nesting habitat in South Dakota, summarize our results and attempt to relate our findings to future expansion into predominantly prairie areas by nesting bald eagles and ospreys.

Study Area

Historically, grasslands dominated South Dakota. The Great Plains grassland covered the western two thirds of South Dakota, and Tallgrass Prairie covered the eastern third of the state (Van Bruggen 1976). Trees historically were most common along permanent water courses. Although more common today due to shelterbelt plantings and fire suppression, expansive woodland tracts still largely are limited to water courses. Except for the Black Hills, deciduous tree species constitute the majority of overstory species in woodlands along rivers, lakes and reservoirs in South Dakota. Overstory species common to riparian and bluff areas include American elm (*Ulmus americanus*), basswood (*Tilia americana*), box elder (*Acer negundo*), burr oak (*Quercus macrocarpus*), eastern cottonwood (*Populus deltoides*), eastern red cedar (*Juniperus virginianus*), green ash (*Fraxinus pennsylvanicus*) and hackberry (*Celtis occidentalis*) (Steenhof et al. 1980, McCabe 1984, Roberts 1973).

Water bodies located within the Great Plains grassland or Tallgrass Prairie regions of South Dakota that were assessed during this study included four reservoirs on the Missouri River (Oahe, Sharpe, Francis Case, and Lewis and Clark reservoirs); rivers east of the Missouri River including the Big Sioux, James and Vermillion rivers; rivers west of the Missouri River including the Belle Fourche, Cheyenne, Grand, Moreau and White rivers; 84 natural lakes in Day, Marshall and Roberts counties in the northeast; and approximately 90 unchannelized river miles (RMs) (145 km) along the Missouri River below Fort Randall and Gavins Point dams in the southeast.

Nesting Habitat Suitability Assessments

To assess the suitability of potential bald eagle and osprey nesting habitat along rivers, lakes and reservoirs, we examined three main factors: (1) forage habitat suitability and availability; (2) nesting substrate suitability and availability; and (3) the potential for human disturbance. Habitat assessments along rivers, lakes and reservoirs were conducted using aerial and ground surveys, literature review, and National Aerial Photography Program and Corps of Engineers black and white aerial photographs (1:24,000).

We assessed river, lake and reservoir basin and water quality parameters which could affect potential forage fish abundance and their availability to nesting bald eagles and ospreys. These included discharge rates, turbidity, contamination, basin size, depth and area of river basin habitats (e.g., sandbars and islands).

Information regarding relationships between use by nesting bald eagles or ospreys and river discharge rate, turbidity and lake basin depth was lacking in the literature. In South Dakota, tributaries generally are unregulated, and water levels fluctuate greatly within and among years (Ruelle et al. 1993). During periods of flow cessation or low flow, fish likely migrate downstream. Deep pool areas could provide escape for fish during low flows (Haywood and Ohmart 1986), provided that adequate flows return. In this study, consecutive months of low average discharge rates (Burr et al. 1991, 1992) were assumed to reduce the abundance of potential forage species. Average monthly discharge rates were considered inadequate if less than 100 cubic feet per second (cfs) (3 m^3), marginal if between 100–200 cfs (3–6 m^3) and adequate to sustain a forage base suitable for nesting bald eagles or ospreys if greater than 200 cfs (6 m^3).

Similarly, lake basins in South Dakota are shallow (Koth 1981) and winterkill may be common among closed, shallow lakes during periods of below average precipitation. By using maximum lake depth along with fisheries information obtained from the South Dakota Game Fish and Parks (SDGFP), we determined the status (e.g., permanent or semipermanent fishery) of all lakes included in this study.

High turbidity levels in rivers, lakes and reservoirs were assumed to limit the availability of potential forage fish species to bald eagles and ospreys due to the likelihood that fish would be less easily spotted in turbid waters (Flook and Forbes 1983, Swenson 1981, Vana-Miller 1987). Turbidity levels for river, lake and reservoir habitats were assessed using a turbidity gradient. Turbidity was considered low if less than 30 Nephelometric Turbidity Units (NTUs) (equal to or > 5 feet or 1.5 m secchi disc depth), moderate between 30.1–100 NTUs and high if greater than 100 NTUs (< 1 foot or 0.3 m secchi disc depth).

Nesting substrate suitability was assessed based on the availability of mature uneven-aged woodland because these stands most likely would provide tall dominant trees or snags used by nesting bald eagles (Andrew and Mosher 1982, Mathisen 1983) and ospreys (Vana-Miller 1987). Areas of human activity were noted during field surveys or from aerial photographs and were considered to have a negative effect on bald eagles (Buehler et al. 1991, McGarigal et al. 1991) and potentially the same effect on ospreys (Swenson 1979).

We adapted a method used by Detrich and Garcelon (1986) to classify floodplain woodland along unchannelized sections of the Missouri River. Classifications were based on canopy structure and the presence or absence of suitable nesting trees (large, mature trees extending above the general canopy layer). Woodlands were classified as Class I, II or III. Class I included young woodland stands and moderate-aged to mature woodland stands with closed, even canopies. Class II included mature woodland stands in which canopy height diversity was evident, but not strongly discernible in aerial photographs, suggesting that suitable nesting trees possibly were present. Class III included mature cottonwood stands in which canopy height diversity was strongly evident and large dominant trees (trees extending above the general canopy level) could be identified easily in aerial photographs. Nesting suitability was considered unsuitable for Class I stands, marginal to suitable for Class II stands and highly suitable for Class III stands.

Nesting Habitat Suitability

Missouri River Reservoirs

Nesting bald eagles (Hunt et al. 1992) and ospreys (Henry 1986) have been attracted to reservoirs in western states, and future nesting by bald eagles was considered probable along the four Missouri River reservoirs in South Dakota (South Dakota Ornithologists' Union 1991). However, the elimination of the floodplain forest due to impoundment has severely reduced the availability of adequate nesting substrate along Missouri River reservoirs.

Woodlands along the shoreline of Oahe and Sharpe Reservoirs generally were lacking, which would preclude future nesting by bald eagles and ospreys. Woodlands dominated by burr oak were common along the breaks of Francis Case Reservoir and along the bluffs bordering Lewis and Clark Reservoir. However, woodland structure along Francis Case Reservoir was inadequate and only marginal at best along Lewis and Clark Reservoir to support nesting bald eagles and ospreys. Woodlands along Francis Case and Lewis and Clark Reservoirs had highly closed canopies, and trees generally lacked the height, size and structure of nest trees commonly selected by bald eagles and ospreys. Flooded snags were virtually absent, except near the upper end of Lewis and Clark Reservoir.

Francis Case and Lewis and Clark reservoirs had adequate fisheries to support nesting ospreys. However, foraging habitat suitability was higher along Lewis and Clark Reservoir because it had an average depth of 16 feet (4.9 m) (Wickstrom et al. 1993) and because it contained several backwater areas near its tailwaters. Backwater areas were considered to provide highly suitable foraging habitat because they contained expanses of shallow, clear pools. Francis Case had an average depth of 50 feet (15-m) (Wickstrom et al. 1993) and, due to steep shorelines, the area of shallow foraging habitat in Francis Case Reservoir was limited and narrow.

Missouri River Tributaries

Bald eagle and osprey nesting habitat suitability along the Belle Fourche River and Missouri River tributaries was poor to marginal. Each river had 25 or more occurring or likely occurring fish species (Braaten 1993, Nickum and Sinning 1971, Roddy et al. 1991, Ruelle et al. 1993). Suitable forage species such as common carp (*Cyprinus carpio*), bullhead (*Ameiurus* spp) and channel catfish (*Ictalurus punctatus*) occurred in all rivers. However, inadequate or absent nesting substrate, fluctuating water levels, high turbidity, contamination, development and grazing all negatively affected overall nesting suitability.

Nesting habitat suitability along the majority of the James, Vermillion and Big Sioux rivers was poor. Although islands of suitable woodlands occurred along all of these rivers, especially the lower James River and the Big Sioux River in Brookings and Union counties, expanses of contiguous (several river kilometers), suitable woodland habitat were virtually absent. The potential for human disturbance (buildings, roads and access points) in the floodplain was high for the length of all three rivers. Also, average discharge rates on the James and Vermillion rivers were below 100 cfs (3 m^3) for most of the nesting season in 1990 and 1991. Moderate to high turbidity levels in all three rivers (between 30 and 100 NTUs) occurred from March to September in 1990 and 1991 which further limited the foraging potential of these waters.

Stands of highly suitable woodlands that were dense, with well-developed understories and numerous dominant cottonwoods occurred frequently along the lower 18 miles (30 km) of the Grand and Moreau rivers. However, inadequate discharge rates (below 100 cfs or 3 m^3) and periods of zero flow throughout critical times of the nesting season during 1990 and 1991 limited the nesting suitability along the Grand and Moreau rivers. Furthermore, turbidity levels were high (range of 19–2,300

NTUs), even at low flows. Nesting suitability of the Grand and Moreau rivers was highest near their confluences with Oahe Reservoir. Oahe Reservoir has a permanent fishery, and flooded terrestrial vegetation along the Grand and Moreau Rivers serves as spawning grounds for many fish species in the spring. Flooded snags within the reservoir possibly could aid the establishment of ospreys near the mouths of these rivers. However, flooded snags near the mouths of these two rivers likely are highly deteriorated because they have been inundated for close to 30 years (Burr et al.1992).

The Cheyenne and White rivers are the two largest rivers in western South Dakota, and their discharge rates were adequate (> 200 cfs or 6 m^3) for most of the nesting season. The White River had some of the highest-quality woodland stands encountered among all river surveys. Contiguous expanses of dense woodland habitat with large cottonwoods occurred frequently along the whole survey route (from its confluence with the Little White River to Francis Case Reservoir). However, extremely high turbidity levels (approaching 10,000 NTUs) at low, average and above average flows during March to September in 1990 and 1991 severely limited the suitability of the White River for nesting bald eagles and ospreys.

Moderate to large woodland stands of 10 to 20 acres (approximately 5–10 ha) occurred frequently along the Cheyenne River for most of the survey route (from its confluence with the Belle Fourche River to Oahe Reservoir). However, most of the woodland stands had little or no understory, and trees were widely spaced and deteriorating. Cattle frequently were seen along the length of the Cheyenne River survey route. Cattle grazing may degrade bald eagle nesting habitat by removing understory species, reducing vegetative cover necessary for nest security and eliminating fish habitat through increased stream bank erosion and siltation (Harmata and Heinrich 1990). Furthermore, moderate to extremely high turbidity levels (65 to 8,800 NTUs) throughout the nesting season in 1990 and 1991 limited the nesting suitability of the Cheyenne River.

Some of the most suitable bald eagle and osprey nesting habitat for all Missouri River tributaries occurred along the Belle Fourche River between its confluence with the Cheyenne River and the mouth of Elm Creek. Woodland stands were dense and contained numerous large cottonwoods. Turbidity levels of the Belle Fourche River were lower (15–65 NTUs) than the Cheyenne and White rivers. Water levels of the Belle Fourche River, however, tend to fluctuate due to water diversions to Belle Fourche Reservoir and other irrigation projects (Burr et al. 1992). Also, elevated levels of arsenic, selenium and mercury found in fish and bottom sediments of the lower Belle Fourche River (Goddard 1989, Roddy et al. 1991) and the Cheyenne River from its confluence with the Belle Fourche River to Oahe Reservoir indicated that contamination could affect nesting bald eagles and ospreys. Mercury levels found in fish collected from the Cheyenne River exceeded the maximum concentration (0.10 μg/g wet weight) considered safe for piscivorous birds (Eisler 1987). Mercury levels found in the livers of double-crested cormorants (*Phalacrocorax auritus*) collected at the mouth of the Cheyenne River exceeded 30 micrograms per gram (Ruelle et al. 1993).

Unchannelized Missouri River

Historical information indicated that the Missouri River in South Dakota was marginal habitat for nesting bald eagles and ospreys. However, portions of the unchannelized Missouri River currently appear to be suitable nesting habitat for bald eagles and ospreys.

Foraging habitat of the unchannelized Missouri River was adequate due to low turbidity, the high number of potential forage species, large basin area, and large area of sandbar, backwater and island habitats. Historically high turbidity levels of the Missouri River have decreased drastically since the construction of mainstem dams (Slizeski et al. 1982). From fishery studies conducted by Kallemeyn and Novotny (1977) and Schmulbach et al. (1975), we identified 16 potential bald eagle and osprey forage fish species. Approximately 30,000 acres (12,150 ha) of river basin were mapped, of which 30 percent was sandbar, backwater or island area. Sandbars, backwaters and islands provide or are associated with pools and slack water. Fish in pool and slack water habitats are more susceptible to foraging bald eagles and ospreys (Grubb 1977, Hunt et al. 1992).

Highly suitable nesting substrate was limited along the unchannelized Missouri River. We mapped approximately 16,000 acres (6,600 ha) of floodplain woodlands within 1 mile (1.6 km) of the river bank. Floodplain woodlands comprised only 16 percent of the total upland are mapped. Forty-seven percent of the floodplain woodland area was classified as Class I (poor nesting substrate), 31 percent as Class II (marginal to suitable) and 22 percent as Class III (highly suitable).

Contiguous (several river kilometers) stretches of wooded shoreline also were limited along the unchannelized Missouri River. Agriculture fields, which comprised 54 percent of the total upland area, bordered the river frequently, especially along the reach below Gavins Point Dam. Due to agriculture fields, buildings or roads, only 27 percent of the 175 miles (291 km) of shoreline had no disturbance within 1,640 feet (500 m). An additional 75 miles (125 km) of wooded shoreline was disturbed within 1,640 feet (500 m) by agriculture fields only. Agriculture may be tolerated by bald eagles within their nesting territories. However, bald eagle habitat suitability along rivers probably is a function of contiguous (several river kilometers), suitable nesting habitat instead of woodland stands isolated due to agriculture fields, roads or buildings (Livingston et al. 1990). Contiguous, suitable woodland habitat occurred mainly along the reach below Fort Randall Dam, and included the Karl Mundt NWR where one bald eagle pair recently has nested.

A lack of contiguous, suitable nesting habitat probably would not limit nesting ospreys along the unchannelized Missouri River because ospreys are more adaptable to human activity than bald eagles are (Poole 1989). However, because the majority of the floodplain along the unchannelized Missouri River is privately owned, habitat that currently is suitable for nesting bald eagles and ospreys could be lost in the future through conversion into cropland or cabin developments.

Lakes in Northeast South Dakota

Suitability of bald eagle and osprey nesting habitat around 84 lakes in northeast South Dakota was poor to marginal at best. Suitable nesting habitat was limited because few lakes supported semipermanent or permanent fisheries, woodland area and structure were less than optimum around most lakes, and human activity was high around lakes supporting adequate foraging habitat.

The majority of lakes (65 percent) were less than 500 acres (200 ha). Furthermore, 83 percent had a maximum depth less than 6 feet (2 m) and, accordingly, only 14 lakes supported semipermanent or permanent fisheries (winterkill occasional or very infrequent) (Jacobson 1987, Meester 1990a, 1990b, 1991). In the past, winterkills have eliminated fish populations in poor and marginal fisheries and severely depressed fish numbers in semipermanent and permanent fisheries in the northeast (R. Meester personal communication: 1993). Also, biotic and wind-caused turbidity due to high lake productivity (Koth 1981), shallow basin depths and exposed shorelines could further reduce fish availability in the northeast to nesting bald eagles and ospreys.

Nesting substrate within 0.8 kilometer of lake shorelines was poor to marginal at best. Approximately 11,000 acres (4,455 ha) of woodlands were mapped, comprising less than 10 percent of the total upland area. Thirty-three percent of the woodland area was classified as uneven-aged, mature woodland. The majority of the uneven-aged woodland stands were limited to nine lakes, and these generally lacked trees or snags of adequate size and structure for nesting bald eagles and ospreys.

Human activity was high within 0.5 miles (0.8 km) of lake shorelines, especially lakes with semipermanent or permanent fisheries. Cabin developments affected 20 percent of the wooded shoreline. Based on the amount of developed and wooded shoreline, only 43 percent of the shoreline was available to nesting bald eagles and ospreys. Furthermore, 54 percent of the total shoreline was within 1,640 feet (500 m) of a road, house or farmstead. Of the lakes in the northeast, Bigstone and Traverse, two lakes that occur along the South Dakota/Minnesota border offered the most suitable nesting habitat for bald eagles and ospreys because both lakes exceeded 10,000 acres (4,050 ha), had suitable nest trees along the shorelines and contained wooded islands.

Discussion

Historical information and results from this study suggest that South Dakota provides marginal nesting habitat for bald eagles and ospreys. While suitable bald eagle and osprey nesting habitat does occur in South Dakota, the majority of bald eagle and osprey nesting habitat along rivers, lakes and reservoirs is less than optimum due to inadequate or absent nesting substrate, fluctuating discharge rates, high turbidity, unpredictable forage bases and human disturbance. Currently, it appears that the largest expanse of highly suitable bald eagle and osprey nesting habitat in South Dakota exists along the unchannelized Missouri River below Fort Randall and Gavins Point dams.

Bald eagle pairs recently have nested in South Dakota, and it is likely more pairs will attempt nesting in the near future. Such an increase appears likely in the eastern part of the state due to dramatic increases in Minnesota's bald eagle population (Miller 1990). Saturation of habitats within core nesting areas may promote long-distance dispersal by sexually mature birds (J. Grier personal communication: 1994). Recent nesting attempts in South Dakota and Nebraska were well beyond any perimeter of a large nesting concentration. Furthermore, suitable nesting habitat on wintering grounds and along migration routes in South Dakota may attract nesting birds if core populations continue to expand.

We think it is less likely that ospreys will expand into the prairie region of South Dakota in the near future. There are few osprey nesting pairs in close proximity to South Dakota, and the number of osprey nesting pairs in the Midwest has not increased as rapidly in the last five years as the number of bald eagle nesting pairs. Ospreys do commonly migrate through South Dakota (South Dakota Ornithologists' Union 1991), but few remain during the nesting season. Should they become established, their expansion in South Dakota could be aided greatly by artificial nesting structures.

Artificial nesting structures could be used to mitigate the lack of adequate nesting substrate near large lakes in the northeast or east-central South Dakota with permanent or semipermanent fisheries. Highly adequate osprey nesting habitat currently is available along much of the unchannelized Missouri River and Lewis and Clark Reservoir in southeast South Dakota. Whether through natural expansion or reintroduction, ospreys along the unchannelized Missouri River likely would be highly successful.

Summary

We believe the criteria and methods used for our evaluation (Usgaard 1994) in South Dakota also will have application in other prairie states and provinces. Nesting by bald eagles and ospreys in prairie environments has been rare, and optimum bald eagle and osprey nesting habitat in prairie environments likely differs from optimum nesting habitat in forested environments. Bald eagles and ospreys that pioneer into prairie environments likely will encounter more human activity than currently exists in remote forested regions. Therefore, documentation of nesting habitat characteristics is essential if good management guidelines for these two species are to be possible in the future.

Finally, our results showed that hacking bald eagles or ospreys is feasible in some sites in South Dakota (Usgaard 1994), and hacking also may be feasible elsewhere in the prairies. However, we strongly advise agencies interested in hacking bald eagles or ospreys in prairie environments to consider potential, long-term habitat changes, historic population levels, probability of natural expansion from other areas and adaptability of these two species to environments drastically altered by human intervention before starting a hacking program.

Acknowledgments

We thank Eileen Dowd Stukel for providing the framework for this study and technical assistance. This study was funded by the South Dakota Game, Fish and Parks Department—W–107–R, Statewide Nongame Wildlife Conservation Program—and the South Dakota Cooperative Fish and Wildlife Research Unit in cooperation with the South Dakota Game, Fish and Parks Department; U.S. Fish and Wildlife Service; South Dakota State University; and the Wildlife Management Institute.

References

Agersborg, G. S. 1885. The birds of southeastern South Dakota. Auk 2: 276–289.

Audubon, J. J. 1898. Audubon and his journals. M. R. Audubon and E. Coues, eds., Nimmo Publishers, London. 2 vols.

Braaten, P. J. 1993. The influence of habitat structure and environmental variability on habitat use by fish in the Vermillion River, South Dakota, M.S. thesis, South Dakota St. Univ., Brookings, 99 pp.

Andrew, J. M. and J. A. Mosher. 1982. Bald eagle nest site selection and nesting habitat in Maryland. J. Wildl. Manage. 46: 383–390.

Buehler, D. A., T. J. Mersmann, J. D. Fraser and J. K. Seegar. 1991. Effects of human activity on bald eagle distribution in the Chesapeake Bay. J. Wildl. Manage. 55: 282–290.

Burr, M. J., R. D. Benson and D. S. Hanson. 1991. Water resources data for South Dakota: Water year 1990. USGS Water Res. Div. Rept. No. SD–90–1. 383 pp.

Burr, M. J., R. D. Benson and S. K. Sando. 1992. Water resources data for South Dakota: Water year 1991. USGS Water Res. Div. Rept. No. SD–91–1. 399 pp.

Chilson, H. P. 1968. Knickerbocker's 1869 list of the birds of Fort Wadsworth, Dakota Territory. South Dakota Bird Notes 20: 32–42.

Detrich, P. J. and D. K. Garcelon. 1986. Criteria and habitat evaluation for bald eagle reintroduction in coastal California. Wildl. Manage. Branch Final Rept. No. C–1307. California Dept. Fish and Game, Sacramento. 32 pp.

Dowd, E. 1992. The osprey returns to South Dakota. South Dakota Conserv. Digest. 59: 2–5.

Eisler, R. 1987. Mercury hazards to fish, wildlife, and invertebrates: A synoptic review. U.S. Fish and Wildl. Serv. Biol. Rept. No. 85(1.10). 90 pp.

Farrar, J. 1991. Return of the bald eagle. Nebraskaland 69: 9–11.

Flook, D. R. and L. S. Forbes. 1983. Ospreys and water management at Creston, British Columbia. Pages 281–286 *in* D. M. Bird, ed., Biology and management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Quebec. 325 pp.

Grubb, T. G., Jr. 1977. Weather-dependent foraging in ospreys. Auk 94: 146–149.

Harmata, A. R. and W. R. Heinrich. 1990. Evaluation of habitat and reintroduction potential for bald eagles and peregrine falcons on the Missouri River, Montana. Rept. to USDI Bur. of Land Manage., Billings, MT. Agreement no. AA852–CA7–005. 77 pp.

Hayden, F. V. 1863. On the geology and natural history of the Upper Missouri. Amer. Philos. Soc. 12: 1–218.

Haywood, D. D. and R. D. Ohmart. 1986. Utilization of benthic-feeding fish by inland bald eagles. Condor 88: 35–42.

Henny, C. J. 1986. Osprey (*Pandion haliaetus*): Section 4.3.1, U.S. Army Corps of Engineers Wildlife Resources Management Manual. Tech. Rept. EL–86–5. 36 pp.

Hunt, W. G., J. M. Jenkins, R. E. Jackman, C. G. Thelander and A. T. Gerstell. 1992. Foraging ecology of bald eagles on a regulated river. J. Raptor Res. 26: 243–256.

Jacobson, P. C. 1987. Statewide fisheries surveys, 1985–1986: Survey of public waters, South Dakota. South Dakota Dept. Game, Fish and Parks Progress Rept. No. 87–6. 272 pp.

Kallemeyn, L. W. and J. F. Novotny. 1977. Fish and fish food organisms in various habitats of the Missouri River in South Dakota, Nebraska, and Iowa. North Central Reservoir Investigations. FWS/OBS–77/25. Yankton, SD. 100 pp.

Koth, R. M. 1981. South Dakota lakes classification and inventory, final report. South Dakota Dept. Water and Natur. Resour. Office of Water Quality, Pierre. 693 pp.

Livingston, S. A., C. S. Todd, W. B. Krohn and R. B. Owen. 1990. Habitat models for nesting bald eagles in Maine. J. Wildl. Manage. 54: 644–653.

Mathisen, J. E. 1983. Nest site selection by bald eagles on the Chippewa National Forest. Pages 95–100 *in* D. M. Bird, ed., Biology and management of bald eagles and ospreys. Harpell Press, Ste. Anne de Bellevue, Quebec. 325 pp.

Mayer, P. and R. Collins. 1988. Return of our national symbol. North Dakota Outdoors 51: 9–11.

McCabe, K. F. 1984. Brood-rearing period cover use by wild turkey hens in southcentral South Dakota. M.S. thesis, South Dakota St. Univ., Brookings. 37 pp.

McGarigal, K., R. G. Anthony and F. B. Isaacs. 1991. Interactions of humans and bald eagles on the Columbia River estuary. Wildl. Monog. No. 115. 46 pp.

Meester, R. J., ed. 1990a. Statewide fisheries surveys, 1988–1989: Survey of public waters, South Dakota. South Dakota Dept. Game, Fish and Parks Progress Rept. 90–5. 365 pp.

———. 1990b. Statewide fisheries surveys, 1990: Survey of public waters, South Dakota. South Dakota Dept. Game, Fish and Parks Annual Rept. No. 91–7. 530 pp.

———. 1991. Statewide fisheries surveys, 1991: Survey of public waters, South Dakota. South Dakota Dept. Game, Fish and Parks Annual Rept. No. 92–7. 545 pp.

Miller, M. 1990. Minnesota's bald eagles: A success story. The Loon 62: 52–55.

Nickum, J. G. and J. A. Sinning. 1971. Fishes of the Big Sioux River: An annotated list. Proc. South Dakota Acad. Sci. 50: 143–154.

Nicollet, J. N. 1976. On the plains and prairies: The expeditions of 1838–39 with journals, letters, and notes on the Dakota Indians. E. C. Bray and M. C. Bray, eds., Minnesota Historical Soc. Press, St. Paul. 294 pp.

Poole, A. F. 1989. Ospreys: A natural and unnatural history. Cambridge Univ. Press, Great Britain. 246 pp.

Roberts, R. E. 1973. The vascular vegetation of northeastern Day county in South Dakota. M.S. thesis, South Dakota St. Univ., Brookings. 79 pp.

Roberts, T. S. 1932. The birds of Minnesota. Univ. Minnesota Press, Minneapolis. 2 vols.

Roddy, W. R., E. A. Greene and C. L. Sowards. 1991. Reconnaissance investigation of water quality, bottom sediment, and biota associated with irrigations drainage in the Belle Fourche Reclamation Project, western South Dakota, 1988–89. USGS Water Res. Invest. Rept. No. 90–4192. 113 pp.

Ruelle, R. Koth, and C. Stone. 1993. Contaminants, fish, and hydrology of the Missouri River and western tributaries, South Dakota. Pages 449–480 *in* L. W. Hesse, C. Stalalnaker, N. Benson and J. Zuboy, eds., Restoration planning for the rivers of the Mississippi River Ecosystem. Biol. Rept. No. 19, Nat. Biol. Surv., Washington, D.C.

Schmulbach, J. C., G. Gould and C. L. Groen. 1975. Relative abundance and distribution of fishes in the Missouri River, Gavins Point Dam to Rulo, Nebraska. Proc. South Dakota Acad. Sci. 41: 101–112.

Slizeski, J. J., J. L. Andersen and W. G. Dorough. 1982. Hydrologic setting, system operation, present and future stresses. Pages 15–37 *in* L. W. Hesse, C. Stalalnaker, N. Benson and J. Zuboy, eds., The Middle Missouri River. The Middle Missouri Study Group, Norfolk, NE.

South Dakota Ornithologists' Union. 1991. The birds of South Dakota, 2nd Edition. Northern St. Univ. Press, Aberdeen. 411 pp.

Steenhof, K., S. S. Berlinger and L. H. Fredrickson. 1980. Habitat use by wintering bald eagles in South Dakota. J. Wildl. Manage. 44: 798–805.

Swenson, J. E. 1979. Factors affecting status and reproduction of ospreys in Yellowstone National Park. J. Wildl. Manage. 43: 595–602.

———. 1981. Status of the osprey in southeastern Montana before and after the construction of reservoirs. Western Birds 12: 47–51.

Thwaites, R. G., ed. 1904–1905. Original journals of the Lewis and Clark expedition, 1804–1806. Dodd Mead and Co., NY. 8 vols.

Usgaard, R. E. 1994. Re-establishing bald eagle and osprey breeding populations in South Dakota through hacking: A feasibility study. M.S. thesis, South Dakota St. Univ., Brookings. 129 pp.

Van Bruggen, T. 1976. The vascular plants of South Dakota. Iowa St. Univ. Press, Ames. 538 pp.

Vana-Miller, S. L. 1987. Habitat suitability index models: Osprey. U.S. Fish and Wildl. Serv. Biol. Rept. No. 82(10.154). 48 pp.

Visher, S. S. 1909. A list of birds of western South Dakota. Auk 2: 76–289.

Wickstrom G., D. Fielder, B. Johnson, J. Lott, J. Riis and C. Stone. 1993. Annual fish population surveys on South Dakota Missouri River Reservoirs, 1992. South Dakota Dept. Game, Fish and Parks Progress Rept. No. 93–4.

Wurttemberg, Duke Paul Wilhelm of. 1938. Travels in North America, 1822–1824. South Dakota Historical Collec. 199: 6–474.

Youngsworth, W. M. 1935. The birds of Fort Sisseton, South Dakota, a sixty year comparison. Wilson Bull. 47: 209–235.

The Status of Raptor Conservation and Our Knowledge of the Resident Diurnal Birds of Prey of Mexico

Richard O. Bierregaard, Jr.
Biology Department
University of North Carolina
Charlotte

Introduction

Mexico has a broad spectrum of habitats, from temperate deserts and mountain forests to tropical evergreen forests, and a remarkably diverse biota. It has the highest reptile diversity of any country in the world (717 species, with 53-percent endemic) and the second highest level of mammal diversity (449 species, 33-percent endemic) (McNeely et al. 1990). The total of 1,010 bird species is almost 30-percent higher than Canada and the continental U.S. combined and includes about 19 percent of the world's diurnal birds of prey. More than 15 percent of Mexico's 2,000 plant genera and some 50–60 percent of the projected 30,000 plant species are endemic (McNeely et al. 1990).

In the midst of this rich biota, Mexico's human population reached 88.6 million in 1990 and was projected to grow at an annual increment of 1.81 percent from 1995 to 2000 (World Resources Institute 1992). The rapidly growing population will put pressure on currently undisturbed habitats. It will require extraordinary diligence to minimize the loss of the country's abundant biological resources.

Birds of prey can play an important role in conservation programs. Because top-order predators can exert a stabilizing influence on their ecosystems (Greene 1988, Terborgh 1992), the preservation of raptors is inherently valuable. Additionally, because environmental pollutants can magnify through the food chain, recognizing declines in raptor populations may enable us to identify a broader, impending threat to a particular ecosystem. Further, because they are charismatic, raptor species can serve as effective conservation ''flagship species.''

In this paper, I review the conservation status of Mexico's resident diurnal raptors (Falconiformes) and offer an assessment of our knowledge of their natural history. In so doing, I identify species of special concern, as well as those for which more research is needed.

Methods

This paper is based on extensive reviews (Bierregaard in press, Rodríguez-Yáñez et al. 1994) of the scientific literature on Mexican Falconiformes. Taxonomy follows del Hoyo et al. (1994). Because our knowledge of Mexican owls (Strigiformes) is no more than anecdotal for most species, they are not included in this review.

Biogeography and Landscape

Mexico occupies 756,066 square miles (1,958,201^2 km) stretching from about 33 degrees North to almost 14 degrees North latitude. Over this area, the country extends from Neotropical rainforests in the southeast to temperate desert and mountain forests in the north. Two major mountain chains extend from north to south, on both sides of the Chihuahuan desert in the north, joining in southern Mexico to continue through the mountainous spine of the Central American isthmus.

Major Vegetation Types

Villela and Gerez (1988) described nine vegetation types in the country: coniferous, oak, chaparral and low deciduous forest cover 32 percent of the country; xeric matoral (including deserts) (35 percent), tropical deciduous forest (1 percent), evergreen tropical forest (6 percent), and aquatic and subaquatic vegetation (includes mangroves) (1 percent). Seasonal agriculture, pasture and irrigated farmland occupy 24 percent of the country.

In 1981, 40 percent of the country maintained its natural vegetation, 35 percent was covered with its natural vegetation in some state of disturbance and 25 percent had been totally converted to some human use (Villela and Gerez 1988). The amount of undisturbed habitat obviously has decreased in the 14 years since these data were collected.

According to Rzedowski (1983), cited by Ramos (1986), tropical evergreen forest once occupied about 11 percent of the country. In 1986, Ramos (1986) estimated that the tropical forests probably had been reduced to 10 percent or less of their original extent, or some 1 percent of Mexico's area, an estimate considerably lower than the value of 6 percent presented by Villela and Gerez (1988).

By 1987, there were 129 areas protected or proposed in various conservation units (Villela and Gerez 1988). The protected areas totaled $22{,}154^2$ miles ($57{,}379$ km^2), or about 1.6 percent of the country's total area.

Mexico's Falconiformes

Our knowledge of the distribution of Mexico's raptors is good, although there are gaps in our understanding of some species' ranges further down the Central American isthmus. Sixty-seven extant taxa (52 species and 15 subspecies) of diurnal birds of prey are resident in the country (Appendix). This total does not include the California condor (*Gymnogyps californianus*), which is virtually extinct in the wild, surviving only in captivity (nine captive birds recently have been released), nor the crested eagle (*Morphnus guianensis*) which recently has been sighted in the country (D. F. Whitacre personal communication: 1995). A race of the crested caracara (*Polyborus plancus lutosus*) that occurred on Guadalupe Island off the coast of Baja California was driven to extinction by ranchers around 1900 (Brown and Amadon 1968).

Resident species include 4 vultures (Cathartidae; 5 including the condor), 37 hawks, osprey and eagles (Accipitridae), and 11 falcons, forest-falcons and caracaras (Falconidae). In comparison, only 34 Falconiform species breed in all of North America beyond the Mexican border.

Of the 52 extant species, only 6 are widely distributed both north and south of Mexico (2 falcons, 2 vultures and 2 kites), 12 (13 including the California condor) are temperate zone species whose southern limits reach Mexico, while 34 are tropical species at or near the northern limits of their ranges in Mexico (see Appendix).

There are no endemic diurnal raptor species in Mexico, but nine subspecies of six species are endemic. Four of these occur on islands. Off the west coast of Mexico, there are two subspecies of the red-tailed hawk, *Buteo jamaicensis fumosus* on the Tres Marias Islands and *B. j. socorroensis* on the Revillagigedo Islands (Soccorro Island and neighbors), and a race of the crested caracara, *Polyborus plancus pallidus*, on the Tres Marias Islands. In the Caribbean, a subspecies of the roadside hawk, *Buteo magnirostris gracilis*, is found on the island of Cozumel off the Yucatan Peninsula.

The remaining five endemic races include central highland forms of three species: the bicolored hawk, the sharp-shinned hawk and the red-tailed hawk (*Accipiter bicolor fidens, A. striatus madrensis* and *Buteo jamaicensis hadropus*, respectively), and subspecies of the crane hawk and American kestrel in the northwest (*Geranospiza caerulescens livens* and *Falco sparverius peninsularis*).

Twenty-two taxa are found only in Mesoamerica (extreme southern U.S., Mexico and Central America), and 10 have even more restricted ranges in the tropical forests of southern Mexico and Central America (Appendix).

Natural History

Our knowledge of the natural history of the species of Falconiformes found in Mexico varies greatly from species to species, but generally is good, at least when compared with what is known about most Falconiformes in Central and South America (Bierregaard in press). Since species and ecosystems know no political boundaries, most of our knowledge of Mexico's raptors comes not from work done within Mexico's borders, but rather from papers published on these species in other parts of their ranges. Most temperate species with ranges extending into Mexico have been studied fairly well in the U.S., while many tropical species whose ranges reach Mexico from the south still are poorly known, although, as we shall see, this situation is improving.

Information specifically on the resident populations of Mexico's Falconiformes is rather weak. Rodríguez-Yáñez et al. (1994) compiled a very thorough bibliography of the literature published from 1825–1992 on the birds of Mexico. Of the roughly 3,600 references in the bibliography, only 177 deal with Falconiformes.

Since 1950, 113 papers were published on Mexican Falconiformes, with the number of papers published per decade increasing substantially. By the '50s most major taxonomic issues seemed fairly well resolved. Recently, research on Mexico's raptors has been concentrated on feeding ecology, reproduction and migration (35 percent of papers), status and conservation (25 percent), and distribution (30 percent).

The white-breasted hawk (*Accipiter chionogaster*), traditionally treated as a subspecies of the sharp-shinned hawk (*Accipiter striatus*), is the Mexican raptor about which we know the least (Bierregaard in press). The nest is undescribed and breeding behavior is unknown. Little or no prey data are available and the migratory behavior and conservation status of the species are undetermined. Other poorly known species include the mangrove black hawk (*Buteogallus subtilis*) (nest undescribed, little prey data, breeding behavior unknown), the black solitary eagle (*Harpyhaliaetus solitarius*) (little prey data, nest and breeding behavior scantily known), the short-tailed hawk (*Buteo brachyurus*) (very few data on nest and breeding behavior, as well as migration) and the grey-headed kite (*Leptodon cayanensis*) (nest poorly known and breeding behavior not recorded) (Bierregaard in press).

Fortunately, information for tropical forest raptors is accumulating very rapidly. In the tropical forests around the Tikal ruins in Guatemala, biologists working for the Maya Project are conducting the most extensive studies ever undertaken of the natural history of a community of tropical forest raptors (see Whitacre and Thorstrom 1992 and previous reports). Their results will be of great importance to any programs addressing the conservation of tropical raptors in Mexico.

Conservation Status

This review is focused at the subspecific level. Subspecies are important biological entities, representing distinct genetic subsets of species and should, whenever possible, be the target for conservation programs. Letting a subspecies disappear because the species itself is secure in another part of its range diminishes the species' genetic diversity and, by default, is a form of conservation triage, which represents a partial defeat.

Nearly a decade ago, Ramos (1986) reviewed the conservation status of Falconiformes in Mexico. Since then, only a few papers (e.g., Clinton-Eitniear 1988, 1989, 1991, Henny et al. 1993, Iñigo-Elias et al. 1987b) have addressed the status and conservation of these species. Ramos listed 28 species as declining, mostly because of diminishing habitat, but some also due to pollution, hunting and illegal trade (see also Iñigo-Elias 1986) (Appendix).

Although more than half of Mexico's 52 species of Falconiformes are in decline, at the species level, most have healthy or stable populations elsewhere in their ranges (Appendix). In their extensive review of the threatened birds of the Americas, Collar et al. (1992) considered the California condor the only Falconiform species in Mexico to be threatened with extinction. However, there is little reason to believe that the situation has improved for the 28 species Ramos (1986) suggested were declining; consequently, careful monitoring of these species is demanded, especially the forest-dwelling subspecies with ranges restricted to Mesoamerica.

Tropical forest species. The loss of tropical forests is the single greatest cause for concern for Mexico's raptors. Not only does the loss of forests reduce the available habitat for raptors, but it also increases the loss of raptors to hunting, which inevitably occurs as man moves into former forest areas.

Reliable estimates of the current rates of forest loss after 1988 are difficult to obtain. By 1988, according to the Food and Agriculture Organization (1988), cited by Whitmore and Sayer (1992), the annual rate of deforestation of tropical forests in Mexico was estimated at 1.8 percent or 1,815 square miles (4,700 km^2). While exact and current rates are not available, we can say with certainty that the conversion of primary forest to a mosaic of man-altered habitat continues not only in Mexico but across most of Central America as well.

Although only 4 Falconiform species probably are dependent on large expanses of primary tropical forest, 22 taxa are dependent on at least a mosaic of tropical forests interspersed with second-growth forest or even open country (Appendix). Many of these species would be expected to disappear from areas undergoing expansive deforestation.

Most vulnerable are the taxa restricted to Mesoamerican forests—subspecies of barred forest-falcon (*Micrastur ruficollis*), white-breasted hawk and black solitary eagle, which Clinton-Eitniear (1991) believes already is threatened. Ridgely and Gwynne (1989) reported that the red-throated caracara (*Daptrius americanus*) experienced a region-wide decline throughout Central America, with no recent records north of Costa Rica. Some of this decline surely is due to deforestation, but the species is inexplicably absent from large tracts of relatively undisturbed forest. Ramos (1986) considered that the species probably already has been extirpated from Mexico.

Indicative of the species' tenuous status, the most recently published record of a harpy eagle (*Harpia harpyja*) (Iñigo-Elias et al. 1987a) in Mexico was a bird shot by a hunter. The vulnerability of the harpy eagle to shooting and its territorial demands make it very vulnerable in the face of ongoing deforestation in the south. However, over its vast range, the harpy probably maintains healthy populations, at least in the more remote reaches of Amazonia, so the situation in Mesoamerica does not constitute a threat to the species as a whole.

N. Clum currently is studying the possibility that the Mesoamerican populations of the harpy represent a distinct genetic population (Anonymous 1994). Even if her research does not identify the Mesoamerican harpy eagles as a distinct genetic population, there is ample justification to preserve the species *in situ*. Foremost among these is the harpy's value as a flagship species for conservation of the tropical forest ecosystem itself.

Another large eagle of neotropical forests, the crested eagle, is conspicuously absent from the list of Mexico's resident avifauna. However, a 1992 sighting in Campeche, and the discovery of an active nest in 1994 by researchers at Tikal, Guatemala, only about 36 miles (60 km) from the Mexican border, (D. F. Whitacre personal communication: 1995), suggest that the bird may be breeding in the country. Should the crested eagle be confirmed as a resident species, it would be vulnerable to the same pressures as the harpy eagle.

Northern species. A handful of species reach their northern limit very close to the U.S./Mexico border and maintain marginal populations in the U.S. While some of these species are quite rare in the U.S., for example, the gray hawk (*Buteo nitidus*) has around 45 pairs in the U.S. (del Hoyo et al. 1994), all have healthy populations only a few hundred kilometers south of the border, and some even may be expanding their ranges into Texas (e.g., hook-billed kite (*Chondrohierax uncinatus*)).

In contrast, the aplomado falcon's (*Falco femoralis*) range has retracted considerably during this century. At the turn of the century, the aplomado falcon's range extended from Mexico broadly across the U.S. border into Arizona, New Mexico and Texas (Hector 1988). By 1930, the species had virtually disappeared from its former range in the southwestern U.S. (Hector 1981). The declines probably resulted from some combination of habitat change, human exploitation and pesticide contamination (Hector 1987, Kiff et al. 1980). The Peregrine Fund now is working on a captive breeding and release program aimed at establishing a viable population in portions of the former U.S. range (Burnham et al. 1994).

Among the 13 species whose ranges extend into Mexico from the north, the conservation status of three species merits discussion. The bald eagle (*Haliaeetus leucocephalus*), peregrine falcon and California condor all are on the U.S. endangered or threatened species lists.

In prehistoric times, the range of the California condor once extended from southwestern Canada to northern Mexico and through much of the southern U.S. However, by this century the species was restricted to a small portion of coastal California and northern Baja California (Kiff 1990).

A cooperative program between the U.S. Fish and Wildlife Service, the San Diego and Los Angeles Zoos, and The Peregrine Fund aims to re-establish the condor in the wild. As of late 1994, there were 79 condors in a captive breeding population and 9 in the wild. Experimental releases in the area last occupied have been problematical. Northern Mexico may provide a suitably remote habitat for future releases (Anonymous 1994).

In the contiguous United States, the known population of the bald eagle has increased from 417 to 4,016 pairs from 1963 to 1994, probably in response to the restriction of the use of persistent pesticides in the country (Anonymous 1994). The species has been down-listed in the U.S. from the endangered species to threatened species list. Although the Baja California area is relatively pesticide free, the Mexican population is disjunct and, by 1977, had been reduced to a very small relict of about three pairs (Henny et al. 1993), which may be threatened by local fishermen and their gear (Rodríguez-Estrella et al. in press).

Across much of temperate North America, the anatum peregrine falcon (*Falco peregrinus anatum*) declined to alarmingly low numbers in the 1950s and 1960s (Hickey 1969), prompting its eventual listing on the U.S. endangered species list. An extensive 20-year effort to re-establish the species in its former range east of the Mississippi and bolster populations in the Rocky Mountains through captive breeding and reintroduction has been remarkably successful (Cade et al. 1988, Enderson et al. 1995).

Surveys of peregrine populations in the Chihuahuan Desert of Texas and northern Mexico from 1975–1982 showed similar numbers of breeding peregrine pairs in the Mexican Chihauhuan Desert over the time period (Hunt et al. 1988). However, the number of young per adult pair declined from 1.2–1.7 in 1975–1978 to 0.7 in 1979 and 0.9 in 1982, especially in the east, perhaps as a result of agricultural pesticide use near the Sierra Madre Oriental (Hunt et al. 1988).

Porter et al. (1988) reported that the peregrines of Baja California, both on western Baja and around the Gulf of California, exhibited close to normal eyrie occupancy rates, but somewhat lower productivity per nest than populations further north. Unfortunately, no reliable data were available to compare with current population levels, so the reproductive rates may not be unusually low or unhealthy for the region.

Endemics. By definition, endemic taxa are highly vulnerable, and island endemics as a rule require special attention. However, Mexico's four island endemics seem fairly secure at the moment. All four (two races of the red-tailed hawk, a race of the crested caracara and a race of the roadside hawk) are generalist species that adapt well to modified habitats. The red-tails and caracara inhabit very small, remote islands that are unlikely to suffer substantial encroachment from humans. In fact, the red-tailed hawks of Socorro Island offer an interesting case study in conservation biology, as a very small population of about 20 pairs has persisted since the island was discovered 123 years ago (Walter 1990). The roadside hawk seems quite secure on Cozumel, where very little deforestation has occurred over the past 15 years (personal observation).

Of the non-island endemics or near endemics, the three taxa that are restricted to forest habitats, *Accipiter striatus madrensis, A. s. suttoni* and *A. bicolor fidens*, must be considered the most vulnerable.

Conclusions

Our understanding of the natural history and conservation status of the 67 taxa of Falconiformes resident in Mexico varies substantially from species to species. More information on resident populations in Mexico is needed for almost all species.

Northern forms are, in general, well known and only one, the California condor, is seriously threatened, already extinct in the wild. Neotropical species, particularly forest dwellers, are not as well known biologically, and many species probably are experiencing population declines associated with on-going deforestation throughout Mesoamerica.

There are no endemic Falconiform species in Mexico, although 15 subspecies are restricted to Mexico or Mexico and the immediate vicinity. Among these taxa, the six forest-dwelling subspecies are especially vulnerable and should be carefully monitored.

Acknowledgments

L. S. Barden, L. F. Kiff, R. Rodríguez-Estrella and D. F. Whitacre made useful comments on earlier drafts of this paper.

References

Anonymous. 1994. Newsletter, No. 24. The Peregrine Fund, Boise, ID.

Bierregaard, R. O., Jr. In press. The biology and conservation status of Central and South American Falconiformes: A survey of current knowledge. Bird Conserv. Int.

Brown, L. and D. Amadon. 1968. Eagles, hawks and falcons of the world. McGraw-Hill, New York, NY. 945 pp.

Burnham, B., N. Clum, B. Heinrich, P. Jenny and C. Sandfort. 1994. Northern Aplomado falcon restoration. Prog. rept. 1994. The Peregrine Fund, Boise, ID. 105 pp.

Cade, T. J., J. H. Enderson, C. G. Thelander and C. M. White, eds. 1988. Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Clinton-Eitniear, J. 1988. Status of the ornate hawk-eagle in Mexico and Central America. Eyas 11: 8–10.

———. 1989. Habitat loss and shooting threaten king vulture in Mexico and Central America. Eyas 12(2): 9–11.

———. 1991. The solitary eagle *Harpyhaliaetus solitarius* a new threatened species. Birds of Prey Bull. 4: 81–85.

Collar, N. J., L. P. Gonzaga, N. Krabbe, A. Madroño Nieto, L. G. Naranjo, T. A. Parker III and D. C. Wege. 1992. Threatened birds of the Americas. Third Ed. (Part 2). Smithsonian Inst. Press and Int. Counc. for Bird Preserv., Cambridge, U.K. and Washington, D.C. 1,150 pp.

del Hoyo, J., A. Elliot and J. Sargatal, eds. 1994. Handbook of birds of the world. Lynx Edicions, Barcelona.

Enderson, J. H., W. Heinrich and L. F. Kiff. 1996. Population changes in North American peregrines. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.

Food and Agriculture Organization of the United States. 1988. An interim report on the state of forest resources in the developing countries. For. Resour. Div., For. Dept., FAO, Rome. Rept. FO:MISC/88/7.

Greene, H. W. 1988. Species richness in tropical predators. Pages 259–274 *in* F. Alemada and C. Pringle, eds., Tropical rainforests: Diversity and conservation. California Acad. Sci., San Francisco.

Hector, D. P. 1981. The habitat, diet, and foraging behavior of the aplomado falcon, *Falco femoralis* (Temminck). M.S. thesis, Oklahoma St. Univ., Stillwater.

———. 1987. The decline of the aplomado falcon in the United States. Am. Birds. 41(3): 381–389.

———. 1988. Aplomado falcon. Pages 315–322 *in* R. S. Palmer, ed., Handbook of North American birds. Vol. 5, Part 2. Yale Univ. Press, New Haven, CT. 465 pp.

Henny, C. J., B. Conant and D. W. Anderson. 1993. Recent distribution and status of nesting bald eagles in Baja California, Mexico. J. Raptor Res. 27: 203–209.

Hickey, J. J., ed. 1969. Peregrine falcon population: Their biology and decline. Univ. Wisconsin Press, Madison. 596 pp.

Hunt, W. G., J. H. Enderson, D. Lanning, M. A. Hitchcock and B. S. Johnson. 1988. Nesting peregrines in Texas and northern Mexico. Pages 115–121 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Iñigo-Elias, E. 1986. The trade in diurnal birds of prey in Mexico. Birds of Prey Bull. 3: 128–140.

Iñigo-Elias, E., M. Ramos and F. Gonzalez. 1987a. Two recent records of neotropical eagles in southern Veracruz, Mexico. Condor 89(3): 671–672.

Iñigo-Elias, E., M. A. Ramos, and F. González. 1987b. Feeding habits and ingestion of synthetic products in a black vulture population from Chiapas, Mexico. Acta Zool. Mexicana. (22): 1–17.

Kiff, L. F. 1990. To the brink and back. Terra 28(4): 7–18.

Kiff, L. F., D. B. Peakall and D. P. Hector. 1980. Eggshell thinning and organochlorine residues in the bat and aplomado falcons in Mexico. Pages 949–952 *in* Proceedings XVII Int. Ornithol. Congress, Berlin.

McNeely, J. A., K. R. Miller, W. V. Reid, R. A. Mittermeier and T. B. Werner. 1990. Conserving the world's biological diversity. Int. Union for Conserv. Nature and Natur. Resour., World Resour. Inst., Conserv. Int., World Wildl. Fund—U.S., and World Bank. Gland, Switzerland and Washington, D.C. 193 pp.

Porter, R. D., M. A. Jenkins, M. N. Kirven, D. W. Anderson and J. O. Keith. 1988. Status and reproductive performance of marine peregrines in Baja California and the Gulf of California, Mexico. Pages 105–114 *in* T. J. Cade, J. H. Enderson, C. G. Thelander and C. M. White, eds., Peregrine falcon populations: Their management and recovery. The Peregrine Fund, Boise, ID. 949 pp.

Ramos, M. A. 1986. Birds in peril in Mexico: The diurnal raptors. Birds of Prey Bull. 3: 26–42.

Ridgely, R. S. and J. A. Gwynne Jr. 1989. A Guide to the birds of Panama with Costa Rica, Nicaragua, and Honduras. Second ed., Princeton Univ. Press, Princeton, NJ.

Rodríguez-Esterlla, R., J. A. Donazar and F. Hiraldo. In press. Fishermen and their gear may threaten Bald Eagles in Magdalena Bay, B.C.S., Mexico. J. Raptor Res.

Rodríguez-Yáñez, C. A., R. M. Villalón and A. G. Navarro. 1994. Bibliografía de las aves de México (1825–1992). Publ. Espec. Mus. Zool., Univ. Nac. Autónoma México. (8): 1–146.

Rzedowski, J. 1983. Vegetación de México. Second ed. E. Limusa, Mexico City, Mexico.

Terborgh, J. 1992. Maintenance of diversity in tropical forests. Biotropica 24: 283–292.

Villela, O. F. and P. Gerez. 1988. Conservacion en Mexico: Sintesis sobre vertebrados terrestres, vegetacion e uso del suelo. Inst. Nacional de Investigaciones sobre Recursos Bioticos, Jalapa, Mexico. 302 pp.

Walter, H. S. 1990. Small viable population: The red-tailed hawk of Socorro Island. Conserv. Biol. 4(4): 441–443.

Whitacre, D. F. and R. K. Thorstrom, eds. 1992. Maya project: Use of raptors as environmental indicators for design, management, and monitoring of protected areas and for building local capacity for conservation in Latin America. Prog. rept. V, 1992. The Peregrine Fund, Inc., Boise, ID.

Whitmore, T. C. and J. A. Sayer. 1992. Tropical deforestation and species extinction. Chapman and Hall, London, U.K. 153 pp.

World Resources Institute. 1992. World resources 1992–1993. Oxford Univ. Press, New York and Oxford. 385 pp.

Appendix. Distribution, status and habitat of the diurnal birds of prey resident in Mexico.

Species	Species distribution	Subspecies distribution[b]	Species status[c]	Mexico trend[d]	Habitat[e]
Coragyps atratus	N/S[a]	Nearctic	s	d	Human-altered
Cathartes a. aura	N/S	Nearctic	s	d, s	Mixed forest-open
Cathartes b. burrovianus	Neotropical	Meso-n S.A.	s		Tropical forest/river, marsh
Gymnogyps californianus	Nearctic	Nearctic	extinct (wild)	extinct	Montane forest/arid/open
Sarcoramphus papa	Neotropical	Neotropical	s	d	Tropical forest
Pandion haliaetus carolinensis	Nearctic	Nearctic	Nearctic	d, s	Water
Leptodon c. cayanensis	Neotropical	Meso-Amaz.	s	d	Tropical forest/mixed
Chondrohierax u. uncinatus	Neotropical	Neotropical	s	d	Tropical forest/mixed
Elanoides forficatus yetapa	N/S	Neotropical	s	d	Tropical forest/mixed
Elanoides f. forficatus	N/S	Nearctic		d	Tropical forest/mixed
Elanus leucurus majusculus	N/S	Mesoamerican		i	Grassland
Rostrhamus sociabilis major	Neotropical	Endemic (nearly)	s	d	Marsh
Harpagus bidentatus fasciatus	Neotropical	Meso-n S.A.	s	d	Tropical forest/mixed
Ictinia plumbea	Neotropical	Neotropical	s		Forest/river
Ictinia mississippiensis	Nearctic	Mesoamerican	i		Forest/open
Haliaeetus l. leucocephalus	Nearctic	Neactic	i	d	Water
Circus cyaneus hudsonicus	Nearctic	Nearctic	s	s	Open
Accipiter striatus suttoni	Nearctic	Endemic (nearly)	s	d, s	Forest
Accipiter s. madrenis	Nearctic	Endemic			Forest
Accipiter chionogaster	Neotropical	Mesoamerican			Forest
Accipiter b. bicolor	Neotropical	Neotropical	s	d	Tropical/dry forest
Accipiter b. fidens	Neotropical	Endemic			Tropical/dry forest
Accipiter cooperi	Nearctic	Nearctic	s	d	Forest
Accipiter gentilis atricapillus	Nearctic	Nearctic	s		Forest
Geranospiza caerulescens nigra	Neotropical	Mesoamerican	s	d	Tropical forest/open
Geranospiza c. livens	Neotropical	Endemic			Open
Leucopternis albicollis ghiesbreghti	Neotropical	Endemic (nearly)	s	d	Tropical-mixed forest
Buteogallus subtilis rhizophorae	Neotropical	Mesoamerican	s?		Mangrove
Buteogallus a. anthracinus	Neotropical	Meso-n S.A.	s	s	Riparian/open

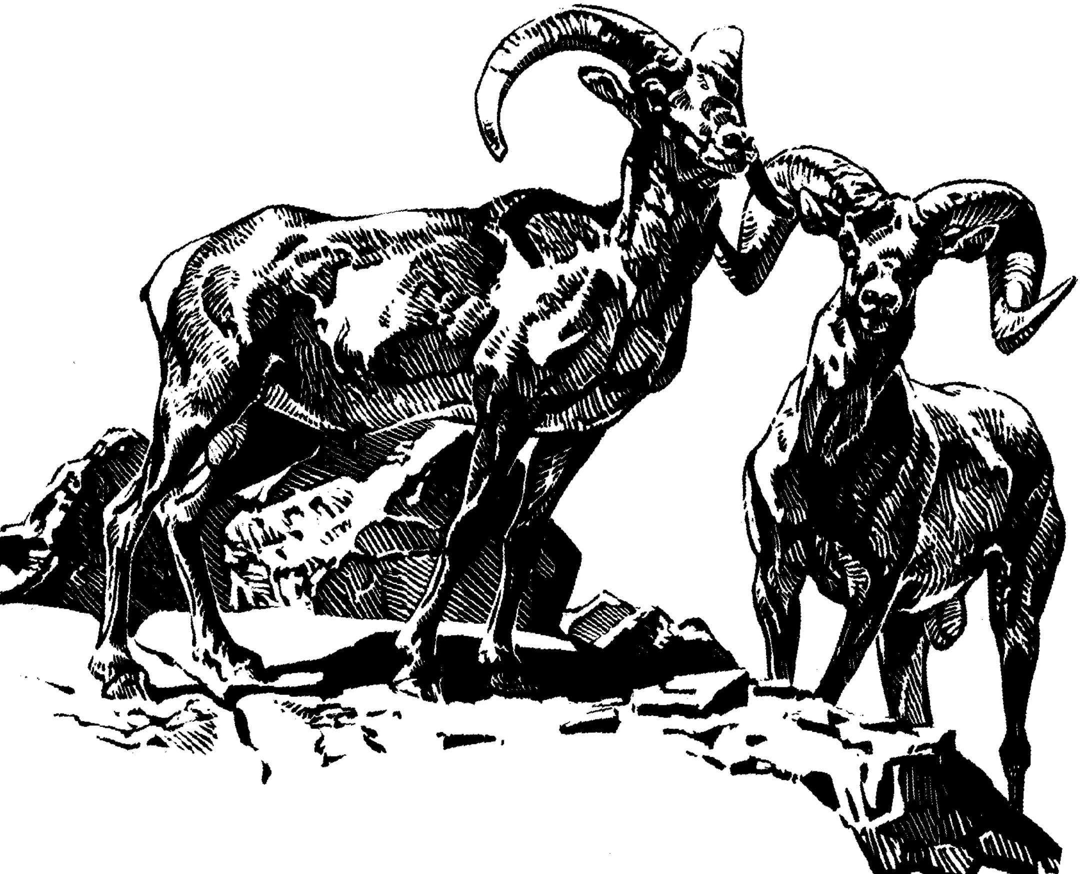
Appendix. Continued.

Species	Species distribution	Subspecies distribution[b]	Species status[c]	Mexico trend[d]	Habitat[e]
Buteogallus urubitinga ridgwayi	Neotropical	Mesoamerican	s	d	Tropical forest/open
Parabuteo unicinctus harrisi	Neotropical	Meso-w S.A.	s	s	Open
Busarellus n. nigricollis	Neotropical	Neotropical	s, d	d	Water
Harpyhaliaetus solitarius sheffleri	Neotropical	Mesoamerican	i, d	d	Montane forest
Buteo nitidus plagiatus	Neotropical	Mesoamerican	s	s	Forest/open
Buteo magnirostris griseocauda	Neotropical	Mesoamerican	s	i	Tropical forest/open
Buteo m. conspectus	Neotropical	Endemic (nearly)			Forest/open
Buteo m. gracilis	Neotropical	Endemic			Tropical forest/open
Buteo lineatus elegans	Nearctic	Nearctic	s		Woodlands
Buteo l. texanus	Nearctic	Endemic (nearly)			Woodlands
Buteo brachyurus fuliginosus	Neotropical	Mesoamerican	s		Tropical forest/open
Buteo swainsoni	Nearctic	Nearctic	s, d	d, s	Open
Buteo albicaudatus hypospodius	Neotropical	Meso-n S.A.	s, i	d	Dry forest/savanna
Buteo albonotatus	Neotropical	Neotropical	s	s	Open-high altitude
Buteo jamaicensis calurus	Nearctic	Nearctic	s, i	s	Mixed forest/open
Buteo j. fuertesi	Nearctic	Endemic (nearly)			Mixed forest/open
Buteo j. hadropus	Nearctic	Endemic			Mixed forest/open
Buteo j. kemsiesi	Nearctic	Mesoamerican			Mixed forest/open
Buteo j. fumosus	Nearctic	Endemic			Mixed forest/open
Buteo j. socorroensis	Nearctic	Endemic			Mixed forest/open
Harpia harpyja	Neotropical	Neotropical	s, d, extirpated	d	Tropical forest
Aquila chrysaetos canadensis	Nearctic	Nearctic	s	d?	Open
Spizaetus melanoleucus	Neotropical	Neotropical	near threat	d	Tropical forest/savanna
Spizaetus tyrannus serus	Neotropical	Meso-Amaz.	s, d	d	Tropical forest/semi-open
Spizaetus ornatus vicarius	Neotropical	Meso-n S.A.	s, d	d	Tropical forest
Daptrius americanus	Neotropical	Neotropical	s	extirpated	Tropical forest
Polyborus plancus auduboni	Neotropical	Mesoamerican	s, i	s	Open/savanna
Polyborus plancus pallidus	Neotropical	Endemic			Open/savanna
Polyborus p. lut. (ext)	Neotropical	Endemic		extinct	

Appendix. Continued.

Species	Species distribution	Subspecies distribution[b]	Species status[c]	Mexico trend[d]	Habitat[e]
Herpetotheres chachinans chapmani	Neotropical	Mesoamerican	s	s	Tropical forest/savanna
Micrastur ruficollis guerilla	Neotropical	Mesoamerican	s	d	Tropical forest/mixed
Micrastur semitorquatus naso	Neotropical	Meso-w S.A.	s	d	Tropical/deciduous forest
Falco s. sparverius	N/S	Nearctic	s	d, s	Open
Falco s. peninsularis	N/S	Endemic			Open
Falco femoralis septentrionalis	Neotropical	Mesoamerican	s, i	s	Open/savanna
Falco rufigularis petoensis	Neotropical	Meso-w S.A.	s	s	Tropical forest/edge
Falco mexicanus	Nearactic	Nearctic	s	s	Arid
Falco peregrinus anatum	N/S	Nearctic	i	d	Open
Falco deiroleucus	Neotropical	Neotropical	s, d	Tropical forest	

[a]N/S indicates species whose ranges extend across much of North and South America.
[b]For subspecies with limited ranges in the Neotropics, the southern limit of the range is indicated.
[c]Species-wide status after del Hoyo et al. (1994): s = stable, d = decreasing, i = increasing. A species may be designated as stable, even though regional populations are declining, as will inevitably be the case with forest-dwelling species. The status of polytypic species is indicated only for the first subspecies listed.
[d]After Ramos (1986). Codes as in species status column.
[e]Mixed forest or "Mixed" refers to a variety of forest types including primary, closed forest, disturbed or second-growth forest, gallery forest and wooded savanna.



Special Session 4. *Conservation Potpourri*

Chair
CARROL L. HENDERSON
Minnesota Department of Natural Resources
St. Paul, Minnesota

Cochair
LAURA JACKSON
Iowa Department of Natural Resources
Boone, Iowa

Opening Remarks

Carrol L. Henderson
Minnesota Department of Natural Resources
St. Paul

Welcome to the "Conservation Potpourri" session of the North American Wildlife and Natural Resources Conference. When Lonnie Williamson asked me to chair this session for the Conference, I told him I didn't know if it was right for me to be in charge of a session whose name I couldn't spell. Considering the Scandinavian roots of many people from this region, maybe this session should have been called the "Conservation Smorgasbord." Whatever we call the session, however, I feel that there is a very real need in conferences like this one for the important papers that don't fit into sessions that have more narrowly defined topics.

This morning, we have a fascinating variety of papers. Interest and concern about forest management and its effects on biological diversity are reflected in papers about martens in Newfoundland, and Minnesota's production of a generic Environmental Impact Statement to get the big picture on the long-term, cumulative impact of timber harvesting across the state of Minnesota. Another paper assesses the concerns expressed about bird mortality associated with the development of wind power as a source of electricity.

Waterfowl issues are included in papers about the effects of haying on CRP lands in the Prairie Pothole Region, about waterfowl harvest and hunter activity in Mexico, and in an evaluation of restoration of trumpeter swans in North America.

I also wish to pass along best wishes from my original cochair, Laura Jackson, who moved to Oregon in January and was unable to return for this Conference. She was previously the nongame wildlife biologist for the Iowa Department of Natural Resources. Her husband DeWaine accepted a position as a big game biologist with the Oregon Department of Fish and Wildlife last autumn.

Walking the Line: Science versus Advocacy

James M. Sweeney
Champion International Corporation
Washington, D.C.

Peter W. Stangel
National Fish and Wildlife Foundation
Washington, D.C.

Introduction

Today, there is an increasing call for professional wildlife and fisheries biologists to bring their research or management experience to bear on public decisions involving use of our natural resources. Traditionally, these professionals, when serving as scientists, were viewed by the general public as objective sources of information; politically and emotionally neutral individuals who, untainted by opinion, could present a statement of fact based on "scientific data." Although their statements of fact then may have been used by others to promulgate a particular viewpoint, scientists themselves enjoyed an image of being above that sort of partisanship.

Increasingly, however, we as professionals are being asked to serve as witnesses before court or Congress, or before the larger stage of public media. This presents the opportunity to step beyond the neutrality of the traditional scientist and instead move into the role of advocate for a particular position.

For many biologists, and perhaps for our profession as a whole, this is a new challenge. With the role of advocate comes a new set of responsibilities and consequences for which many biologists may not be prepared. As professional biologists, most of us have thorough training in basic biology and ecology. As researchers, we understand and use the scientific method. However, as Bob Lee (1994) pointed out in his book *"Broken Trust, Broken Land,"* few wildlife professionals have the training or background for making public policy decisions involving the complex ethical and moral issues at work within a democracy.

In this paper, we examine the role of the professional wildlife or fisheries biologist. We ask the question: can a professional biologist serve as an advocate? Or, to put it another way, can a professional biologist afford *not* to be an advocate? We will explore this question at two levels—the individual professional wildlife or fisheries biologist, and the collective level of our professional societies. We do not provide a set of guidelines, nor choose one role as right or wrong. Rather, we hope to stimulate discussion on what we believe is an important issue in wildlife biology and ethics.

The Professional as Scientist or Advocate

In recent years, decisions concerning management of natural resources have become more controversial as resources dwindle and the number of user groups laying claim to them increase. The stakes in these decisions often are enormous—biologically, financially, and in terms of public and private rights. The very nature of the topic of our profession provides room for considerable interpretation and debate. We are working with a very complex, highly variable system. We often have to make do with very limited data; particularly in the case of rare or sensitive species which, unfortunately, tend to be the more controversial species. True experimentation is the exception and likely never will become the norm. Our systems are not static. Even if we could measure all components accurately, they will change tomorrow. There also is the variability in data interpretation some of which may be due to differences in each investigator's own evaluation of what is acceptable risk.

As the stakes and controversy have increased, proponents of particular positions increasingly have sought to reinforce their stance with scientific opinion. This role for science and scientists is not new. For years, the legal system has taken advantage of "professional" witnesses as means to prove or disprove the validity of a particular point—recall courtroom scenes of psychiatrists presenting diametrically opposed diagnoses of a defendant accused of some sordid crime. Same defendant, same data, different professional conclusions!

Attorneys, the professional spokespeople for litigants, do not emulate scientists by providing and unbiased set of facts. Instead, they present only that information which supports their client's point of view. This behavior of filtering information is not only accepted, but expected. Attorneys are selected by their clients on just that ability to skillfully present a well-crafted case that favors the client's point of view. The attorney is the professional advocate for the client.

But is this the realm of science, at least as professional wildlife biologists historically have defined science? Science operates best when we have open and free debate. The need for such debate probably is particularly relevant to the wildlife and fisheries professions given the complexity of the natural sciences. Stimulating as this approach may be in the academic environment, it does not suit most court rooms or Congressional inquiries. These systems are driven by the need for definitive information upon which to draw a conclusion.

The playing field has shifted from the classroom or professional meeting, where intellectual debate is encouraged, to the courtroom or Congress, where definitive answers are demanded and decisions made on the best presented case. Like it or not, the "scientific" advocate probably will defeat the neutral scientist every step of the way.

However, movement to advocacy is a departure from tradition and, as such, is likely to draw the ire of colleagues. Questions will be asked. Not all agree that professional wildlife or fisheries biologists should be advocates. Others feel that it is a role we must accept. But, at what cost, personally and professionally, do we make the shift from neutrality to advocacy? Many will see this as a shift from objectivity to advocacy. Can you be an objective advocate? Does our current professional system allow for this career track?

Mary O'Brien, in an article in *Science* entitled, "Being a scientist means taking sides," offered the opinion that "Once you are a scientist . . . [and] systematically ask questions about the universe, you take a political side." She reasoned that, as there is an infinite set of possible questions, but only a finite number you as a scientist can ask, you must make a choice." [Your] decision has implications for society, for the environment, and for the future . . . [and] therefore is necessarily value laden . . . as well as scientific" (O'Brien 1993). By O'Brien's logic, then, we all have become advocates, at least in a very general sense, and perhaps unknowingly.

Taking her logic one step farther, we are faced with the question: is the traditional image of professional/scientist as a neutral, objective source of information a false image? We do choose research questions focusing on particular points of interest. Note, we did not say "conclusions." We do develop our investigations based on a set of assumptions/statements we want to prove or disprove. And how a question is asked can impact results. The fact that we as professionals, in addition to professional insight, have personal interests or biases should not come as earth shaking news. But the admission might.

Yet, in the public's mind, there remains a distinction between scientist and advocate. Because of this public perception, we as professionals, therefore, must make it abundantly clear what role we are taking when we present ourselves before court, Congress or the media. But separating the two roles may be easier said than done.

Kai Lee (1993), in his writings on forestry in the age of the "Philosopher King," made the assumption that professionals are capable of separating scientific judgment from moral opinion; that we are not only able to identify the gray line, but walk it successfully. However, Bob Lee (1994) in his book *"Broken Trust, Broken Land,"* argued that this is a naive assumption; that it is not within human nature to be able to separate such strongly held emotions and beliefs.

The unfortunate reality is that regardless of whether or not you think we can do it, we must recognize that we will be asked to become "scientist advocates." For many of us, this is a real dilemma. It also is a challenge facing our professional societies. But, while an individual can make the personal choice of serving as scientist or advocate, can the professional society?

The Professional Societies

The Wildlife Society and American Fisheries Society both recently have had a "majority" of their members say they support increased involvement in influencing public resources policy and programs—advocacy (Moffitt 1988, T. Franklin personal communication). The strength of a professional society is its diversity of both members and views; and with this diversity comes the ability to examine any given issue from most perspectives. But this very strength could be problematic as a society attempts to advocate one particular view. The challenge before the society is to examine all data and consider all views, yet, respond to issues in a timely fashion. Even if a formal procedure exists to generate the society's position, and even if that view is held by the majority of members, can a professional society present only those data that support one position?

Given the diversity of views within our professional societies, there likely always will be one or more minority opinions. Should these not be voiced as well? But if presented as a "minority opinion," will it be accepted as an equally professional view? Our experience tells us that is unlikely. So how does a professional society overcome the negative image of a minority opinion? Can it?

Perhaps, if advocacy is becoming a more common role for members of our profession, and realizing that any member of our profession can join and support any given advocacy group he or she prefers, perhaps it may be increasingly important for the society to become and remain the recognized neutral body where the full suite of views can be obtained reliably.

The Wildlife Society

The Wildlife Society (TWS) does not have a published statement or policy on advocacy. However, over the past 10 years, actions taken by the Society's Council point to an increased involvement in political advocacy. TWS recently visibly increased its advocacy role through the development of a Government Affairs position in its headquarters office. Tom Franklin, the new Director of Government Affairs, stated that professional societies, like TWS, have an important role to play in bringing science to the table and representing professional opinion in the policy process independent of special interest groups or employers (T. Franklin personal communication).

The Western Section, and the Oregon and Texas chapters all have hired lobbyists to help them get more involved. And the Wisconsin Chapter is considering taking similar action. The role of these section lobbyists differs from one of simply monitoring what is going on in state or regional politics, to one of formal lobbying (T. Franklin personal communication).

Tom also noted that, while some within TWS believe professionals should not be involved in advocacy, all agree that if done, advocacy should be based on the best science. One group not necessarily in support of the Society getting more involved in advocacy is state and federal administrators. Their concern is that many of their employees are members of local chapters and sections, and it is possible that these chapters or sections could take a political position that is in conflict with agency direction. However, most TWS members believe that, in order to have an effective wildlife program, we must be involved in policy formulation or else policy will not reflect our interests or objectives (T. Franklin personal communication).

The American Fisheries Society

The American Fisheries Society (AFS) actively encourages its professionals to become advocates. The AFS has a published policy statement on advocacy, complete with " advocacy guidance criteria." Only one of the eight criteria relates directly to science and asks "Does the [AFS Chapter or Section] have sound and the best available technical information?" The other criteria address the more practical aspects of advocacy, such as whether AFS involvement will make a difference, or whether there is sufficient membership support to follow through (P. Brouha personal communication).

The AFS Membership Concerns Committee survey of 1986 found that 92 percent of its members felt it was either a medium or high priority that AFS should participate in and more actively comment on development of environmental policy (Moffitt 1988). The majority (68 percent) felt this should include chapter and section activities (Brouha 1991). In response to that survey, the AFS developed a Long-Range Plan (Hubley 1989) that provides clear direction for increased science based advocacy. As the Society's Executive director, Paul Brouha (1991) put it, "Our responsibility goes beyond the scientific method. Our responsibility is to put facts into a context of shared community values to affect appropriate change . . . that is the definition of advocacy".

Both of these societies recognize the right of individual members to become advocates. The direct support of advocacy, at least on the surface, varies considerably. Both societies also apparently believe it is appropriate for a society as a whole to take a position of advocacy if all relevant facts are considered openly and honestly.

Conclusion

Kai Lee (1993), in his book *"Compass and Gyroscope,"* stated that "Science and politics serve different purposes." Many would use the same dichotomy for science and advocacy. Science, in its purest form, searches for truth. It builds knowledge. Advocacy strives to direct how knowledge is applied in the political processes of our democracy.

However you look at it, it is likely that the professional can serve in either role. But it is essential that we handle ourselves with personal and professional integrity, base our comments on solid data, identify "expert opinion" or assumptions as such, *and* that we clearly identify which role we are taking. But we also caution that, while we may have a well-earned professional reputation, the experience and training behind that may not prepare us to meet the complex ethical choices found in public policy. Credentials earned in biological science do not necessarily transfer to political science.

As we enter this new arena, it is important that we not only be cognizant of our strengths and the valuable professional insight we can offer, but we also must remember that science is not the only element of social and political decisions. We don't have *the* answer, we only have part of it.

Acknowledgments

The authors would like to thank the following reviewers for there meaningful comments: Paul Brouha, Reed Noss and Gene Wood.

References

Brouha, P. 1991. The role of AFS in fostering responsible environmental advocacy. Fisheries (July–August): 11.

Lee, K. N. 1993. Compass and gyroscope: Integrating science and politics for the environment. Island Press, Washington, D.C. 243. pp.

Lee, R. G. 1994. Broken trust, broken land: Freeing ourselves from the war over the environment. BookPartners, Wilsonville, OR. 210 pp.

O'Brien, M. H. 1993. The professional biologist: Being a scientists means taking sides. BioSience 43(10): 706–708.

The Impact of Haying Conservation Reserve Program Lands on Productivity of Ducks Nesting in the Prairie Pothole Region of North and South Dakota

Randy W. Renner
Ducks Unlimited, Inc.
Bismarck, North Dakota

Ronald E. Reynolds
U.S. Fish and Wildlife Service
Bismark, North Dakota

Bruce D. J. Batt
Institute for Wetland and Waterfowl Research
Ducks Unlimited, Inc.
Memphis, Tennessee

Introduction

The Conservation Reserve Program (CRP) was authorized in 1985 under the Food Security Act (Public Law 99–198). It is administered by the U.S. Department of Agriculture (USDA) with objectives of reducing soil erosion on highly erodible land, reducing crop surpluses and improving wildlife habitat. Farmers contracted with USDA to convert cultivated land to permanent cover, such as grass or trees, in return for an annual payment for a period of ten years. Haying, grazing or other commercial uses of CRP forage are not allowed during the contract period unless the Secretary of Agriculture releases it in response to drought or other agriculture emergency.

In the Prairie Pothole Region of North Dakota and South Dakota, most lands enrolled in CRP were planted to a mix of introduced grasses and legumes composed primarily of wheatgrass (*Agropyron* spp.), smooth brome (*Bromus inermis*), alfalfa (*Medicago sativa*) and sweetclover (*Melilotus* spp.). CRP cover provides attractive and relatively secure nesting habitat for ducks in the northern plains (Reynolds et al. 1994). These benefits are important because populations of upland-nesting duck species such as mallard (*Anas platyrhynchos*), northern pintail (*A. acuta*) and blue-winged teal (*A. discors*) generally have declined since the early 1970s. Record low numbers occurred from 1985–91 (Caithamer et al. 1994). Benefits of CRP in this region also extend to other grassland birds that apparently have declined because of conversion of native grasslands to annually tilled cropland (Johnson and Schwartz 1993).

The Secretary of Agriculture released some CRP acres to emergency haying or grazing in North and South Dakota in six of nine years since the program was initiated (Agricultural Stabilization Conservation Service unpublished report). No releases were made during the first two years of the program because the vegetative cover was not well established. The amount of CRP acreage released each year has ranged from 75 to 100 percent of the contract acres in the affected counties, however, actual acres hayed never have reached these levels. Reduction in annual rental payment required on hayed acres has ranged from 0 (if forage was donated to a livestock producer in need) to 50 percent.

In 1993, USDA released 50 counties in North Dakota and 47 counties in South Dakota. Approximately 500,000 acres (202,429 ha) were hayed in North Dakota and 200,000 acres (80,971 ha) in South Dakota. These acres represent 17 percent and 14 percent, respectively, of the total CRP in eligible counties and the largest amount of haying in both states since CRP began. Haying occurred late in the growing season from mid-August to late September when the potential for vegetative regrowth was limited.

The impact of haying CRP on duck and other grassland bird production is unknown. Haying removes cover that would be residual the following spring (Luttschwager et al. 1994) and subsequently may result in lower use and success by nesting birds. Studies by Duebbert and Kantrud (1974) and Kirsch et al. (1978) demonstrated that waterfowl nest success and waterfowl nest densities were higher in fields of undisturbed cover compared with fields that were hayed or grazed.

Because haying of CRP in 1993 occurred after nesting by most prairie birds was completed, the impact on production that year was minimal. Above average precipitation during summer 1993 and winter 1993–94 increased the wetlands available to breeding ducks the following spring. This resulted in record high numbers of breeding ducks surveyed within the Prairie Pothole Region of North and South Dakota in May 1994 (Caithamer et al. 1994).

Coincident with these changes in habitat for breeding ducks and the harvest of CRP forage, we were conducting a study of waterfowl use and nesting success in CRP cover in the Prairie Pothole Region of Montana, and North and South Dakota (Reynolds et al. 1994). Therefore, we had an opportunity to evaluate the impact of haying on certain aspects of duck production. We used a portion of CRP fields, from a larger sample selected as part of our main study, to investigate the impact of haying 1993 on duck use and productivity the following year. We compared nest densities, nest success and total hatchlings produced in hayed and unhayed areas during the 1994 duck breeding season.

Study Area and Methods

Our study area included that portion of North and South Dakota that lies east and north of the Missouri River and is part of the Prairie Pothole Region of North America. Our sample of CRP fields came from the larger sample being used to evaluate effects of CRP on duck recruitment in the same geographical area (Reynolds et al. 1994). Study sites were 2- by 2-mile (3.2 by 3.2 km) units from which CRP fields were randomly selected until the last field selected reached or exceeded 200 acres (80.9 ha) for that site. In sites where CRP acreage available was less than 200 acres (80.9 ha), all fields were selected. Because our primary objective was to evaluate the importance of the overall program, we did not select fields based on knowledge that they were hayed or not. However, our sample included fields which were hayed in 1993. This allowed and evaluation of impacts of haying on ducks using CRP in North and South Dakota.

During the spring/summer of 1994, we located duck nests (scrape or bowl containing ≥ 1 egg) following procedures of Klett et al. (1986). Each field was searched three times at approximately three-week intervals starting on May 1. We recorded date, species, field treatment, number of eggs and stage of laying or embryonic development for each next (Weller 1956).

Apparent nest densities (nests found/100 acres [40.5 ha]) and nest daily survival rate (DSR) were estimated, and total hatchlings produced per 100 acres (40.5 ha) was measured for each treatment by field. A successful nest was defined as one from which 1 or more eggs of a clutch hatched. DSR was calculated using the modified Mayfield method of Johnson (1979). Productivity (hatchlings produced) was measured using the number of eggs observed to have hatched from all successful nests in each treatment by field. This last measurement assumes that all successful nests that occurred in the respective fields were detected. Given the interval between searches (approximately 21 days) and the exposure period (33–36 days) required for a successful nest, all successful nests were available for detection during at least one search attempt.

For analysis of haying impacts, we included only those fields in which a portion of the field was hayed and a portion was unhayed. Fourteen fields met this condition in 1994 and were treated as replicates. Of these fields, 13 were located in North Dakota and 1 in South Dakota.

We used analysis of variance techniques (ANOVA) to assess the effects of haying treatment (hayed or idle) on the response variables DSR, nest density and hatchlings produced by waterfowl species (blue-winged teal, gadwall [*A. strepera*], mallard, northern pintail and northern shoveler [*A. clypeata*]) and for all species combined. We assumed a completely randomized design with blocking (Steel and Torrie 1980), in which CRP fields served as blocks. ANOVAs were conducted using SAS Inst. Inc. (1989) statistical software.

Results

In 1994, we searched 14 CRP fields on 9 study sites (Figure 1) in which some portion of each field had been hayed and some portion was left idle. Overall, hayed acres searched totaled 681 and idled acres totaled 586. We found 536 duck nests of which 216 and 320 occurred in hayed and idle areas, respectively. Of these nests, all were useable for estimating nest density and 504 could be used for estimating DSR. Nests in which 1 or more eggs hatched totaled 333, and this data was used to calculate hatchlings produced. Principal species found were blue-winged teal (19 percent), gadwall (30 percent), mallard (24 percent), northern pintail (14 percent) and northern shoveler (10 percent).

Mean DSR of nests was not significantly different ($P \geq 0.05$) between hayed versus idle areas for any species or for all species combined (Table 1). Nest density generally was higher in the idle CRP cover compared with the hayed CRP cover for all species and was statistically significant for blue-winged teal ($F_{1,13} = 5.52$, $P = 0.0353$). For all species combined, nest density was nearly twice as high in idle CRP cover compared with hayed CRP cover ($F_{1,13} = 4.73$, $P = 0.0487$) (Table 2).

Certain idle fields exhibited extremely high densities of hatchlings compared with the hayed counterparts (Table 3). Overall, differences in total hatchling

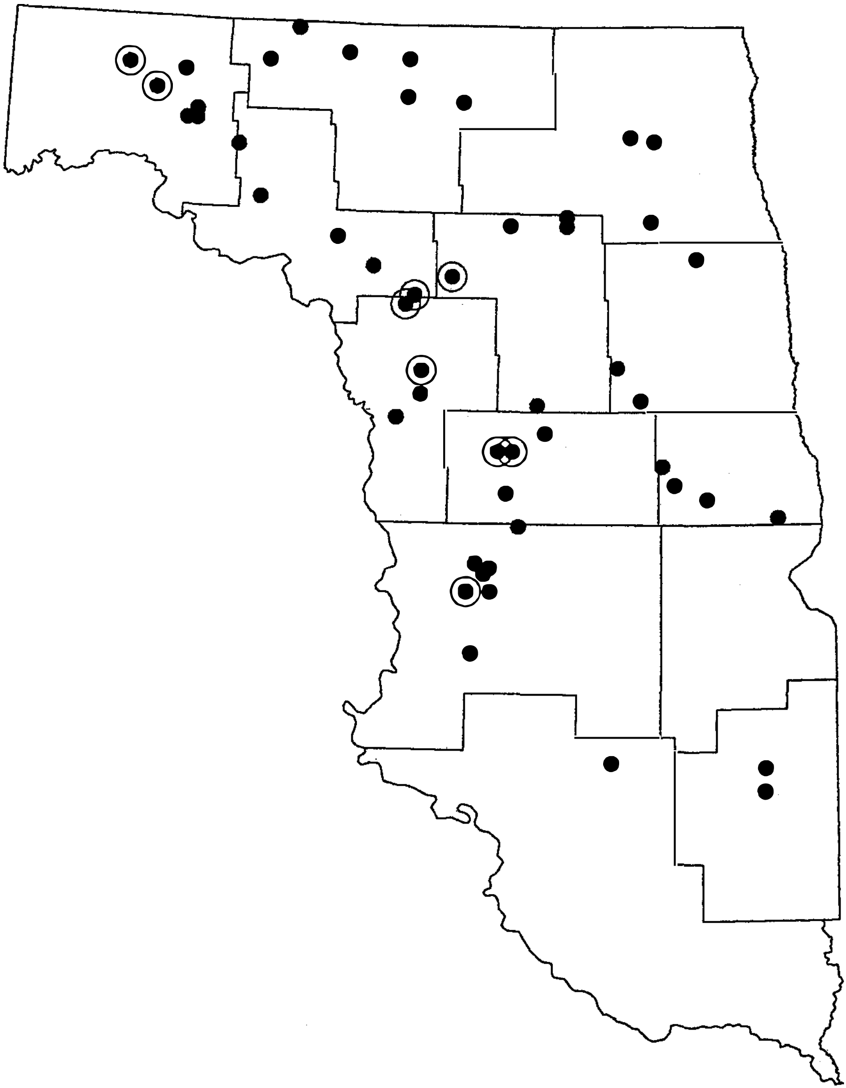


Figure 1. Locations of study sites in the Prairie Pothole Region of North and South Dakota used in the CRP evaluation, and those sites where haying occurred (circled) in 1993.

density were similar to differences in nest density between the two treatments and the two variables were highly correlated in both idle (r = 0.967, P = 0.0001) and hayed (r = 0.930, P = 0.0001) treatments. Also, we were unable to demonstrate a treatment difference in DSR and, hence, its derivative nest success. Therefore, we concluded that nest density is an adequate measure of productivity for comparison between treatments. We present raw hatchling density for comparative purposes by study block in Table 3.

Table 1. Mean[a] daily survival rate values for nests of five duck species in hayed and idle CRP cover in 1994.

Species	Hayed $\bar{x}$	Hayed SE	Idle $\bar{x}$	Idle SE	*P*
Blue-winged teal	0.9662	0.0179	0.9571	0.0153	0.7231
Gadwall	0.9651	0.0069	0.9663	0.0069	0.9105
Mallard	0.9812	0.0163	0.9512	0.0163	0.2122
Northern pintail	0.9690	0.0113	0.9324	0.0137	0.0911
Northern shoveler	0.9215	0.0403	0.9810	0.0403	0.4254
All species	0.9767	0.0049	0.9665	0.0049	0.1662

[a]Least-squares means.

Discussion and Recommendations

Our results show that mean production of hatchlings was much higher in idle CRP fields than in hayed fields. However, mean DSR of nests were not significantly different ($P \geq 0.05$) for any of the five species or all species combined in idle and hayed fields. Nest densities of blue-winged teal and all species combined were significantly higher ($P \geq 0.05$) in idle fields than hayed fields. This factor caused the differential in production.

Undisturbed, dense cover is a preferred habitat for most nesting dabbling ducks in this region and is the cover in which greater nest success generally occurs (Oetting and Cassel 1971, Duebbert and Lokemoen 1976, Klett et al. 1988, Lokemoen et al. 1990). The differences that we observed in nest densities between the two cover types are consistent with these studies. Although we did not measure cover quality, at the beginning of the nesting period, there was visually less residual cover in the hayed fields because haying occurred in late August and September after the principal growing season for most plant species. Luttschwager et al. (1994) recorded this relationship in South Dakota where they found significantly reduced vegetation density in hayed CRP fields early in the following nesting period, but found no differences later in the season.

Differences in nesting chronology of the five species likely contributed to the distribution of nests between the cover types. In the Prairie Pothole Region, northern pintails and mallards are the earliest nesters, followed by northern shoveler, blue-

Table 2. Mean[a] nest density (nests per 100 acres) for five duck species in hayed and idle CRP cover in 1994.

Species	Hayed $\bar{x}$	Hayed SE	Idle $\bar{x}$	Idle SE	*P*
Blue-winged teal	4.02	3.11	14.36	3.11	0.0353
Gadwall	9.53	2.60	13.89	2.60	0.2572
Mallard	5.60	3.75	15.84	3.75	0.0754
Northern pintail	5.19	2.09	7.18	2.09	0.5107
Northern shoveler	2.13	1.72	5.23	1.72	0.2252
All species	27.37	10.39	59.32	10.39	0.0487

[a]Least-squares means.

Table 3. Hatchling density (hatchlings per 100 acres) in hayed and idle CRP cover for all species combined by study block in 1994.

Study block	Hayed	Idle
1	87	381
2	80	215
3	133	118
4	509	1,869
5	97	224
6	75	0
7	206	237
8	22	9
9	240	142
10	74	280
11	344	554
12	57	112
13	49	376
14	250	262
Mean	159	341

winged teal and gadwall (Higgins et al. 1992, Greenwood et al. 1995). During the early part of the season, the hayed areas of CRP cover are less attractive to hens seeking denser nesting cover but, later in the year, both cover types may have similar attractiveness. This is supported by our observations that median nest initiation date was 19 and 23 days later for northern pintails and mallards, respectively, in hayed compared with idle cover. For later-nesting species, such as blue-winged teal and gadwall, median nest initiation date was similar, being 0 and 5 days later in the hayed compared with idle cover for these species, respectively. Nevertheless, the marked difference in nest density indicates lack of residual cover may be a factor throughout the nesting period.

We conclude that dabbling duck preference for denser cover resulted in a higher proportion of nests being located in undisturbed cover. We cannot evaluate whether the total nesting effort was affected by reduced cover availability. Nor could we evaluate if the apparent redistribution of nesting ducks affected overall nest success by concentrating birds in the remaining cover, as has been suggested by Cowardin et al. (1983). However, we do not believe this to be likely because only 14 and 17 percent of CRP was hayed in South Dakota and North Dakota, respectively, and, on most of our study sites, ample acres of idle CRP cover still were available.

Average nest success (DSR raised to the power equal to the mean laying plus incubation periods for successful nests) (Klett et al. 1986) on hayed and idle CRP fields ranged from 22–74 percent and 16–71 percent, respectively, for all species. These values are above the level considered to be necessary, on average, to maintain populations (Klett et al. 1988).

Our observations regarding haying effects on nest densities and nest success are similar to those of Kirsch et al. (1978), who reviewed previous studies on the effects of grazing and mowing grass legume cover on game and nongame birds. Kirsch et al. (1978) noted that periodic disturbance of the cover was necessary to maintain stand quality and they recommended haying, grazing and burning as practical tools. They provided general guidelines on how frequent disturbance should occur in various regions, based on the dryness of the prairie.

Luttschwager et al. (1994) found that the negative effect of haying on the nesting cover apparently only lasts through the early portion of the nesting period in the following year. Our results suggest the effect may last throughout the following season because late-nesting species such as blue-winged teal and gadwall tended to have higher nest densities in the idle cover.

Hay provides forage that has an economic value as cattle feed. Our concern is that haying, or any other form of disturbance, should not be allowed to substantially reduce the amount of idle CRP cover available to nesting birds in a given year. In the absence of CRP, idle planted cover is uncommon on private land in the Prairie Pothole Region (Cowardin et al. in press). If overly liberal haying activity were allowed on CRP acres, nesting hens would be displaced to other habitats where the probability of success is lower (Klett et al 1988).

Although we demonstrated that hayed CRP cover produced fewer ducks, we acknowledge that controlled haying can sustain vegetation quality and increase habitat diversity. We recommend that new, or renewed, USDA contracts for CRP in this region provide provisions for haying to meet the emergency forage needs of ranchers and also help to maintain the quality of the cover for wildlife. However, we suggest that haying be allowed on a rotational basis on no more than 20 percent of the contract acres annually, so that each stand would not be hayed more frequently than once every five years. This haying frequency is consistent with that recommended by Duebbert et al. (1981) for establishing seeded grassland for wildlife habitat in the Prairie Pothole Region. Haying should be scheduled to occur after July 20, when most game and nongame bird nests will have hatched. This schedule is crucial because earlier haying can reduce production by destroying nests and hatchlings, and it can increase mortality on incubating females that get trapped in haying equipment (Lee et al. 1964, Bollinger et al. 1990, Frawley and Best 1991).

We believe such an approach is preferable over the current emergency provisions which rely too heavily on a subjective assessment of forage needs. It would allow a mutually beneficial practice to proceed in a planned manner, while eliminating the threat of excessive haying that exists under the current system. If haying is allowed without any payment penalty, landowners may be willing to enroll CRP acres at lower contract prices. This provision would add to the benefits that already are recognized from CRP and should reduce the costs of the program. Further benefits may occur as a result of increased diversity of habitat structure that could serve a broader spectrum of wildlife species, as suggested by Bowen and Kruse (1993) and Johnson and Schwartz (1993).

Acknowledgments

We thank R. J. Greenwood, National Biological Service, for his assistance in coordinating the nest searching crews. Financial support was provided by the U.S. Fish and Wildlife Service, Ducks Unlimited, Inc. through the Great Plains Regional Office and the Institute of Wetland and Waterfowl Research, National Biological Service, Central Flyway Council, Mississippi Flyway Council and the U.S. Bureau of Reclamation. We especially thank W. E. Newton for his assistance with the statistical analyses. R. J. Greenwood, C. N. Hillman, M. R. McEnroe, R. L. Meeks, W. E. Newton and R. A. Warhurst reviewed the manuscript. O. J. Schlittenhardt assisted with manuscript preparations. We sincerely thank the landowners who allowed access onto their property. Finally, we thank the individuals who made up the nest searching crews who dedicated the effort necessary to obtain the data used in this study.

References

Agricultural Stabilization Conservation Service. 1994. CRP haying and grazing history. Unpubl. rept., Fargo, ND. 8 pp.

Bollinger, E. K., P. B. Bollinger and T. A. Gavin. Effects of hay-cropping on eastern populations of bobolink. Wildl. Soc. Bull. 18: 142–150.

Bowen, B. S. and A. D. Kruse. 1993. Effects of grazing on nesting by upland sandpipers in southcentral North Dakota. J. Wildl. Manage. 57: 291–301.

Caithamer, D. F., J. A. Dubovsky, F. A. Johnson, J. R. Kelley, Jr. and G. W. Smith. 1994. Waterfowl status and fall flight forecast, 1994. Annual rept. U.S. Fish and Wildl. Serv., Laurel, MD. 39 pp.

Cowardin, L. M., A. B. Sargeant and H. F. Duebbert. 1983. Problems and potentials for prairie ducks. Naturalist 34: 4–11.

Cowardin, L. M., T. L. Shaffer and P.M. Arnold. In press. Evaluations of duck habitat and estimation of duck population sizes with a remote sensing-based-system. Biol. Sci. Rept. 2, Nat. Biol. Serv., Washington, D.C. 26 pp.

Duebbert, H. F. and H. A. Kantrud. 1974. Upland duck nesting related to land use and predator reduction. J. Wildl. Manage. 38: 257–265.

Duebbert, H. F. and J. T. Lokemoen. 1976. Duck nesting in fields of undisturbed grass-legume cover. J. Wildl. Manage. 40: 39–49.

Duebbert, H. F., E. T. Jacobson, K. S. Higgins and E. B. Podoll. 1981. Establishment of seeded grasslands for wildlife habitat in the prairie pothole region. Spec. Sci. Rept. Wildl. 234, U.S. Fish and Wildl. Serv., Washington, D.C. 21 pp.

Frawley, B. J. and L. B. Best. 1991. Effects of mowing on breeding bird abundance and species composition in alfalfa fields. Wildl. Soc. Bull. 19: 135–142.

Greenwoood, R. J., A. B. Sargeant, D. H. Johnson, L. M. Cowardin and T. L. Shaffer. 1995. Factors associated with duck nest success in the prairie pothole region of Canada. Wildl. Monogr., Blacksburg, VA. 128: 57 pp.

Higgins, H. K., L. M. Kirsch, A. T. Klett and H. W. Miller. 1992. Waterfowl production on the Woodworth Station in south-central North Dakota, 1965–1981. Resour. publ. 180, U.S. Fish and Wildl. Service, Washington, D.C. 79 pp.

Johnson, D. H. 1979. Estimating nest success: The Mayfield method and an alternative. Auk. 96: 651–661.

Johnson, D. H. and M. D. Schwartz. 1993. The Conservation Reserve Program and grassland birds. Conserv. Biol. 7: 934–937.

Kirsch, L. M., H. F. Duebbert and A. D. Kruse. 1978. Grazing and haying effects on habitats of upland nesting birds. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 43: 486–497.

Klett, A. T., H. F. Duebbert, C. A. Faanes and K. F. Higgins. 1986. Techniques for studying nest success of ducks in upland habitats in the prairie pothole region. Resour. publ. 158, U.S. Fish and Wildl. Serv., Washington, D.C. 24 pp.

Klett, A. T., T. L. Shaffer and D. H. Johnson. 1988. Duck nest success in the prairie pothole region. J. Wildl. Manage. 52: 431–440.

Lee, F. B., R. L. Jessen, N. J. Ordal, R. I. Benson, J. P. Lindmeier, R. E. Farmes and M. M. Nelson. 1964. J. B. Moyle, ed., Ducks and land use in Minnesota. Tech. Bull. 8, Minnesota Dept. Conserv., St. Paul. 140 pp.

Lokemoen, J. T., H. F. Duebbert and D. E. Sharp. 1990. Homing and reproductive habits of mallards, gadwalls, and blue-winged teal. Wildl. Monogr. 106. 28 pp.

Luttschwager, K. A., K. A. Higgins and J. A. Jenks. 1994. Effects of emergency haying on duck nesting in Conservation Reserve Program fields, South Dakota. Wildl. Soc. Bull. 22: 403–408.

Oetting, R. B. and J. F. Cassel. 1971. Waterfowl nesting on interstate highway right-of-way in North Dakota. J. Wildl. Manage. 35: 774–781.
Reynolds, R. E., B. G. Peterjohn, J. R. Sauer and T. L. Shaffer. 1994 Conservation Reserve Program: Benefit for grassland birds in the northern plains. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 59: 328–336.
SAS Institute, Inc. 1989. SAS/STAT User's guide, Version 6, Fourth ed. Vol. 2. SAS Inst. Inc., Cary, NC. 846 pp.
Steel, R. G. D. and J. H. Torrie. 1980. Principles and procedures of statistics: A biometrical approach. 2nd ed. Mcgraw-Hill Publ. Co., New York, NY. 633 pp.
Weller, M. W. 1956. A simple field candler for waterfowl eggs. J. Wildl. Manage. 20: 111–113.

Minnesota's Generic Environmental Impact Statement (GEIS) on Timber Harvesting and Forest Management: Process, Findings, Follow-up and Implications

Alan R. Ek
University of Minnesota
St Paul, MN

Douglas G. Parsonson
Jaakko Pöyry Consulting, Inc.
Tarrytown, NY

Introduction and Overview of the GEIS

An environmental impact statement typically requires the cooperation of a wide array of experts and the synthesis of many different types of data and their linkage via models, all in a relatively short time span. That is especially true for a statewide generic environmental impact statement. In this case, the contractor organized the project personnel into specialized study groups covering key subject areas such as: (1) timber and the resource base; (2) forest soils and forest health; (3) water quality and fisheries; (4) wildlife and biodiversity; (5) recreation, aesthetics and cultural resources; and (6) economics and management. Additionally, five background papers were prepared on public policy, silviculture, harvesting, recycled fiber and global warming implications. Expectations often were higher than realities for data quality, modeling capability, available expertise and scheduling. This paper describes the study process, methods, general findings, and follow-up recommendations in hopes that it will be a useful guide to similar studies that might be developed elsewhere.

For the purposes of this paper, the study is broken into five components:

- assembling the study team and process;
- operational climate and linkages;
- background and technical papers;
- reconciling model reliability, economics and politics; and
- implications.

The emphasis here will be on the first three items and the impact assessment process for wildlife.

Assembling the Study Team and Process

We must acknowledge the organizational and project direction skills of Jaakko Pöyry Consulting, Inc., the prime contractor, particularly Jim McNutt, Project Manager. Their leadership in developing the proposal and carrying it through to an operational plan and the actual conduct of the study was crucial. An essential ingredient to a successful study is the ability to envision the big picture and the utility of the whole study, beginning to end. Mike Kilgore, Project Manager from the Minnesota Environmental Quality Board (EQB), likewise was a key person with respect to vision and progress. As for our knowledge of the project, the senior author's role was that of coordinating communications among study groups and assisting study groups as necessary (e.g., with direction, review of documents, etc.). Also, he served as a member of the study group responsible for describing the resource base. The junior author's overall role was project coordinator. Both authors were members of the core study group writing the final GEIS (see Jaakko Pöyry Consulting, Inc. 1994).

Assembling the study team was not easy. It became apparent early on that we needed a mix of expertise, but with some commonalties. Each study group needed a true expert or experts in that field, specialists to do the literature review and analysis, and sufficient data handling skill to deal with the large (statewide) nature of this problem. Further, as time went on, it became apparent that each group needed to develop a big-picture view of the study and become much more cognizant of Minnesota forestry data, specifically the Forest Inventory and Analysis (FIA) data of the USDA Forest Service. Few study participants came with that view and familiarity with forest inventory data. In fact, most study participants were specialists who had focused on a specific aspect or component of their discipline, such as small mammals, stream water quality, aesthetics or cultural resources. Few had the experience of working on a large-scale assessment and syntheses of information as was required in the GEIS. To summarize, participants needed to be (1) specialists, (2) oriented to a big-picture view, (3) very familiar with forest resource data and practices, and (4) effective at large-scale data analysis. Finally, they needed to be able to shed their own preconceptions and approach the study objectively and with a clear understanding of what the study called for and what it did not call for.

Managing the communication was taxing. Fortunately, many of the study participants were located in Minnesota and many of those in St. Paul. In retrospect, the funding for the study simply would not have allowed participation by widely separated persons, the travel costs would have been excessive and the communication requirements would not have been possible to meet. There also is "chemistry" that develops in close proximity of specialists that is an important factor in communication.

The study framework imposed significant constraints on the project. First, and most important, was the time frame, originally specified as one year and later stretched to three. A second constraint, imposed in part by the time frame, was that there would be no new field or other research undertaken for the project. The study had to be a synthesis effort, as there was no time for lengthy research on nutrient cycling, or predator/prey relationships, etc. The third constraint was that of the available data. In this case, the study was largely based on the forest resource description provided by the FIA data, its limitations and the linkages of that to other data sets. In fact, we believe the North Central region is in a better position than most other regions of the U.S. with respect to the quality and completeness of the FIA data. However, significant unanticipated problems arose in using that data. Among those was the difficulty of developing broad understanding of the data among all study participants.

Operational Climate and Linkages

The circumstances leading to the study involved a heavy dose of politics and environmental issues. The politically charged nature of the study caused us to try to infuse a very impartial approach to the work effort. We fully expected everybody's ox to be gored at least once in the course of the study. Thus, the study's leadership needed to deflect the flak and encourage focus on the study and its credibility if results were to be both timely and useful to all parties. In other words, it helped to have a thick skin.

At the same time, participants and stakeholders came to the study with many perceptions that simply were not well founded. Two that we tried to deal with were perceptions of the history of Minnesota's forests and their current composition. However, a number of stakeholders and participants (yes, even study specialists), after hearing all the recent talk about global warming, tropical forest devastation, etc., simply assumed the forest was disappearing and fast. But, in fact, our forests are aging much like the human population, as the various forest types have regrown considerably after the logging and land clearing of settlement times. As resource analysts, we need to do a better job of articulating the history, structure and dynamics of our forests both within and beyond the natural resource professions. As an aside, few study participants were old enough to have observed the rather significant changes in our forests since earlier times in this century. In this study, it was especially important to relate this history to specialists and lay people alike.

Scheduling was another problem. Progress was frequently slowed by a number of factors including: availability and reliability of data; the process of developing, linking and testing highly complex models; and communication within the study team and between the study team and the study advisory committee and the EQB. The time constraint also affected the study group progress. All study groups commenced work at the same time, with tight deadlines for the transfer of data and model outputs. This can be termed a *parallel*, as distinct from *linear*, study structure. Under the linear structure, the resources-based description and timber supply scenarios would have been developed and validated first and then given to the other study groups for analysis. Under the parallel structure, there was little time available for modification and validation of model output. The tight deadlines meant that the detailed analysis and testing of model output occurred at the same time other study teams were doing their own analysis. This led to some duplication and wasted effort as study groups had to repeat analyses where input data later was found to need refinement. Progress also was slowed by the considerable amount of communication necessary to develop the understanding of data within and between groups. It is clear now that frequent meetings of study participants to exchange information on procedures and findings are absolutely essential for such interdisciplinary efforts. Also, there is much subject matter background in each study area that must be mastered by other study groups. Understanding at the level of textbook simplifications or limited personal experience is inadequate for a large and complex study. Such a communication process also needs more time than that planned for in this study.

Communicating interim study outputs to the advisory committee and the EQB also consumed far more time than had been anticipated. The work had to be put into a format for lay group understanding of what had been done and the results, add to that the vagaries of working with governments. A benefit of those interim outputs was early review and sharpening of the final study reports.

Additionally, the flow of information into the study was not immediate. It was a process. Sometimes, the early politics precluded asking the most obvious sources or the most direct route. In other cases, the actual synthesis of information or a response from an agency took months. Sometimes, a first question stimulated activity by a source that led to more and better data, but that required time. In fact, many data needs of the study, though the data was in some sense available, took considerable time to specify or develop. Studies need to allow for that process. A benefit is that it can stimulate sources to new and deeper understanding of the questions and data needs posed by the study.

Background and Technical Papers

The actual study to be conducted was specified in considerable detail by the final scoping document (FSD) developed to accompany the call for study proposals. That scoping document was the result of a year-long scoping process conducted by the EQB and its advisory committee. The FSD outlined a set of issue areas, associated questions and specific study tasks. The actual study contract also identified associated documents (deliverables) to be developed as a part of the study. Included in the deliverables were background and technical papers as described below.

Background Papers

The required background and technical papers were the technical heart of the study. Background papers were developed on the following topics:

- public forestry organizations and policies (history, policy and timberland availability);
- silvicultural systems;
- harvesting systems;
- global atmospheric change; and
- recycled fiber opportunities.

These papers are cited as Jaako Pöyry Consulting, Inc. (1992i–m), respectively.

The first paper provides a comprehensive review of resource management history, structure and policy of the state's major forestry organizations. However, even with published plans, it was difficult to synthesize agency goals. Most plans are not easily distilled and digested. Many are very helpful in describing activities and direction, but less helpful in identifying tangible goals. A key part of this review was documenting and estimating the availability of timberland for harvest among the various types of ownerships. That was a crucial input to the model-based simulations of timber supplies and impacts to be discussed later.

The silviculture and harvesting systems papers documented, in part through surveys, the various on-the-ground practices and potential practices. A primary benefit was to clarify just how much acreage is subject to clearcutting, partial cutting, site preparation for regeneration and other practices, and how these are affected in terms of disturbance to the forest. The atmospheric change paper attempted to identify the potentials for change in the state's forest due to anthropogenic impacts. It treated the topic popularly referred to as "global warming." The recycled fiber paper attempted to address the use of such fiber as a substitute for virgin fiber, thereby reducing the acreage of forest that would be harvested to sustain a specified level of industry activity.

Technical Papers

Each of the technical papers began with a description of the issue area and a listing of the corresponding questions the FSD asked to have addressed with respect to the issues. That led to an agreed upon (via the work plan) series of tasks to address those questions. The FSD specified ten issue areas. Some of these then were combined to facilitate a partition of the study into a manageable set of six study groups. These study groups were:

- forest productivity and the resource base;
- forest soils and forest health;
- water quality and fisheries;
- biodiversity and wildlife;
- recreation, aesthetics and cultural resources; and
- economics and management.

The corresponding technical papers are Jaako Pöyry Consulting, Inc. (1992a–h and 1993), respectively.

Roughly 4 to 10 specialists then comprised a study group. The organization and efforts of these study groups are described below by group, with an emphasis on technical aspects of the study. For background and illustration, the first study group effort is described in detail. Further reference to study groups 2, 5, and 6 is omitted (see references for detail). Then, we describe the work of study groups 3 and especially 4, in more detail. The description of these studies draws heavily from the above referenced technical papers, but with much condensation of the methods and results.

Forest productivity and the resource base. In response to the specific issues of concern identified in the work plan, this group focused on the assessment of the current resource based and the productive potential of Minnesota forests. The specific questions addressed were:

"*Maintaining productivity of forest for timber production.* Making sure that forests are able to sustain (over long periods of time) the production of ample supplies of timber in an environmentally sensitive manner is of major importance to society. Considering previously specified timber harvesting levels and looking at timber harvesting and management activities statewide:

1. Based on most recent statewide forest inventory information, what allowable timber harvest rates are sustainable for major Minnesota forest types? What rates are possible for sustaining economic activity based on pulp, fuelwood and quality sawtimber products? What methods are used (or could be used) to estimate allowable harvest rates (considering structural and taxonomic diversity, specific geographic areas, and various landowner classes)?
2. What is the relationship between current and future estimates of sustainable timber supplies and the demands expected for the supply of such timber? Are there seasonal differences in timber demand and supply?
3. Are there classes of landowners, geographic regions or forest types where timber harvest rates may be expected to exceed allowable timber harvest rates or biological growth? If needed, what strategies can be implemented to assure the perpetuation of a renewable forest resource? What are the impacts of these strategies and what forest conditions will result from in their implementation.

"*Forest Resource Base.* Forests are dynamic ecosystems which change naturally and in response to human intervention (e.g., timber harvesting). Understanding the nature and extent of such change is important to the making of wise management and land use decisions. Considering previously specified timber harvesting levels and looking at timber harvesting and management activities statewide:

1. To what extent have changes occurred in the size and composition of Minnesota's forest land base (using reliable statewide information)? What were the major factors contributing to this change?
2. To what extent do timber harvesting and management activities impact the abundance, composition, spatial distribution, age class structure, generic variability and tree species mixture (for example, in creating forest monocultures) of Minnesota's forests (based on reliable information)? To what extent are changes in these characteristics specifically attributable to timber harvesting and management of certain forest landowner categories?''

The Final Scoping Document (FSD) further specified examination of three harvesting scenarios. The first or base scenario reflected current (1990) timber consumption levels. The medium scenario reflected the demand of the forest industry after several of the plant expansions under construction or in the design stage went on line about 1997. The high scenario was not based on projected demand, but on an estimate of the maximum biological production potential of the state's commercial forest lands given current levels of investment in management.

The total of all this clearly required substantial methodology. To deal with the problem, the approach involved three major elements;

(1) *The resource.* A description of the forest developed from the recently completed statewide forest inventory database provided by the USDA Forest Service's Forest Inventory and Analysis Unit located at the North Central Forest Experiment Station. The database contained records on 14,296 field plots covering timberland (commercial forest), unproductive and reserved forest. The inventory also provided a spatial approximation of the total resource.

(2) *Harvest and change modeling.* A harvest scheduling model plus an individual tree-based forest change (stand growth) model provided long-term (50 years) forest harvest, management and change simulation capability.

(3) *Impacts assessment.* The simulated spatial and temporal changes to the forest that were projected under the three harvest scenarios provided a set of future databases to analyze for impacts as they affected forest and related resources as assigned to the various study groups.

A key to assessment was the ability to link the various resource-related characteristics to the FIA plots, i.e., to relate simulated stand conditions to timber and nontimber resource characteristics. As harvesting proceeded, key aspects of the forest changed, including stand age and size class distribution and species composition. These changes were examined by the other study groups to determine how they would impact the particular aspects or values of the forest they were charged with assessing. For example, the wildlife and biodiversity study group assessed changes to habitat. If harvesting diminished key habitat for a particular species of animal, the translation of that harvest to animal abundance provided an estimate of the impact. However, a basic step in assessing the relative importance of this impact was the prior development of criteria defining when an impact was significant. For example, if the animal declined to less than a specified percentage of its 1990 population level, as suggested by habitat loss, the impact then was judged as significant and the problem later would lead to mitigations in harvesting to ameliorate the impact.

The key variables extracted from the FIA database were:

- plot location, including legal description and UTM coordinates;
- ownership;

- stand age, history, FIA cover type and timber size class;
- site index and physiographic class;
- stand size (acres) and area expansion factor (how many acres each plot represented);
- plot tree lists (species, diameters, etc.);
- distance to water and roads; and
- recreation opportunity spectrum (ROS).

Additional descriptors added to this list via geographic information systems were:

- landform and soil type; and
- ecoregion (the study was designed to report results by seven ecoregions).

The harvest scheduling model, given multi-product demands by seven specified market centers in the state, then developed the harvest scenarios by an algorithm that attempts to meet market center demand by mimicking market dynamics. Doing so in a sustainable manner (i.e., avoiding liquidation of the growing stock) over time was ensured by assuming an infinite planning period. Harvesting options included thinning and clearcutting, and thinning options that served to approximate uneven-aged management. Allowances also were made for old growth retention, riparian buffers, etc.

There were additional reasons to support the above approach. First, a complete and current spatial database, e.g., a GIS database, simply was not available. Even if it were available, its size and complexity quickly would have exhausted the budget. Second, the forest change model retained the individual tree detail (tree species, size, etc.) of the database throughout the simulations, thus, allowing a variety of analyses without concern for processes of aggregation and/or disaggregation. In brief, it was easier to carry the tree detail than to use simpler stand models that required aggregation of the data that was later difficult to disaggregate. Third, the harvest scheduling model allowed great detail in stand and scenario description, yet, was cost effective to run on microcomputers. Fourth, all of the above model components were tried and available.

Interestingly, this detail tends to inspire great expectations and an anticipation of a finer level of resolution than really is possible. There also is an expectation that, since the whole thing is computerized, we need only press certain buttons and out come the answers.

Despite limitations, the model was very capable of producing results at a level of precision germane to the major policy questions of the GEIS. Included in that level of precision was the ability to portray the *direction* and approximate *magnitude* of forest cover type change with respect to harvesting intensity and considering succession (via FIA data-based regeneration and cover type change algorithms developed for the study). Submodels also estimated how species composition of the forest might change with changes in the forest age class distribution. Consequently, the study was able to provide scenario sensitive characterizations of the future forest and its implications for both timber and nontimber resources and values.

Regarding the actual FIA data, its utility depends on its completeness. Most FIA reports to date have concentrated on the tree and stand-related characteristics of the forest. Thus, there may be gaps in the completeness of data for other variables. For example, shrub forest floor data may be absent for plot data collected in the winter; some variables may not be fully edited because nobody ever used them before; procedures may have changed between surveys; etc. Locating and fixing these problems can be frustrating and time consuming. Also, classifications in the data may be designed for the present, such as the FIA cover type algorithm that utilizes tree location information on sample points. Thus, as this study found, there is a need to develop new cover type algorithms for projected plot data. Also the trend to sampling with some form of partial replacement can lead to a need for updating records to a common point in time. In summary, the list of adjustments, projections, etc., in a study like this can be substantial. We need to design forest inventories with more attention to their use in projection efforts like this.

Up to this point, we have described the basic model framework. In treating the remainder of the study components, we will limit comment to the key concepts and limitations.

Water quality and fisheries. This study group dealt with quantifying the impact of harvesting at two levels: a) water body specific where harvesting was close to water; and b) watershed impacts, where portions of first, second or larger order waterways might be impacted by the extent of harvesting in any time period. Impacts of harvesting on lakes often are not a problem area. The lakes are surrounded by bands of private cabins. However, a major limitation in the use of FIA data to look at impacts on streams was the fact that distance to water was not recorded for water bodies less than 33 feet wide. Thus, this study group relied heavily on the literature and the data we did have on the number of plots near larger water bodies in their efforts to estimate harvesting impacts. A small sample of sections statewide also was drawn and mapped from aerial photographs to describe the localized spatial impacts of harvesting with respect to water quality and fisheries impacts. We will not describe this part of the study further, since the study indicated that given Minnesota's terrain, recent and potential harvesting patterns, and assumed full implementation of water quality BMP's in the future, harvesting impacts on water quality and fisheries were expected to be minimal.

Biodiversity and wildlife. This study group developed separate reporting for biodiversity in general and wildlife. The former has important definitional aspects; the latter are more amenable to quantification. Consequently, here we will emphasize wildlife. The specific questions addressed were:

''*Forest Wildlife.* Forest wildlife is an integral part of forest ecosystems. Considering previously specified timber harvest levels and looking at timber harvesting and management activities statewide, the following are addressed in this analysis.

1. What are the forest dependent wildlife species, their specific habitat requirements, and their current status and distribution? and
2. To what extend does timber harvesting and management impact populations and habitats of each of the ten groups of wildlife as defined in the FSD?''

The harvest scheduling and forest change models developed spatial and temporal characterizations of the future forest for use in assessing wildlife habitat quality and availability. The most important of these characterizations was by cover type and stand size class (nonstocked, recent clearcut, seedlings/saplings, poletimber and sawtimber). The wildlife study team then identified species distributions, habitat requirements and animal abundance by type of habitat. For projections, this amounted to applying estimates of animal density (or indices postulated to correspond to such densities) to the various habitat classes (cover type and stand size class) at each decade in the 50-year study period. However, major difficulties in doing so were the sheer number of species to consider (173 bird, mammal and herp species groups), and the high variability in knowledge of habitat requirements and habitat-density relationships. In the case of forest birds, a workshop of expert ornithologists was used to help establish relative abundance and population levels for the available types of habitat. Finally, changes in animal population levels were inferred from the changes in habitat by ecoregion.

For most species, there is good information on species range, but much less is known about density, annual and cyclical variability in numbers, etc., especially for species that require several types of habitat, say, for cover versus food or winter versus summer, or at different stages of development. Further, research in this area more often than not has been linked to cover type characterizations that are more localized than the FIA data. In some cases, landscape or context considerations were necessary, such as the presence of conifers in the landscape. In other cases, there was little evidence of firm habitat associations or cause-effect relationships.

In practice, the study treated wildlife species as four groups: small mammals, large mammals, birds and herps. However, these were broken down further to facilitate analysis, for example, to consider cavity-dependent species of birds.

Apart from model resolution, three assumptions are important in interpreting study findings: (1) the species-habitat linkages will not change over the study period, (2) species-habitat associations are indicative of long-term habitat requirements, and (3) species interactions will not be altered as a result of forest harvesting.

Assessment of Significance

The impacts identified by the study groups were assessed to determine their relative significance using criteria developed as part of the study process. The criteria were developed based on technical inputs from the study groups to which was added a "social" element from the study advisory committee and the EQB. The resulting criteria were thresholds which, when exceeded, indicated that an impact was significant and, therefore, would require mitigation. The two levels of significance employed for wildlife impact analysis were:

- harvest or forest management activity projected to diminish the habitat of a species of special concern, threatened or endangered species by 5 percent or more statewide; and
- available habitat for (any) species is projected to change by 25 percent or more in any ecoregion.

Unfortunately, no one ecoregion size is appropriate to all species, and the size of ecoregions is known to influence the occurrence of significance. Additionally, the analysis assumes that current population levels are appropriate and that deviation from those is the basis for concern. Given that the forest age class structure is far from being balanced or near presettlement conditions, there is reason to believe that some habitat-dependent wildlife populations also may be out of balance, or that target population levels may differ from today's levels.

Study Findings

The description of findings below is an illustration of the form of results to aid the understanding of GEIS implications. Readers desiring more information are referred to the very detailed technical paper on forest wildlife (Jaako Pöyry, Inc. 1992f). Study findings indicated that a number of species would be impacted significantly (as per the above criterion) by the various harvest scenarios at the ecoregion level. Table 1 below summarizes some of the changes statewide, however, this presentation needs qualification. In fact, significance was tallied by species, ecoregion and decade. Thus, this statewide table oversimplifies and downplays the many findings of significance as determined by study-specified protocol at the ecoregion level. Clearly, the harvesting has an impact and the extent of that impact is greatest at the high harvest level.

As a result of these impacts, and in consideration of the requirements of the species impacted, the forest wildlife study team suggested the following mitigations:

- extended rotation forest to provide habitat with certain structural features;
- increased use of selective cutting and patch cutting; less clearcutting;
- retention of mast-producing trees during harvest;
- retention of snags and trees with cavities during harvest;
- retention of slash on site after harvest;
- retention and increase of conifers, i.e., conifer covertypes, inclusions and understories;
- harvest spatial patterns that provide diverse patch sizes and travel corridors;
- retention and establishment of riparian corridors in highly fragmented southern Minnesota forests;
- protection of sensitive sites that harbor rare animal species during harvesting; and
- reduction in use of herbicides that kill fruit- and browse-producing shrubs, valuable to some wildlife species.

These later were examined in light of suggestions by other study groups, assessed for feasibility and incorporated as appropriate in the recommendations of the final GEIS.

Reconciling Model Reliability, Economics and Politics

We have touched on the major technical aspects of the GEIS. These is much more detail to relate, but we should not overlook the context and potential results of the study. One of the major benefits of the GEIS has been a much-improved factual understanding of forest dynamics, human influences and the various interdependencies that exist. That has served to focus concerns of various interests. The study also has led to new standards in approaches to environmental monitoring and resource analysis. The long-term modeling approach employed was especially illuminating. This approach brought many basic assumptions and forest management alternatives

Table 1. Summary of statewide changes in projected wildlife species population levels; number of species showing a decrease, stability or an increase, for 173 species, 1990–2040 (adapted from Table I, Jaakko Pöyry Consulting, Inc. 1992f).

Harvest scenario	Decrease (decrease ≥ 25 percent)	Stable	Increase (increase ≥ 25 percent)
Base	5	143	25
Medium	11	134	28
High	48	87	38

into focus. These results likely will be of lasting value. A less quantitative study likely would have left many more questions unanswered. Also, an important by-product of the study was the synthesis of truly interdisciplinary groups of analysts. Additionally, the study illuminated technical aspects of policy development.

Regarding modeling credibility, the forest growth and change models have a considerable literature on their precision and accuracy. These models were also tested further within the study using FIA plot remeasurements. This provides an understanding of capabilities and shortcomings. However, the wildlife habitat models and linkages developed here lack a quantitative body of literature on their performance. In effect, the study was a first in terms of how forest characteristics (specifically FIA data) might be linked to habitat requirements over a large area. The need now is to further quantify the relationships between forest characteristics and wildlife population levels, the precision of these relationships, and their stability over time. Since the impact of the suggested mitigations has important economic implications for forest management and dependent forest industry, full acceptance of the models developed and used here will require strong supporting data.

Up to this point, we have focused on the biophysical aspects of impacts and the development of *site-level responses* or mitigations as specific actions that might take place on the ground. In total the GEIS identified a lengthy list of those and examined their feasibility. Additionally, the study identified *landscape-level* and *research responses.* The study also considered broad policy tools available (education, taxation, incentives, voluntary approaches and regulatory approaches) and what organizations or structures, governmental or otherwise, might best implement them. Recommendations in this area were drawn from experiences elsewhere in the USA and from around the world, as well as new approaches developed specifically for Minnesota. The consideration of organizations or structures and study implementation processes was a major element of follow up as described in the next section.

Implications

Politics are unique in every state. In Minnesota, the final GEIS led to appointment of a GEIS Roundtable by the Commissioner of the Department of Natural Resources. This 25-member group of stakeholders was charged with advising the Commissioner on the development of a consensus-based plan to implement the strategic program recommendations contained in the GEIS. The Roundtable met on 19 days to develop the plan, which ultimately was agreed to by 24 of the 25 members in the fall of 1994 (see GEIS Implementation Strategy Roundtable 1994). Note that this charge concerned the process for implementation, not the specific site, landscape and research recommendations. The recommendations cover (1) administrative mechanisms to seek and obtain stakeholder input in the discussion and resolution of issues, and securing long-term implementation commitment; (2) processes for establishing comprehensive landscape- and site-level programs; and (3) activities to support successful implementation of landscapes and site-level programs. The report since has evolved to proposed legislation and budget recommendations introduced to the Minnesota Legislature. Notable in the legislation is the establishment of a Forest Resources Council, directions for planning, and development of guidelines for timber harvesting and forest management. The proposed legislation also includes directions for monitoring, an advisory committee for research, an information cooperative, continuing education, and voluntary certification for forest resource professionals and loggers. The actual guidelines for harvesting and forest management would be voluntary on private lands.

It is difficult to tell, at this stage, whether the above described legislation and funding will come to fruition. Lacking that, progress invariably will be slowed. Still, much has been accomplished and many research and management directions now are clear. Wildlife and forest management in Minnesota henceforth will be very linked adventures. We hope that the technical and process aspects of this study will prove useful background in similar environmental impact analyses elsewhere.

Acknowledgments

Special acknowledgment is due the study group who prepared the technical paper on forest wildlife: Donald P. Christian, subgroup leader for small mammals; Lee E. Frelich; JoAnn M. Hanowski; Calvin J. Harth; Peter Jordan, study group leader and subgroup leader for large mammals and forest grouse; Gerald J. Niemi, subgroup leader for birds; William C. Pitt, subgroup leader for herps; with assistance from Pat Collins, Rita Hawrot, William Lane, Ann Lima, Kent Montgomery, Carol Pearson and Phil Radtke. The considerable effort of this group has added much to the understanding of forest wildlife in Minnesota.

References

GEIS Implementation Strategy Roundtable. 1994. Report of the GEIS implementation strategy roundtable. Submitted to the Commissioner, Minnesota Dept. Natur. Resour., St. Paul, 51 pp.

Jaako Pöyry Consulting, Inc. 1994. *Final generic environmental impact statement on timber harvesting and forest management in Minnesota.* Prepared for the Minnesota Environmental Quality Board. Jaako Pöyry Consulting, Inc., Tarrytown, NY.

———. 1992a. *Maintaing productivity and the forest resource base.* A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992b. *Forest Soils.* A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992c. *Forest health.* A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992d. *Water quality and fisheries.* A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992e. *Biodiversity.* A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992f. *Forest Wildlife.* A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992g. *Unique historical and cultural resources.* A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992h. *Economics and management issues.* a technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992i. *Public forestry organizations and policies.* A background paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992j. *Harvesting systems.* A background paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992k. *Silvicultural systems.* A background paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992l. *Global atmospheric change.* A background paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1992m. *Recycled fiber opportunities.* A background paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

———. 1993. *Recreation and aesthetics.* A technical paper for a generic environmental impact statement on timber harvesting and forest management in Minnesota. Tarrytown, NY.

Waterfowl Harvest and Hunter Activity in Mexico

Gary W. Kramer
U.S. Fish and Wildlife Service
Willows, California

Eduardo Carrera
Ducks Unlimited de Mexico
Nuevo Leon

Daniel Zaveleta
Secretaria de Desarollo Social
Mexico City, Mexico

Introduction

For decades both hunters and biologists have speculated on the number of waterfowl harvested in Mexico. Many sportsmen believe that this harvest amounts to millions of waterfowl annually. Others contend that the number of ducks and geese harvested per hunter is high, but the number of hunters and resulting total harvest are low. Further, many speculate that most hunters are Mexican nationals who hunt waterfowl for both sport and commercial purposes. While these assumptions have been debated, particularly in waterfowl hunting circles, there is a paucity of data that quantifies the harvest of waterfowl in Mexico (Migoya 1989). In order to manage waterfowl on a continental basis, an accurate estimate of the waterfowl harvest in North America is essential. The harvest of waterfowl in both the United States and Canada is surveyed and estimated annually (Levesque et al. 1993, Martin and Patting 1994). Unfortunately, a similar process does not exist in Mexico.

This study was designed to quantify the number and species of ducks, geese and cranes harvested in the Republic of Mexico, and to determine hunter effort and origin. Data were gathered from 1987 to 1993 under the auspices of the U.S./Mexico Joint Committee on Wildlife Conservation.

Study Area

The study was conducted throughout the Republic of Mexico in the states and specific geographic locations where waterfowl hunting is a traditional activity (Migoya 1985, J. Cauley personal communication: 1987) (Figure 1). The areas were selected based on the magnitude of waterfowl populations as estimated by winter waterfowl surveys (Saunders and Saunders 1981, U.S. Fish and Wildlife Service 1948–87), the number of waterfowl hunting licenses sold, and conversations with biologists and hunting guides/outfitters.

Funding and logistics did not allow all areas to be sampled in the same year. Data were collected during a single waterfowl season at each study site. The areas and years of study were: Bahia de San Quintin, Baja California (1987–88); Mexican

Figure 1. Major waterfowl harvest areas in Mexico.

Highlands, Chihuahua (1988–89); Sinaloa (1989–90); Yucatan (1990–91); Tamaulipas (1991–92); Sonora (1992–93); and Rio Colorado Delta, Baja California (1992–93). Detailed descriptions of the areas can be found elsewhere (Leopold 1959, Saunders and Saunders 1981, Kramer and Migoya 1989, Baldassarre et al. 1989).

Methods

The waterfowl hunting season in Mexico during our study was 120 days long. In most states, the season began in late October or early November and closed in late February or early March. Daily limits were 10 or 15 ducks, 4 or 5 geese, 2 or 3 sandhill cranes (*Grus canadensis*).

An attempt was made to record the harvest of every individual who hunted in the state or geographic location selected for study. This was accomplished by technicians from Mexican universities, Ducks Unlimited de Mexico (DUMAC), the Secretaria de Desarollo Social—Direccion General de Conservacion Ecologica de los Rescursos Naturales (SEDESOL) and the U.S. Fish and Wildlife Service (USFWS). Data collection concentrated on harvest statistics from daily bag checks, and hunter and guide/outfitter interviews conducted in the field. The data included: name of hunting club or specific location of hunting activity, hunter days, national origin of hunters, number and species of waterfowl harvested, crippling loss, and band recoveries. For the purposes of this study, hunter use days are defined as a hunter in the field for any portion of a day. Final results are reported to represent a single season's total harvest but are based on an aggregate of all sampling locations among years.

Results

During the study period, 6,293 hunter days of effort resulted in an estimated annual reported harvest of 51,607 ducks, 5,597 geese and 218 sandhill cranes. Hunters reported crippling 2,407 birds (Table 1).

However, the data reported does not represent the total harvest that took place in Mexico during the study period. Throughout the study, it was apparent that accurate data were not being provided by some of the clubs/outfitters and that some hunting activity was not sampled.

For example, at one hunting club in Sinaloa, several species of ducks were conspicuously absent from hunters' bags, while other nearby clubs harvested the "missing" species. We determined that: American wigeon (*Anas americana*), northern shoveler (*Anas clypeata*) and ruddy ducks (*Oxyura jamaicensis*) were considered poor table birds and, therefore, were not brought in from the field as part of the daily bag. Instead, they were removed from the hunter's possession and given to the local people for their consumption before bag checks were conducted. For this club, we added a correction factor for the "missing" birds based on the percentage of these species bagged at the other clubs in Sinaloa (Table 2).

There were several other factors that prevented the collection of complete harvest data. There was a small amount of freelance or unguided hunting, along with some hunting by local citizens that was not quantified, and one hunting club refused to allow the collection of data. Because of these factors, we estimated that 10 to 20 percent more birds actually were harvested than our bag checks indicated.

Another area of under-reporting was crippling loss. Hunters frequently report less crippling than actually occurs (Crissesy 1960, Kramer 1976). The degree of underreporting is variable and depends on the type of hunting, the density of emergent vegetation, and the presence or absence of hunting guides (Bellrose 1953). The reported crippling loss varied from 2.9 to 14.1 percent. To more accurately estimate crippling loss, we expanded the reported crippling loss by 10 percent to more closely approach crippling loss reported in other studies (Bellrose 1976, Martin and Padding 1994).

As a result of these adjustments, we believe the actual bag in the study area exceeded the reported bag by 13 to 425 percent. At Bahia de San Quintin, a relatively small area with few hunting locations, hunters were easy to contact and we believe

Table 1. Reported waterfowl harvest in Mexico (sample period 1987–1993).

Location	Year	Hunter days	Ducks	Geese	Crippling loss Number	Crippling loss Percentage	Total
Bahia de San Quintin	1987–88	761	300	2,682	175	5.9	3,157
Mexican Highlands	1988–89	448	206	1,083[a]	182	14.1	1,471
Sinaloa	1989–90	2,485	32,813	77	947	2.9	33,837
Yucatan	1990–91	734	5,225		404	7.7	5,629
Tamaulipas	1991–92	904	4,434	1,519	373	6.3	6,326
Sonora	1992–93	853	7,894	402	284	3.4	8,580
Rio Colorado Delta	1992–93	108	735	52	42	5.3	829
Total		6,293	51,607	5,815	2,407		59,829

[a]Includes 218 sandhill cranes.

Table 2. Extrapolated waterfowl harvest in Mexico (sample period 1987–1993).

Location	Year	Recorded harvest	Correction factor (add)	Total estimated harvest
Bahia de San Quintin	1987–88	3,157	424	3,581
Mexican Highlands	1988–89	1,471	6,273	7,744
Sinaloa	1989–90	33,837	18,478	52,315
Yucatan	1990–91	5,629	1,135	6,764
Tamaulipas	1991–92	6,326	1,289	7,615
Sonora	1992–93	8,580	1,769	10,349
Rio Colorado Delta	1992–93	829	259	1,088
Total		59,829	29,627	89,456

we recorded most (87 percent) of the harvest. In contrast, the Mexican Highlands was a large geographic area where hunters were not as concentrated as in other regions. In this area, we sampled hunters from two major hunting zones and extrapolated the data to the remainder of the Mexican Highlands. This resulted in a correction factor of 425 percent for the Highlands. In the remaining study areas, we estimate that the harvest was 20 to 55 percent higher than the reported data.

When all the correction factors were applied, the estimated total hunting harvest, including crippling loss, was 89,456 ducks, geese and cranes. Most of the harvest occurred in Sinaloa (58 percent), followed by Sonora (12 percent) and Tamaulipas (9 percent) (Table 2).

Of the reported harvest, green-winged teal (*Anas crecca*) were most frequently bagged, followed by northern pintails (*Anas acuta*), cinnamon teal (*Anas cyanoptera*), blue-winged teal (*Anas discors*) and whistling ducks (*Dendrocygna* spp.) (Table 3).

Pacific black brant (*Branta bernicla*) were the most common geese in the bag with 87 percent of the brant harvest concentrated at Bahia de San Quintin. The only other location where brant were taken was the coastal region of Sonora, west of Ciudad Obregon. Snow geese (*Anser caerulescens*) dominated the waterfowl harvest in the

Table 3. Species composition of reported annual waterfowl harvest in Mexico, 1987–1993.

Species	Number	Percentage	Important harvest areas[a]
Green-winged teal	14,408	25.1	S, O
Pintail	7,469	13.0	S, T, O, R
Cinnamon teal	6,454	11.2	S
Blue-winged teal	5,103	8.9	Y
Whistling duck	4,856	8.5	S
Wigeon	4,231	7.3	S, O, R
Shoveler	3,360	5.9	S
Brant	3,083	5.4	Q
Redhead	1,627	2.8	T
Gadwall	1,413	2.5	
Snow geese	1,391	2.4	M
Other	4,027	7.0	
Total	57,422	100	

[a]Q = Bahia de San Quintin; M = Mexican Highlands; S = Sinaloa; Y = Yucatan; T = Tamaulipas; O = Sonora; R = Rio Colorado Delta.

Mexican Highlands and represented the most frequently bagged goose in Tamaulipas. White-fronted geese (*Anser albifrons*) were harvested in Sinaloa, Tamaulipas and the Mexican Highlands. The only sandhill crane harvest was in the Mexican Highlands, where an estimated 218 birds were bagged.

Most (77 percent) hunters were United States citizens, primarily from California and Texas, while 23 percent were Mexican citizens (Table 4). The majority of hunters at Bahia de San Quintin, Sinaloa, Tamaulipas, Sonora and the Rio Colorado Delta were United States citizens. In the Mexican Highlands and the Yucatan, the majority of hunters were Mexican citizens.

Discussion

The estimated annual harvest of waterfowl in Mexico is low, especially when compared with California and the United States. Our estimate of the harvest in all of Mexico is less than 10 percent of the total estimated annual harvest for California (947,600) between 1983 and 1992, and less than 1 percent of the annual harvest estimate of 10 million waterfowl in the United States during the same 10-year period (Bartonek 1994).

Between 1983 and 1992, the average number of hunter days in California was 571,000 (Bartonek 1994). State-operated public hunting areas in California hosted 72,660 hunter days and the Sacramento National Wildlife Refuge Complex (SNWRC) supported 17,000 of these hunter days during the same period (California Department of Fish and Game 1992). By contrast, the 6,293 hunter days in Mexico represent less than 1 percent of California's total. There are more than twice the number of hunters on SNWRC annually than we estimated for the entire Republic of Mexico.

In Mexico, the average reported waterfowl bag per hunter day during the study period was 9.1 birds, a much higher harvest rate than in the United States or Canada, where the average hunter day yields 1.0 and 1.2 waterfowl, respectively (Levesque et al. 1993, Bartonek 1994). Possible reasons for the higher success rate in Mexico include: the number and density of hunters is low; waterfowl are numerous in concentrated wintering areas; and most hunting is with guides (guides have been mandatory for foreign hunters since 1988).

Another factor that we believe increased hunting success in some areas was the use of airboats or power boats to "herd" waterfowl toward hunters. Hunters were

Table 4. National origin of hunters in Mexico, 1987–1993.

Location	Year	Mexican citizens		U.S. citizens	
		Number	Percentage	Number	Percentage
Bahia de San Quintin	1987–88	8	1	753	99
Mexican Highlands	1988–89	331	74	117	26
Sinaloa	1989–90	248	10	2,237	90
Yucatan	1990–91	624	85	110	15
Tamaulipas	1991–92	244	27	660	73
Sonora	1992–93	17	2	836	98
Rio Colorado Delta	1992–93	5	5	103	95
Total		1,477	23	4,816	77

placed in camouflaged blinds surrounded by decoys, and birds were driven toward them. The "herding" sometimes occurred within sight of the hunters, but very often was beyond their view. This illegal practice does not occur at every hunting club or location, but it was observed in all study areas except the Mexican Highlands and Yucatan. In the Highlands, waterfowl and sandhill cranes were hunted over decoys in harvested grain fields; and in the Yucatan, hunters were transported to the blinds by small boats that are poled through the mangrove swamps.

The majority of the hunting pressure and harvest was concentrated in Sinaloa, Sonora and Tamaulipas. All three areas have a reputation for providing excellent waterfowl hunting, are relatively close to the United States and easily accessible, have numerous hunting clubs/outfitters, and most have active booking agents in the United States. In particular, Sinaloa contains three internationally known hunting clubs that have developed an infrastructure to support more than 2,000 hunter days annually. During the 1989–90 season, these three clubs accounted for 83 percent of the reported harvest in Sinaloa and 47 percent of the total reported harvest in Mexico during the study period.

Green-winged teal was the number one bird in the bag in Sinaloa and Sonora, while blue-winged teal accounted for most of the birds harvested in Yucatan. Teal move in small flocks and often are quick to decoy, making them more vulnerable to the gun than other species. Additionally, their preferred habitat is coastal estuaries in Sonora and Sinaloa, and mangrove swamps in Yucatan where the majority of the hunting clubs are located. Although pintail were the most numerous duck in most study areas (except Yucatan) and were a highly sought-after species, they were harvested at relatively low rates. This may be because pintail use open-water habitats and have a tendency to move in large flocks and, therefore, often are difficult to decoy. Whistling ducks were desired by hunters and, even though they are not particularly wary, they do not respond well to decoys. Further, because of specific habitat requirements, they were absent from Bahia de San Quintin, the Mexican Highlands and Rio Colorado Delta.

The low incidence of Mexican hunters at Bahia de San Quintin, Sinaloa, Tamaulipas, Sonora and the Rio Colorado Delta was due to expensive and complicated gun ownership laws, the lack of a hunting tradition, and the relatively high cost of hunting. The cost of shotguns, ammunition and equipment needed for successful waterfowl hunting was beyond the economic capacity of the average Mexican citizen.

We attribute the high incidence of Mexican hunters in the Highlands to the species available and the hunting method employed. Mexican hunters appeared to prefer large birds (e.g., geese and sandhill cranes) and pass shooting birds instead of hunting over decoys.

In Yucatan, we believe the high percentage of Mexican hunters was the result of an avid group of waterfowl hunters living in Merida. These individuals generally are businessmen that have passed down the hunting tradition through several generations. The number of United States hunters traveling to Yucatan has declined since the late 1980s. In the past, four commercial hunting clubs in the Yucatan study area catered primarily to United States citizens. However, due to severe habitat changes caused by Hurricane Gilberto in the mid-1980s, the doubling of the cost of Mexican hunting licenses and gun permits, and the increased difficulty of obtaining these permits, three of these clubs went out of business. This reduced the overall number of hunters, but especially hunters from the United States.

Conclusions

Lack of data often leads to widespread speculation. Such has been the case regarding the harvest of waterfowl in Mexico. Speculation spawned the notion that millions of waterfowl are being slaughtered south of the border. Our data indicate that, while the number of waterfowl killed per hunter is high, the total number of hunters and resulting total harvest is low.

With an estimate of less than 100,000 waterfowl killed annually in Mexico and an average population of 1.5 million birds during the study period, we believe the biological impact of this harvest is insignificant. This is particularly true for green-winged, blue-winged and cinnamon teal, which collectively account for 45 percent of the total harvest in Mexico. While breeding population data are not available for cinnamon teal, current continental population estimates for green-winged and blue-winged teal are well above the 10-year average. Continental pintail populations, while still below the long-term average, are showing a resurgence in numbers (U.S. Fish and Wildlife Service 1994). The number of pintails harvested in Mexico (7,469) is low, particularly when compared with wintering populations which peaked at 418,785 pintails during the study period (U.S. Fish and Wildlife Service 1994). All other species, except for brant, are harvested in very low numbers.

Bahia de San Quintin is the primary hunting area in the Pacific Flyway for brant (Kramer et al. 1979). The number harvested there can have an impact on the total population and should be monitored to prevent overharvest. However, with a flyway-wide population that has averaged 121,000 during the past 10 years and a total Flyway harvest of between 2,700 and 6,100 brant (Pacific Flyway Council 1992), overharvest is unlikely unless hunting pressure increases significantly. Degradation of habitat because of resort development poses a more real and immediate threat.

In 1988, the use of registered guides by foreign hunters became mandatory. Additionally, the paperwork required to obtain hunting licenses and gun permits has become increasingly difficult. Further, the cost of a "license package" increased about 260 percent ($125 to $325) during the study period. These factors have resulted in a decline in hunting activity in Mexico by United States citizens.

The guide requirement has had little effect in Sinaloa and Yucatan where American hunters almost always have used guides. In Sonora and the Mexican Highlands, moderate numbers of American hunters operated on their own and now must use guides. Most severely affected were areas along the United States/Mexico border where American hunters often hunted without guides/outfitters. These areas include Bahia de San Quintin and the Rio Colorado Delta in Baja California and Tamaulipas. In these border states, the guide law has resulted in a decrease in hunting license sales. During the 1987–88 season, before the guide law was enacted, the Mexican Hunting Association issued 1,000 license packages for Baja California. By 1990, after the guide law became effective and was enforced, only 200 were issued. Since that time, license sales have stabilized at about 350 (J. Cauley personal communication: 1994).

We believe that hunting pressure and waterfowl harvest in Mexico is equal to or less than when the study began. Further declines are likely if it continues to be difficult for Americans, who currently represent the majority of hunter days, to hunt waterfowl in Mexico.

Acknowledgments

We thank K. Forrest, G. Mensik and E. Nelson (USFWS); F. Reid (Ducks Unlimited); and S. Harris (Humboldt State University) for reviewing this manuscript. O. Chacon, J. Arroyo, D. Alonso, A. Martinez, L. Zavala of DUMAC; M. Vasquez and H. Rodriguez of the Universidad Autonoma de Tamaulipas; A.. Lafon of the Universidad Autonoma de Chihuahua; J. L. Laccer of the Universidad Nacional Autonoma de Mexico; A. Vargas, S. Cisneros, F. Geovaninni, J. Lopez, M. Lopez, M. Vasquez and R. Migoya of SEDESOL; and B. Henry and W. Eldridge of USFWS assisted in data collection. Funding was provided by the USFWS.

References

Baldassarre, G. A., A. R. Brazda and E. R. Woodyard. 1989. The east coast of Mexico. Pages 407–425 *in* L. M. Smith, R. L. Pederson and R. M. Kaminski, eds., Habitat management for migrating and wintering waterfowl in North America. Texas Tech. Univ. Press, Lubbock.

Bartonek, J. C. 1994. Pacific Flyway data book—waterfowl harvests and status, hunter participation and success, and certain hunting regulations in the Pacific Flyway and United States. U.S. Fish and Wildl. Serv. unpubl. rept., Portland, OR. 92 pp.

Bellrose, F. C., Jr. 1953. A preliminary evaluation of cripple loss in waterfowl. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 18: 337–360.

———. 1976. Ducks, geese and swans of North America. Stackpole Books, Harrisburg, PA. 544 pp.

California Department of Fish and Game. 1983–92. Waterfowl results of public hunt areas. Dept. Fish and Game, Wildl. Manage. Div. Unpubl. repts.

Crissey, W. F. 1960. Waterfowl status report, 1960. U.S. Fish and Wildl. Serv. Spec. Sci. Rept. Wildl. No. 52. 192 pp.

Kramer, G. W. 1976. Winter ecology of black brant at San Quintin Bay, Baja California, Mexico. M.S. thesis. Humboldt State Univ., Arcata, Ca. 79 pp.

Kramer, G. W. and R. Migoya. 1989. The Pacific coast of Mexico. Pages 507–538 *in* L. M. Smith, R. L. Pederson, and R. M. Kaminski, eds., Habitat management for migrating and wintering waterfowl in North America, Texas Tech. Univ. Press, Lubbock.

Kramer, G. W., L. R. Rauen and S. W. Harris. 1979. Populations, hunting mortality and habitat use of black brant at San Quintin Bay, Baja California, Mexico. Pages 242–254 *in* R. L. Jarvis and J. C. Bartonek, eds., Management and biology of Pacific Flyway geese, Oregon State Univ. Book Stores, Corvallis.

Leopold, A. S. 1959. Wildlife of Mexico—The game birds and mammals. Univ. California Press, Berkeley, 568 pp.

Levesque, H., B. Collins and A. M. Legris. 1993. Migratory game birds harvested in Canada during the 1991 hunting season. Cana. Wildl. Serv. Prog. Notes 204. Ottawa, Ontario. 10 pp.

Martin, E. M. and P. I. Padding. 1994. Preliminary estimates of waterfowl harvest and hunter activity in the United States during the 1993 hunting season. U.S. Fish and Wildl. Serv. Admin. rept., Laurel, MD. 33 pp.

Migoya, R. E. 1989. Chronology of migration, harvest and food habits of wintering waterfowl in Sinaloa, Mexico. M.S. thesis. Auburn Univ., Auburn, AL. 100 pp.

Pacific Flyway Council. 1992. Pacific coast brant management plan. U.S. Fish and Wildl. Serv. Unpub. rept. 53 pp.

Saunders, G. B. and D. C. S. Saunders. 1981. Waterfowl and their wintering grounds in Mexico, 1937–64. U.S. Fish and Wildl. Serv. Resour. publ. 138: 1–151.

U.S. Fish and Wildlife Service. 1994. Waterfowl population status, 1994. U.S. Fish and Wildl. Serv., Washington, D.C. 35 pp.

———. 1948–87. Winter waterfowl survey, Mexico. U.S. Fish and Wildl. Serv., Portland Or. 80 pp.

Individual-based Models as a Forest Management Tool: The Newfoundland Marten as a Case Study

William A. Adair and John A. Bissonette
U.S. National Biological Service
Utah Cooperative Fish and Wildlife Research Unit
Utah State University
Logan

Introduction

North America's progress toward ecosystem management has been driven, at least in part, by a dazzling array of new technologies, such as geographic information systems and computer-based simulation models, that finally have made ecosystem-based approaches feasible. These new technologies share at least one characteristic in common with the revolution of powered flight—we have very good reasons to worry about their reliability. Decades of trail and error were required before the Wright brothers' innovation became safe enough for widespread use. However, ecosystem managers cannot afford to postpone critical decisions for just a few years, much less a whole decade. Consequently, we need to examine carefully how these latest tools perform before we can be assured that they indeed are safe enough for managing our natural resources.

Habitat assessment models may be the most widely used (and perhaps misused) tools in ecosystem management. Conroy (1993) provided four criteria that he felt were the hallmarks of useful modeling ventures; (1) the model must be closely linked to existing ecological theory; (2) the model's structure must have a means for validation; (3) model predictions must be testable; and (4) the management framework must provide a mechanism for testing the model's predictions (adaptive management). The Newfoundland marten (*Martes americana atrata*) provides an excellent example of some advantages that can be gained when managers pay careful attention to Conroy's (1993) suggestions during the habitat assessment process. This paper chronicles the recent evolution of a habitat modeling venture designed to predict future habitat conditions for Newfoundland marten.

The Management Situation

The Newfoundland marten appears to require large contiguous tracts of old-growth coniferous forest, which have been disappearing at an accelerating rate during the latter half of this century (Bergerud 1969, Bissonette et al. 1989, Thompson 1991). The island's marten population had declined so dramatically that by 1973, the last remaining primary habitat on the island was designated a "Pine Marten Study Area" (PMSA), wherein all trapping and snaring, then perceived to be the primary causes of mortality, were prohibited (Bissonette et al. 1989). However, timber harvesting, the principal agent of habitat loss, was not regulated until 1987, after approximately half of the forested portion of the PMSA already had been logged. Continued population declines outside the PMSA led the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) to list the Newfoundland marten as threatened in April 1986. Nonetheless, timber harvesting remains largely unregulated outside of the PMSA. The most recent formal estimate places the island-wide population at about 150 individuals, however, this estimate may be optimistic (Forsey et al. 1993).

In 1993, the Western Newfoundland proposal (Bonnell 1993) was accepted as part of the Canada-wide Model Forest program. The Western Newfoundland Model Forest (WNMF), which includes the PMSA within its administrative boundary, is not a land-holding agency, but instead a collaboration between Provincial agencies, local governments, private timber corporations and environmental groups. This collaboration represents the first formal attempt to integrate resource management in western Newfoundland. The WNMF's primary goal is to develop a comprehensive management plan for all resources within its boundaries. However, Newfoundland marten require forest structures that currently are provided only by natural old-growth, and the intensively managed short-rotation forest desired by the timber industry provides none of these structures. Consequently, managing one landscape for both Newfoundland marten and timber harvesting appears to be the WNMF's greatest challenge.

Shortly after its inception, the WNMF management committee agreed with the COSEWIC Recovery of Nationally Endangered Wildlife (RENEW) committee (Forsey et al. 1993) and assigned high priority to the development of a habitat suitability model for the Newfoundland marten. This habitat suitability model, as initially conceived, would serve two primary functions:

1. Quantitatively assess the potential impacts of projected timber management strategies on marten habitat. A range of alternatives based on harvesting strategies would be developed using an independent decision support system (DSS) such as GISFORMAN, in combination with a forest succession model designed to update unharvested stands. The marten habitat model then would be applied to the resulting simulated landscapes. Alternatives would be rated based on the predicted difference in marten habitat suitability caused by the harvesting strategies.
2. Generate an optimal marten habitat management strategy. The model would be used to examine the existing landscape for suitable habitat. Harvesting strategies then would be designed to minimize impact in those areas identified as suitable habitat by the model.

Because the Newfoundland marten's population appears to consist of a number of very small metapopulations with limited interpopulation dispersal and highly variable survival, considerable concern has been expressed about the viability of the species. A logical question was raised: perhaps, because marten appear to be so closely linked to habitat, the habitat suitability model also could be used to address population viability. Managers reasoned that if the habitat suitability model was based on bioenergetics, it should be able to reveal those portions of a landscape that *actually should support marten.* These areas could be populated by simulated marten, and a population viability model (Scheider and Yodzis 1994), designed especially for the purpose, could be applied to these simulated populations.

We suggest that this leap from habitat suitability to population viability is tenuous at best, and dangerous at worst. A considerable array of factors that determine habitat occupancy, such as disease, dispersal, competition and predation events, cannot be predicted from habitat structure alone (Hobbs and Hanley 1990, Pulliam and Danielson 1991, Rosenzweig 1991, Van Horne 1983). In addition, because the Newfoundland marten is a carnivore, its habitat occupancy depends, in turn, on the habitat occupancy of its prey, which itself is affected by disease, dispersal, competition and predation events. These factors are hardly trivial concerns for the Newfoundland marten, which may experience significant accidental mortality when dispersing (Foresy et al. 1993), has suffered catastrophic disease events (Bissonette et al 1989), and is limited to a widely dispersed, highly variable and depauperate prey base (Bissonette et al. 1989).

Clearly, no habitat suitability model could have the power to predict Newfoundland marten population dynamics in the present, much less 10, 50 or 100 years into the future. However, habitat suitability models provide the *only* available mechanism for understanding how the Newfoundland marten population might be affected by changes in the landscape brought on by timber harvesting. The primary challenge, then, is not *whether* to develop a habitat suitability model for the Newfoundland marten, but, rather, to identify the *type* of model that best is suited for the task.

Choosing the Appropriate Model Framework

Because the American marten has earned a reputation as an old-growth obligate, it, not surprisingly, has been the focus of forest planning efforts throughout Canada (Thompson 1991). As a result, a number of habitat models for marten have been developed (e.g., Allen 1982, McCallum 1993, Thompson and Harestad 1994). Almost all of these models follow the habitat suitability index format (HSI) (Morrison et al. 1992, Schamberger and O'Neil 1986).

The HSI Approach

HSIs typically consist of an assemblage of individual habitat structure variables that scientific literature and expert opinion suggest are strong determinants of habitat suitability. For American marten, these HSIs typically rate individual forest stands one at a time based on their canopy cover, stem structure and, in some cases, coarse woody debris (CWD) near the ground. These HSIs generally rate landscapes by aggregating individual stand ratings, typically via a form of weighted average. Surprisingly, although large openings devoid of vertical and horizontal cover represent a severe psychological barrier that inhibits marten dispersal (Brainerd 1990, Buskirk and Powell 1994), most habitat models for marten do not incorporate direct landscape measures of habitat contiguity or connectedness. Because these models contain no direct measurement of resource distribution within their evaluation units, they are not truly spatially explicit, despite claims to the contrary (Schulz and Joyce 1992).

HSI-type models, in general, suffer several defects that diminish their effectiveness as tools for predicting changes in habitat suitability. HSIs represent a problematic combination of phenomenological and mechanistic approaches that hinder interpretation. For each variable, the relationship between habitat suitability (0 to 1 index) and the measured variable may take any one of a variety of shapes (e.g., linear increase or decrease, exponential increase or decrease, logistic, parabolic), depending on the phenomena or mechanisms that direct the relationship. However, because HSI computations always produce a 0 to 1 index, regardless of how the variables are combined, they always imply a linear relationship between landscape condition and habitat suitability. This restriction invites misinterpretation: HSI structure implies that a 1.0 rating is exactly twice as "good" as 0.5. For marten, this problem can be translated fairly simply. If a landscape consists of entirely suboptimal habitat (which might produce a 0.5 rating), will it be inhabited by marten at all?

The structural difficulties that stifle interpretation also serve to defy testing. HSIs follow an artificial structure that has no ecological basis (Conroy 1993). Typical attempts to test HSI-type models compare index ratings with animals numbers or density (e.g., Thomasma et al. 1991). Because most HSIs are created using information gained by examining animal presence or abundance data, frequently under the same conditions covered by the model, this form of testing employs somewhat circular logic. Finally, the troublesome link between habitat occupancy and suitability (Hobbs and Hanley 1990, Pulliam and Danielson 1991, Rosenzweig 1991, Van Horne 1983) not only limits HSI interpretation, but generally prohibits testing (Conroy 1993).

Individual-based Models

Models of population dynamics based on the interactions of individuals with their environment first were developed more than 20 years ago (Schoener 1973), but just now are beginning to be applied as management tools (DeAngelis and Gross 1992). Likewise, individual-based models of habitat selection based on foraging theory and its derivatives have been equally well developed (Stephens and Krebs 1986).

Individual-based habitat selection theory examines how organisms balance the energetic costs exacted by existing traveling through different environments and predation risk with gains provided by foraging. Although there is some debate about the relationship between these models and evolutionary adaptation (Pierce and Ollason 1987), the descriptive and predictive capability of these models has been upheld in a variety of applications (Stephens and Krebs 1986, Stearns and Schmid-Hempel 1987). Furthermore, individual-based habitat selection models have the potential to meet all of Conroy's (1993) criteria for successful models.

Several features of the Newfoundland Marten's habitat ecology suggest that it is an ideal candidate for individual-based habitat selection modeling. First, the Newfoundland marten appears to be a limited almost entirely to contiguous forest, rarely venturing into large openings (Snyder and Bissonette 1987, G. Drew personal communication: 1994). There are a number of landscape connectivity indices, including fractal dimensions, that possibly could describe marten habitat use patterns in existing landscapes. However, such indices are phenomenological (condition-dependent), and because they do not directly address the mechanism that directs selection behavior, they cannot reliably predict marten response to novel or future landscapes. The only way to address marten habitat use directly, and consequently predict it in novel landscapes, is to examine habitat selection at the individual level.

American marten exploit fluctuating food resources throughout their range (Martin 1994), however, the problem is especially acute in Newfoundland, where the only widespread prey types not only prefer habitats that marten avoid, but appear to be highly cyclical (Adair unpublished data, Tucker 1988). Because food frequently is very rare and always difficult to obtain, landscape suitability immediately can be tied to food. The fitness of reproducing females is dependent upon their ability to maximize food intake, which in turn depends on forage-producing habitats near their maternal dens. Because these females should be evolutionarily adapted to maximize their food intake, they are ideal candidates for optimal foraging theory (Schmitz 1990).

Individual-based habitat selection modeling provides significant benefits not realized with conventional approaches. By concentrating on reproducing females, which are the seat of fitness in an intrasexually territorial species like the marten, we are able to provide a concrete link between habitat suitability and population fitness without needing to know how many individuals comprise the population and where they actually are. Because the model follows a well-defined and proven framework, we can test the actual mechanisms of habitat selection. Marten certainly are tied closely to old-growth coniferous forests, however the mechanisms that define that tie remain unknown. The three general hypotheses most commonly suggested for this behavior, predator avoidance, minimizing thermal energetic costs, or maximizing accessible food, can be quantitatively tested *within the model framework.* Finally, because individual-based habitat selection models are based on the mechanisms of habitat selection, they should be far more universally applicable in time and space than phenomenological models. For example, marten energetic responses to the thermal environment, which are functions of the species' physiology, should be consistent throughout its range, and, therefore, at least this part of the model will be applicable from Newfoundland to Alaska, and for as long as the species persists. Some model parameters will change of course; the thermal environments that the marten responds to and its behavioral response certainly will depend on location.

Individual-based models do present some distinct disadvantages, however. The parameters needed to develop the model can be particularly difficult to obtain, especially for wide-ranging carnivores like the marten. For example, to develop our central-place foraging model for denning female marten, we need to be able to estimate the female's foraging success for each hunting trip. In addition, their complexity means that individual-based models have the potential for concatenating error with each additional parameter. Testing the model's behavioral predictions requires a considerable amount of highly detailed data, which often is beyond the reach of most forest managers. As a result, mechanism-based models at present may be most suitable for wildlife species that are very well-studied (e.g., white-tailed deer, *Odocoileus virginianus*) or have very high profiles and are of special concern (e.g., Northern Spotted Owl, *Strix occidentalis*).

Interpretation

Individual-based models by nature are more complex and, consequently, less easily understood than phenomenological models. As a result, if careful attention is not paid to interpretation, individual-based models are just as likely to be misused as traditional phenomenological habitat models. Individual-based habitat selection models can be a powerful tool when properly appreciated, otherwise, they can be dangerous and deceptive (Conroy 1993, Thomas 1986).

References

Allen, A. W. 1982. Habitat suitability index models: Marten. U.S. Fish and Wildl. Serv. FWS/OBS–82/10.11 9 pp.

Bergerud, A. T. 1969. The status of pine marten in Newfoundland. Can. Field-Nat. 83: 128–131.

Bissonette, J. A., R. J. Fredrickson and B. J. Tucker. 1989. American marten: A case for landscape-level management. Trans. 54th No. Am. Natur. Resour. Conf. 89–101.

Bonnell, B. 1993. Western Newfoundland model forest proposal. Collaborative effort produced by Corner Brook Pulp and Paper Ltd., Newfoundland For. Serv., Newfoundland Wildl. Div., Abitibi-Price Inc., City of Corner Brook, Humber Environ. Action Group, and Centre for For. and Environ. Studies.

Brainerd, S. M. 1990. The pine marten and forest fragmentation: A review and general hypothesis. Trans. 19th IUGB Congress: 421–434.

Buskirk, S. W. and R. A. Powell. 1994. Habitat ecology of martens and fishers. Pages 283–296 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael and R. A. Powell, eds., Martens, sables and fishers: Biology and conservation. Cornell Univ. Press, Ithaca, NY.

Buskirk, S. W. and L. F. Ruggiero. 1994. American marten. Pages 7–37 *in* L. F. Ruggiero, K. B. Aubrey, S. W. Buskirk, L. J. Lyon and W. J. Zielinski, eds., The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. USDA For. Serv. Gen. Tech. Rept. RM–254.

Conroy, M. J. 1993. The use of models in natural resource management: Prediction, not prescription. Trans. 58th No. Amer. Wildl. and Resour. Conf. 509–519.

DeAngelis, D. L. and L. J. Gross eds. 1992. Individual-based models and approaches in ecology: Populations, communities, and ecosystems. Chapman and Hall, NY 525 pp.

Forsey, O., J. A. Bissonette, J. Brazil, K. Curnew, J. Lemon, L. Mayo and I. D. Thompson. 1993. Recovery plan for the Newfoundland marten (*Martes americana atrata*). RENEW document prepared for Newfoundland and Labrador Wildl. Div.

Hobbs, N. T. and T. A. Hanley. 1990. Habitat evaluation: Do use/availability data reflect carrying capacity? J. Wildl. Manage. 54: 515–522.

Martin, S. K. 1994. Feeding ecology of American martens and fishers. Pages 297–315 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael and R. A. Powell, eds., Martens, sables and fishers: Biology and conservation. Cornell Univ. Press, Ithaca, NY.

McCallum, I. R. 1993. Long-term effects of timber management on marten (*Martes americana*) habitat potential in an Ontario boreal forest. M.S. thesis, Lakehead Univ., Thunder Bay, Ontario. 190 pp.

Morrison, M. L., B. G. Marcot and R. V. Mannan. 1992. Wildlife-habitat relationships: Concepts and applications. Univ. Wisconsin Press, Madison 343 pp.

Pierce, G. J. and J. G. Ollason. 1987. Eight reasons why optimal foraging theory is a complete waste of time. Oikos 49: 111–118.

Pulliam, H. R. and B. J. Danielson. 1991. Sources, sinks, and habitat selection: A landscape perspective on population dynamics. Amer. Nat. 137 suppl.: 50–66.

Rosenzweig, M. L. 1991. Habitat selection and population interactions: The search for mechanism. Amer. Nat. 137 suppl.: 5–28.

Schamberger, M. L. and R. V. O'Neil. 1986. Concepts and constraints of habitat-model testing. Pages 5–10 *in* J. Verner, M. J. Morrison and C. J. Ralph, eds., Wildlife 2000: Modeling habitat relationships of terrestrial vertebrates. Univ. Wisconsin Press, Madison.

Schmitz, O. J. 1990. Management implications of foraging theory: Evaluating deer supplemental feeding. J. Wildl. Manage. 54: 522–531.

Schoener, T. W. 1973. Population growth regulated by intra-specific competition for energy and time: Some simple representation. Theor. Popl. Biol. 4:56–84.

Schneider, R. R. and P. Yodzis. 1994. Extinction dynamics in the American marten (*Martes americana*). Conserv. Biol. 8: 1,058–1068.

Schulz, T. T. and L. A. Joyce. 1992. A spatial application of a marten habitat model. Wildl. Soc. Bull. 20: 74–83.

Snyder, J. E. and J. A. Bissonette. 1987. Marten use of clear-cuttings and residual forest stands in western Newfoundland. Can. J. Zool. 65: 169–174.

Stearns, S. C. and P. Schmid-Hempel. 1987. Evolutionary insights should not be wasted. Oikos 49: 118–125.

Stephens, D. W. and R. R. Krebs. 1986. Foraging theory. Princeton Univ. Press, Princeton, NJ 247 pp.

Thomas, J. W. 1986. Wildlife-habitat modeling—cheers, fears and introspection. Pages xix–xxv *in* J. Verner, M. J. Morrison and C. J. Ralph, eds., Wildlife 2000: Modeling habitat relationships of terrestrial vertebrates. Univ. Wisconsin Press, Madison.

Thomasma, L. E., T. D. Drummer and R.O. Peterson. 1991. Testing the habitat suitability index model for the fisher. Wildl. Soc. Bull. 19: 291–297.

Thompson, I. D. 1991. Could the marten become the spotted owl of eastern Canada? For. Chron. 67: 136–140.

Thompson, I. D. and A. S. Harestad. 1994. Effects of logging on martens, and models for habitat management. Pages 355–367 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael and R. A. Powell, eds., Martens, sables, and fishers: Biology and conservation. Cornell Univ. Press, Ithaca, NY.

Tucker, B. J. 1988. The effects of forest harvesting on small mammals in western Newfoundland and its signficance to marten. M.S. thesis, Utah St. Univ., Logan. 52 pp.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. J. Wildl. Manage. 47: 893–901.

An Evaluation of Trumpeter Swan Management Today and A Vision for the Future

Laurence N. Gillette
The Trumpeter Swan Society
Maple Plain, Minnesota

Ruth Shea
The Trumpeter Swan Society
Rigby, Idaho

The Trumpeter Swan Society is a nongovernment organization dedicated to the welfare of trumpeter swan populations throughout North America and to restoring the species to as much of its former range as possible. This paper describes the Society's perspectives on the present status and future prospects for the trumpeter swan.

The trumpeter swan is one of the largest waterfowl in the world. It has been a protected species throughout most of this century. Historically, they nested across North America. Today, three basic populations of trumpeter swans are recognized for management purposes (Figure 1). They are:

- the Pacific Coast Population (PCP), which nests in Alaska and winters along the Pacific Coast as far south as California;
- the Rocky Mountain Population (RMP), which is comprised of a relatively nonmigratory tri-state subpopulation and a migratory interior Canadian subpopulation which winters in the tri-state region (Idaho, Montana and Wyoming; and
- the Interior Population (IP), which is comprised of small, scattered populations across the Upper Midwest.

The total wild population was estimated at just under 19,000 birds in 1994. While the PCP and RMP have grown from remnant flocks, the IP has been recreated through restoration efforts begun in 1960.

Market and subsistence hunting almost eliminated trumpeters as a species by 1900. The IP was extirpated. The RMP was reduced to less than 200 birds for both U.S. and Canadian flocks, which wintered in the remote higher elevations of the Rocky Mountains around Yellowstone National Park. The PCP consisted of approximately 1,000 swans that nested in remote areas in Alaska and wintered along the Pacific Coast of Canada. This population was thought to be extirpated until its rediscovery in 1952.

While the RMP made some initial recovery during the 1940s and 1950s, due in part to winter feeding at Red Rock Lakes National Wildlife Refuge (NWR), all three trumpeter swan populations made dramatic gains during the past 25 years (Figures 2, 3, and 4). The recovery of the RMP has been called one of the great conservation success stories of this century. Unfortunately, all three populations face serious problems today associated with winter habitat. In fact, the RMP birds may be at greater risk today than they were 25 years ago, even though the population has grown five fold.

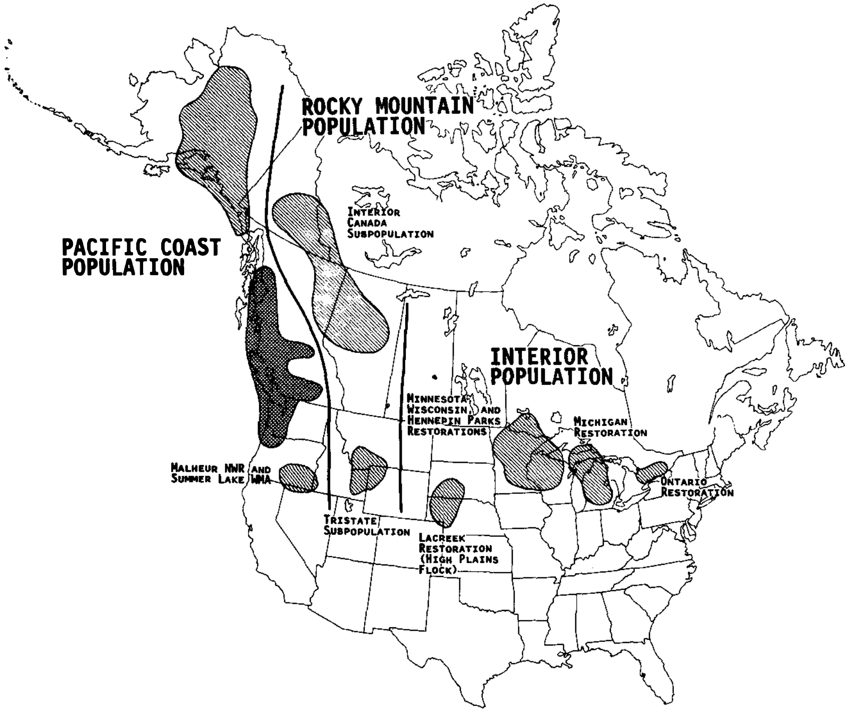


Figure 1. Trumpeter Swan Populations. Breeding ranges are shown in light shading. Winter range of the Pacific Coast Population is shown in dark shading. Winter ranges overlap with summer ranges for other populations.

Although the primary problem confronting each population involves some aspect of winter habitat, the problems differ for each population. Therefore, each population is described separately, starting with the RMP, which faces the most immediate threat.

The Rocky Mountain Population of Trumpeter Swans

By 1930, the breeding flocks of trumpeters in western Canada and the western U.S. had been reduced to no more than 200 birds wintering in the remote Yellowstone region (known at the tri-state region), where winter climate is among the most severe in the lower 48 states. Approximately one-half remained in the region year-round and one-half summered near Grande Prairie, Alberta. Trumpeters which migrated to all other wintering areas had been eliminated. For 57 years (1935–1992), artificial winter feeding of grain at Red Rock Lakes NWR allowed the population to grow, which created unnatural concentrations of trumpeters in otherwise low-quality, unsuitable winter habitat. Feeding discouraged migration southward from the Yellowstone region. The construction of the Island Park Dam created additional winter habitat on the Henry's Fork of the Snake River due to continuous bottom discharge of water. Since 1960, the increase in the RMP has been due entirely to the growth

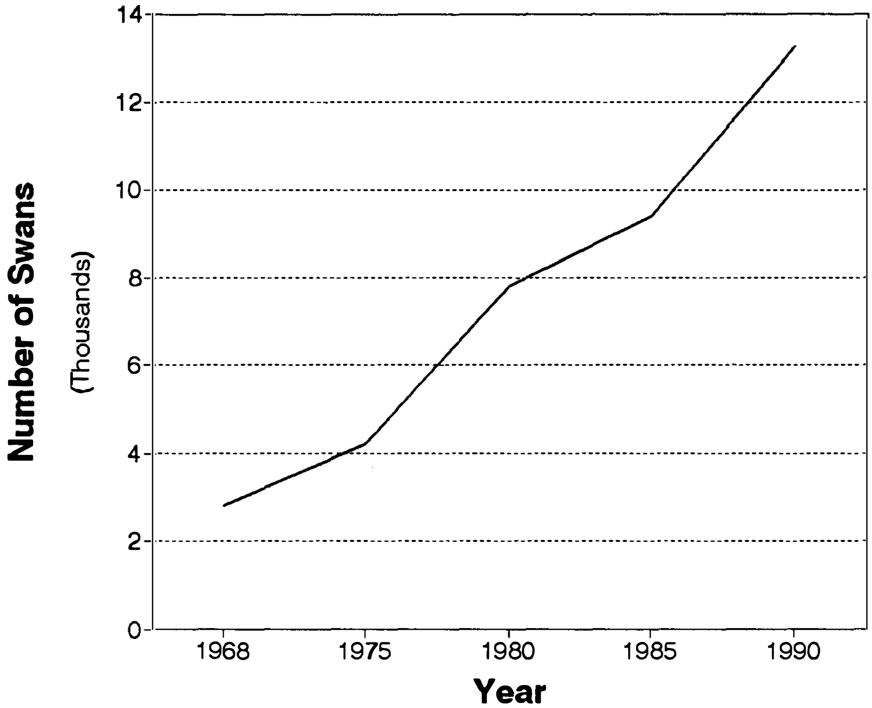


Figure 2. Five-year summer surveys for the Pacific Coast population of trumpeter swans (B. Conant personal communication: 1995).

of the Canadian portion of the population. Unfortunately, almost all these swans continued to use the tri-state area as their exclusive wintering site (Gale et al. 1987, Subcommittee on Rocky Mountain Trumpeter Swans 1992).

By 1990, the growing flocks had overwhelmed the capacity of the Refuge's small feeding ponds and overgrazed aquatic vegetation in adjacent high elevation sites. Although the RMP has increased to about 2,800 swans (USFWS 1995), migrations to more suitable historic wintering areas, scattered from California to the Gulf Coast, have not been restored. With increasing numbers of trumpeters being concentrated in marginal and declining winter habitat, high winter mortality appears to be unavoidable. A series of six mild winters has forestalled a die-off (Shea 1994).

Trumpeter swans migrate as family units rather than in large flocks. It is an extremely difficult and lengthy process for them to establish new migratory traditions, since they rely on recruitment of offspring over generations as much as they do on attracting swans from other units. To make matters worse, the entire state of Utah, which lies directly south of the core wintering area for RMP trumpeters and which probably was part of the historic migration route, has been open for tundra swan hunting for the last 30 years. Not only does this increase the probability that pioneering trumpeters will be killed, but it has precluded consideration of the Great Salt Lake Basin as an intermediate destination for winter range expansion until now (Shea 1994).

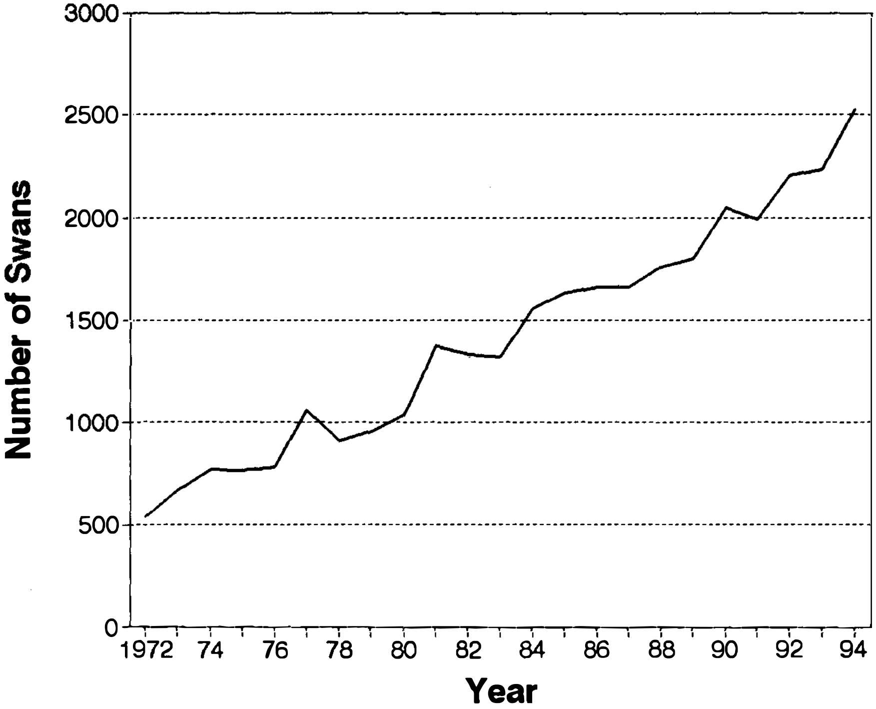


Figure 3. Midwinter surveys for the Rocky Mountain population of trumpeter swans. Based on annual midwinter surveys (Shea 1994).

Joint efforts between the U.S. Fish and Wildlife Service (USFWS) and the Pacific Flyway states have focused on dispersing the wintering RMP trumpeters from high risk areas to rebuild a broader and more secure winter distribution through termination of artificial feeding, hazing and translocations (Shea 1993). Success has been marginal at best, in part because the most natural route through Utah could not be used. Only a few hundred Canadian trumpeters now are exploring habitats scattered from the Texas panhandle to central California and no firm traditions have been established. Most of the tri-state nesting swans still are nonmigratory (Shea 1994).

Since feeding was terminated, less mobile resident flocks have declined to the lowest adult numbers since 1945. Encouragingly, the survivors have shown increasing attempts to migrate southward into southern Idaho and Utah. The ability of the U.S. nesting flock to survive without artificial feeding may depend in large part on the success of these migrants (Shea 1994).

Current distribution problems are the result of differential survival rates resulting mainly from human activities over the decades. Trumpeters that attempted to migrate into regions inhabited by people suffered low survival compared with trumpeters that sought refuge in the sanctuaries of the high wilderness with supplemental feed. Ultimately, managers will have to reverse this selective pressure to solve the distribution problem. Survival of migrants must increase, and severe winters will reduce the survival of trumpeters that try to winter in the tri-state region.

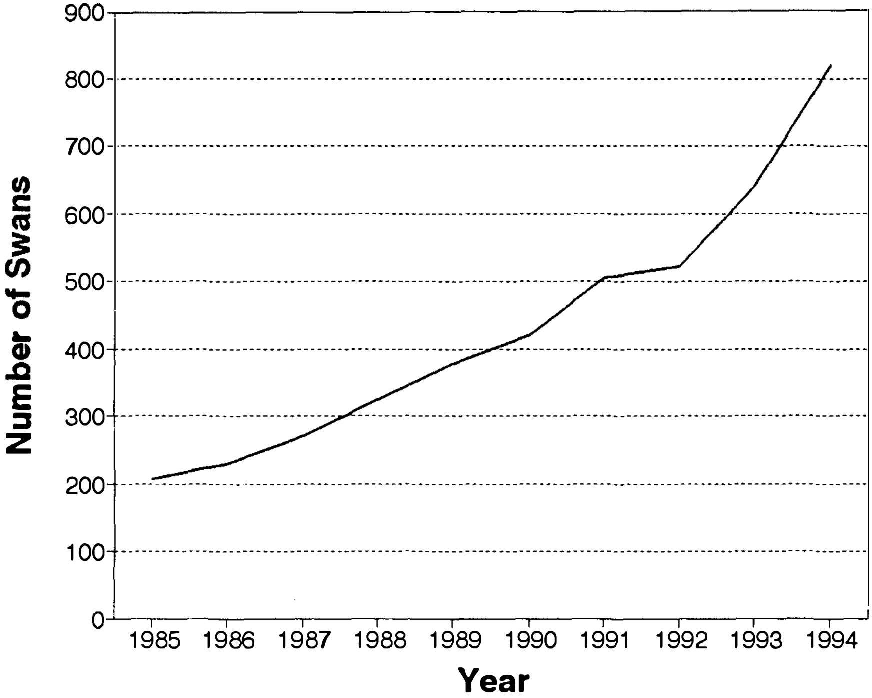


Figure 4. Autumn surveys for the interior population of trumpeter swans.

The Trumpeter Swan Society has endorsed a proposal to the USFWS to restore the RMP trumpeters as a secure and migratory population that utilizes diverse breeding and wintering areas primarily outside the limited tri-state area which currently is utilized. It proposes zoning tundra swan hunts in time and space to minimize the risk to migrating trumpeters and to reduce harassment later in the season as security areas freeze up. These recommendations recognize different management priorities for both native species and maintain most tundra swan hunting opportunities at times and locations of high abundance, while providing additional protection for trumpeters. It is a compromise in the management of each species.

The Trumpeter Swan Society is convinced that a winter dieoff will occur in the near future. Managers are in a race against time to get the RMP trumpeters to redistribute sufficiently before a major die-off occurs within the tri-state region. Modifications to existing tundra swan seasons appear to be essential for success, but other techniques, such as translocations, also are necessary to speed up the process.

The successful restoration of the RMP requires increasing its migrations and winter distribution, as well as its numbers. The future of the population, particularly of the flocks that nest in the tri-state region, will depend in large part on the survival of swans that disperse to more suitable wintering sites.

Pacific Coast Population of Trumpeter Swans

The immediate prospects are much brighter for the PCP trumpeters, which number 15,000, but loss of winter habitat may create serious problems in the future. Historically, these birds used wetlands, bays and estuaries as winter habitat as far south as California and northern Mexico. Most of this habitat has been destroyed by drainage, filling or pollution. These swans have adapted to using agricultural fields in British Columbia, Washington and Oregon during the last 20 years, either out of preference or necessity. Harvested corn, pea, potato and carrot fields are preferred, along with hay fields and pastures. Several swan experts attribute this adaptation to new winter food sources as the primary reason for the rapid population growth of the PCP in recent years (J. King personal communication: 1993). Many other species of waterfowl also are dependent on these agricultural areas.

The PCP trumpeters face the long-term threat of loss of the agricultural base in the region due to development of the land or conversion to unusable crops like raspberries, strawberries, tulips, nursery trees and cottonwood plantations. The birds no longer have the option to return to their original wetland habitats which have been destroyed. Protection of the agricultural infrastructure and the continued growing of crops which can be beneficial to waterfowl are essential for the welfare of trumpeters on the west coast.

While the trumpeters and other waterfowl are considered to be beneficial on harvested fields, they can cause damage to hay fields, particularly in wet weather. Finding ways to keep the birds away from fields where they are not wanted is a concern, particularly on Vancouver Island. Ducks Unlimited of Canada is working on several techniques to reduce this conflict (Wareham 1994).

Although the PCP swans nest in remote areas in Alaska, they are far from wilderness birds on their winter range in the heart of the agricultural belt in the Pacific Northwest. The swans have demonstrated the same ability to adapt that has been shown by other species of waterfowl. They can live in close proximity to man if habitat is preserved.

The PCP trumpeters likely will increase to more than 25,000 in the next 15 years (Conant 1994). Preserving adequate winter habitat for these swans and tens of thousands of other waterfowl will be a major challenge as the Pacific Northwest undergoes a rapid human population explosion. Joint venture projects, land-use zoning that emphasizes preservation and innovative multi-disciplinary planning will be necessary to protect these swans in the future.

The Interior Population of Trumpeter Swans

Historically, the IP probably contained more trumpeters than the other two populations combined and exceeded 100,000 birds. As mentioned, they were gone by 1900. The present flocks are the results of restoration efforts on the part of six different agencies. All of the birds have been released on historical nesting areas and, although the collective population has grown to more than 800 swans, less than 20 percent are migrating to southern wintering locations.

Many of the restored swans use man-made, open-water areas as wintering sites in the north. As with the RMP swans, mortality of migrants has been much higher than it is for more sedentary birds. Unlike the RMP, however, tundra swan hunting is not a significant factor. Instead, lead poisoning resulting from ingestion of spent lead shot is estimated by the authors to account for more than half of all trumpeter mortality in the IP. The trumpeter's feeding habitats make it more likely to find lead buried in the bottom than any other species of waterfowl, and its diet of coarse roots and seeds requires extensive grinding in the gizzard which increases the rate of absorption of lead (Gillette 1991).

Most of the better-quality wetlands in the Midwest have a long history of waterfowl hunting. Accumulated lead makes them unsafe for all waterfowl, but especially so for trumpeters. It is anybody's guess how long it will take before lead is purged from these wetlands. In the meantime, strategies must be developed to get trumpeters to lead-free wintering sites and to encourage them to stay there if the restored populations are ever going to regain even a small portion of their former numbers. Efforts currently are underway to develop a management plan that would address this issue, resulting in coordination among state game and nongame sections and the USFWS. Hopefully, the threat of lead poisoning will diminish with time and migratory populations can be restored to the Midwest.

A Vision for the Future

The future of the trumpeter swan is far from secure. However, with proper planning, coordination and cooperation, most of the obstacles in the way of the trumpeters' continued recovery can be overcome.

Specifically, the authors recommend the following strategies to resolve the problems confronting trumpeters throughout their range:

- Focus on the restoration of nesting flocks of trumpeters in the western U.S., which will be migratory and independent of winter feeding;
- increase the dispersal of RMP Canadian trumpeters to diverse wintering areas, possibly including movement to the Southeast, as well as to California;
- increase the integration of tundra and trumpeter management as the species distributions overlap;
- increase the development of proactive partnerships with farmers to preserve the agricultural community in the Pacific Northwest in a form that will be beneficial to waterfowl; and
- increase the number of swans that migrate in the Midwest by implementing a management plan for the Interior Population of trumpeters.

References

Conant, B., J. I. Jodges, D. J. Groves and J. G. King. 1994. A potential summer population of trumpeter swans (*Cygnus buccinator*) for Alaska. Proceedings and Papers of the 14th Trumpeter Swan Society Conference. The Trumpeter Swan Soc., Maple Plain, MN. 179 pp.

Gale, R. S., E. O. Garton and I. J. Ball. 1987. The history, ecology and management of the Rocky Mountain Population of trumpeter swans. U.S. Fish and Wildl. Serv., Montana Coop. Wildl. Res. Unit, Missoula. Unpubl. rept. 314 pp.

Gillette, L. N. 1991. Ways to reduce the potential for lead poisoning in trumpeter swans. Proceedings and Papers of the 12th Trumpeter Swan Society Conference. The Trumpeter Swan Soc., Maple Plain, MN 200 pp.

Shea, R. E. 1994. Status of the Rocky Mountain Population of trumpeter swans, June 1993–May

1994. U.S. Fish and Wildl. Serv., Southeast Idaho Refuge Complex, Pocatello, Unpubl. rept. 30 pp.
Shea, R. E., R. C. Drewien and C. S. Peck. 1994. Overview of efforts to expand the range of the Rocky Mountain Population of trumpeter swans. Pages 111–117 *in* D. C. Compton, M. H. Linck, H. K. Nelson and J. R. Balcomb, eds., Proceedings and Papers of the 14th Trumpeter Swan Society Conference, The Trumpeter Swan Soc., Maple Plain, MN. 179 pp.
Subcommittee on Rocky Mountain Trumpeter Swans. 1992. Pacific Flyway management plan for the Rocky Mountain Population of trumpeter swans. Pacific Flyway Study Comm., Portland, OR. Unpubl. rept. 27 pp.
U.S. Fish and Wildlife Service. 1995. Mid-winter trumpeter swan survey. U.S. Fish and Wildl. Serv., Red Rock Lakes NWR. Montana. Unpubl. rept. 7 pp.
Wareham, B. and G. Fowler. 1994. The Comox Valley Waterfowl Management Project, 1991–1993. Proceedings and Papers of the 14th Trumpeter Swan Society Conference. The Trumpeter Swan Soc., Maple Plain, MN. 179 pp.

Assessing Avian Interactions with Windplant Development and Operation

Harvey K. Nelson
Environmental Consultant
Bloomington, Minnesota

Richard C. Curry
Kenetech Windpower
Washington, DC

Introduction

Fewer than 100 years ago, windmills provided an important source of power for rural homes throughout the midwest and other parts of the United States and Canada where strong winds prevailed. These machines converted wind energy into electricity for homesites and water pumps, and, in other instances, merely lifted water from shallow wells. Beginning in the 1930s, rural electrification programs began to replace windpower with electricity generated from fossil fuels and subsequent hydropower developments (Hansen et al. 1992). During the 1970s through the 1980s, there were new attempts to revive interest in windpower development through government subsidies and tax incentives to encourage new research to improve turbine efficiency.

Windpower development was dominated initially by utilities and large manufacturers. They began with large-scale wind turbines capable of generating one or more megawatts of power; however, these behemoths could not withstand the force of the wind and were subject to repeated mechanical failures. These players abandoned the field and their place was taken by those who began with smaller turbines and gradually increased the generating capacity. Progress was slow because of the higher production costs associated with the early development of wind power and other renewable energy technology.

California became the birthplace of the wind industry in the United States because, in the 1970s, a conscious public policy decision was made by the state government to support the Federal Energy Program. The federal program encouraged the development of renewable energy technology as a means of combating air pollution and other forms of environmental degradation associated with fossil fuel technologies. As a result, a state regulatory structure was created that encouraged development of renewables through subsidies and mandatory purchase requirements.

The system worked. As an example, the founders of what now has become Kenetech Windpower, the world's largest producer of wind energy, moved west and flourished in this environment. Kenetech took the incentives offered by the state and federal governments and reinvested them in product development. These actions evolved into the establishment of an intensive research and development program undertaken in 1987 by Kenetech Windpower through a consortium which included the Electric Power Research Institute (EPRI), Pacific Gas and Electric Company (PG&E) and Niagara Mohawk Corporation (NIMO). The effort culminated in the design and production of the current KVS-33 model wind turbine (initially introduced as the 33M-VS model). This model is a variable speed turbine with power electronic controls which enable the machine to run with the varying speed of the wind and produce an even flow of power. The swept rotor diameter is 33 meters (108 feet) and the blades face into the wind (upwind) moved into position by a powered yaw drive mechanism (Gartenbein 1993).

These improvements in the technology have reduced production costs to $0.05 per kilowatt hour or less. The price generally is competitive with fossil fuel technology and has enabled the company to compete in many more markets. Kenetech Windpower recently opened a 25-megawatt (Mw) plant on Buffalo Ridge in southwestern Minnesota as the initial phase of a new windpower development program being launched by Northern State Power Company. Construction of a facility is underway in Texas, and two projects will be installed this year in Quebec, Canada. Environmental impact statements for projects in Wyoming and Washington currently are under review. Sites have been identified in Maine and West Virginia and are under study. Kenetech's first Latin American project is scheduled for construction this year in Costa Rica. Overseas, a plant is under construction in Spain, and other projects are in various stages of development in the United Kingdom, the Netherlands and the Ukraine. Turbine sales have been made in India.

The expansion of windpower has brought the issues of power plant siting to center stage. In general, the conversion to renewable energy technologies, such as wind energy, receives strong public support because of the potential environmental and economic benefits (Hansen et al. 1992). Once the concept takes the form of a project proposed for a specific place, however, environmental concerns arise. The windpower project does not enjoy any special immunity from the rigors of the permitting process. There must be compliance with the Migratory Bird Treaty Act, the Bald Eagle Protection Act and the Endangered Species Act. No proposed development whether it is a national park or a wind energy production facility, can escape the "not in my backyard" syndrome. There may be general concerns about the impact of the construction and operation of any facility on natural resources. Construction and maintenance of roads, the footprint of the development, and the amount and type of activities associated with operation of the windplant all have impacts on resources, both temporary and ongoing. Alternative uses for the land and potential for multiple uses also are factors for consideration.

In addition, there are three special concerns that arise with respect to the development of windplants. These are noise, aesthetic impacts, and the interaction between birds and wind turbines. The concern over noise is largely an artifact of early development employing the very large turbines. Noise levels at the base of an operating KVS-33 model wind turbine range from 45 to 50 decibels. The sound of the wind blowing through the structure usually exceeds any sound emanating from the mechanical operation of the turbine. Visual impacts are very site specific and subjective. In the initial screening process, sites are dropped from further consideration by developers, such as Kenetech, if they are adjacent to special set-aside areas where the viewshed is a critical element of the overall preservation strategy. In some instances, photographic simulations of the proposed development are prepared as tools of visual impact assessment. The potential impact of windplant development that has attracted the most interest, however, involves avian interactions with wind turbines, and that is the focal point of this paper. Our purpose is to acquaint the conservation and scientific communities with advancements in the windpower industry and actions being taken to address avian issues.

Avian Interactions

Background

Birds usually have the capability to avoid natural or man-made obstacles in their flight paths. Nevertheless, it is estimated that 57 million birds are killed annually in collisions with vehicles; there are 1.25 million bird collisions with tall structures such as buildings, communications towers and stacks; and more than 97.5 million birds have collisions with plate glass windows (Banks 1979, Klem 1991). The earlier studies of avian collision with man-made structures such as power transmission lines and radio/television towers documented the number of associated fatalities which ranged in level of significance from limited to substantial (Avery et al. 1978, 1980, Faanes 1987, Cochran et al. 1958, Olendorff et al. 1981). The expansion of windpower development in California during the early 1980s raised the specter of avian collisions with wind turbines. Initial studies of single wind turbines concluded that there appeared to be little or no impact on birds (Howell et al. 1991). Subsequent studies (Howell et al. 1990, Howell et al. 1992, Orloff et al. 1992) focused attention on the incidence of raptor mortality at the Altamont Pass and Solano county wind resource development sites in California.

In 1993, an International Workshop, Avian Interactions with Utility Structures, was convened by EPRI. The workshop dealt largely with bird collisions with transmission line structures and electrocution by power lines. It focused on finding solutions through integration of information from biologists, engineers and economists (Gauthreaux 1993). One paper on avian interactions with wind turbines was presented that essentially was an update of the California Energy Commission (CEC) study (Orloff et al. 1993).

The CEC report (Orloff et al. 1992) on the two-year study at the Altamont Pass site identified 43 bird carcasses, 19 of which were raptors, that appeared to have been killed by wind turbines within the study area that included about 16 percent of the 80 square-mile (207.2 km) wind resource area (WRA). Extrapolation of those data indicated that as many as 576 raptors may have died during the two-year period within the entire wind resource area that contained more than 7,000 turbines. It was estimated that as many 78 of these raptors were golden eagles (*Aquila chrysaetos).* Other prominent raptors were red-tailed hawks (*Buteo jamaicensis*) and American kestrels (*Falcon sparverius*). Death was attributed to collisions with turbines (55 percent), collisions with wires (11 percent), electrocution (8 percent) and unknown causes (26 percent). The CEC study estimated that the number of raptor strikes per 100 turbines ranged from 2.3 to 5.8 annually. Separate studies at the Solano County wind resource area estimated a range of 1.7 to 4.8 raptor strikes per 100 turbines annually. These losses are statistically rare events and limit the capability to analyze mortality data accurately because of small sample size (Table 1).

An earlier study (McCrary et al. 1986), designed to monitor nocturnal migrants at the San Gorgonio Wind Resource Area (WRA) in Southern California, reported 40 dead birds, of which only one was a raptor. The authors estimated that as many as 6,800 birds could be killed annually, including passerines, but considered that to be

Table 1. Avian mortality rates—strikes per turbine as reported for seven studies.

Wind resource area (source)	Turbines in study	All birds	All raptors
Montezuma Hills, California (Howell and Noone 1990–91)	178	0.029	0.018
Montezuma Hills, California (Howell and Noone 1991–92)	230	0.074	0.048
Altamont Pass, California (Howell et al. 1990–91)	75	0.067	0.007
Altamont Pass, California (Howell and DiDonato 1988–89)	359	0.117	0.050
Altamont Pass, California (Orloff and Flannery 1989–90)	1,169		0.058
Altamont Pass, California (Orloff and Flannery 1990–91)	1,169		0.023
Buffalo Ridge, Minnesota Higgins et al. 1994)	50	0.0[a]	0.0

[a]Five bat carcasses found.

an insignificant number compared with the total number of migrants passing through the area. Because of lack of funds, the planned studies were not completed and the final report on actual avian mortality has not been published.

In the most recent avian monitoring program conducted for Kenetech by a South Dakota State University research team at the new Buffalo Ridge Windplant™ in southwestern Minnesota, there were no avian fatalities attributed to collisions within the Windplant during the first eight months of operation. Baseline information being developed for present and future development units of the Buffalo Ridge area indicate that raptors are relatively few in number, no golden or bald eagles (*Halizeetus leueocephalus*) were observed, few waterfowl and other waterbirds were present, and summer breeding populations of all species were low (Higgins et al. 1995). This avian monitoring program, including mortality surveys, will be continued during 1995 to detect any change in bird abundance, distribution, behavior and mortality within the windplant.

In a recent overview of bird/wind turbine investigations in Europe involving 14 studies of 108 different sites with one or more turbines, a higher mortality rate was reported at night than during daylight hours. Estimates of total loss were possible for only two sites, which varied from 0.04 to 0.09 birds per turbine per day. Death by collision ranged from 27 percent to 41 percent of all carcasses found. Many birds survived collisions with turbines and wires (Winkelman 1994).

Principle Risk Factors

It is evident that the magnitude of migratory bird mortality varies considerably by site. In our review of specific studies conducted by Kenetech, other published information available, unpublished reports that we had to access to, personal observations relayed by a number of field investigators working on various aspects of this overall problem and our personal experiences, we attempted to highlight the principal factors influencing the potential risk of avian fatalities. The following are believed to be the most significant (order of listing does not indicate priority):

- avian abundance, species composition and seasonal distribution;
- use of habitats and food resources within the windplant;
- other predator/prey relationships;
- presence of traditional migration corridors or daily flight lanes;
- utilization of the area by local breeding populations;
- landscape features and surrounding land use;
- use of towers, turbines, transmission lines and other natural features for perching and nesting;
- seasonal climatic conditions;
- ability of birds to detect and avoid structures and turning blades;
- ability of birds to detect distances between turbines and other natural gaps;
- configuration of windplant and turbine strings; and
- rotor speed of revolving turbine blades.

New Research and Development

Kenetech's Avian Research Program

Kenetech has been actively engaged in efforts to understand the cause and magnitude of avian mortality in its windplants since the mid-1980s. The company has taken the lead in promoting and funding such special studies to understand and alleviate these problems. Through 1992, the company had allotted more than $1 million to avian research and mitigation measures, exclusive of costs associated with baseline biological information for proposed development sites. Since 1992, the effort has more than doubled. During a reassessment of these efforts, it became evident that certain elements of avian behavior required more basic research to determine the capability of birds to detect and avoid obstacles in their flight paths, and to determine whether such capabilities could be enhanced to reduce risk of collision. It also was determined that research must be directed to overall impacts on specific populations of birds sustaining the greatest mortality, primarily raptors.

In 1992, Kenetech established the Avian Research Task Force (ARTF) consisting of five academic scientists experienced in raptor ecology and behavior, aerodynamics of avian flight, flight behavior and orientation, migration, and sensory physiology.[1] The change to the ARTF was to design and oversee a multifaceted research program to understand better the interaction between birds and wind turbines, to use such information to help reduce the frequency of bird collisions, and to assess the biological significance of fatalities that occur.

Two strategies were developed to guide development of a more systematic, integrated research program: (1) identify areas of research required to guide modification of towers, equipment, turbines, plant siting, layout and operations that will reduce the risk of bird collisions; and (2) initiate avian ecology studies to determine the effect of bird losses from collision on the regional population of principal species involved. The primary objective was to build a solid information base employing acceptable scientific methods that could be used to guide the future development of

[1]The members are Tom Cade, Chair and Director of The Peregrine Fund; Mark Fuller, Director of the Raptor Research and Technical Assistance Center; Melvin Kreithen, University of Pittsburgh; Vance Tucker, Duke University; and Charles Walcott, Director, Laboratory of Ornithology, Cornell University.

effective long-term measures to reduce the threat of windplants to birds, particularly raptors. At the National Avian—Wind Power Planning Meeting (Denver, Colorado, July 20–21, 1994) Tom Cade summarized the task force's position that adequate management of bird collisions at wind farms must be approached at four levels. (1) Initial plans for siting wind farms must take into consideration the entire annual cycle and pattern of avian use of the proposed area. If the area proves to be one of high use and dense concentration for birds, then alternative sites should be sought. (2) The size and physical configuration of the wind plant (spacing turbines, position of turbine rows) need to be evaluated with respect to the kinds of birds and their activities in the area. (3) The structure of turbines and towers should be designed to reduce perching opportunities to a minimum. In addition, turbine blades should be patterned to maximize their visibility to birds under as wide a range of conditions as possible; exactly how to accomplish this remains to be worked out. (4) Where unpreventable mortality may continue to occur, off-site mitigation should be considered. These strategies, objectives and recommendations now are evolving into a three-phased action plan that will guide early planning and siting procedures, mitigation where applicable, and modifications of wind turbines and/or entire wind energy systems. The primary research and development program components being conducted under the ARTF through Kenetech facilities at Livermore, California and at Boise State University at Boise, Idaho are summarized (Kenetech 1994).

Sensory physiology of raptors. Previous studies raised several questions as to how well birds perceive the world around them: (1) do birds see turbine blades; (2) can turbine blades be made more perceptible; and (3) how can wind turbines be sited to reduce avian interactions?

The ARTF recommended that new research be conducted on the visual and acoustic capabilities of raptors. Laboratory investigations concerning the sensory physiology of raptors have been underway at Boise, Idaho for 18 months. These studies are designed to measure the visual acuity of raptors accurately, starting with American kestrels and then using red-tailed hawks and golden eagles. Preliminary results indicate that pattern contrast, color and rotation are the most significant variables influencing the ability of birds to detect turbine blades. Information is being used to design avoidance cues that may be added to wind turbines, such as painting contrasting patterns on blades. The next stage will be to conduct controlled flights of raptors through modified turbines to determine actual field response. Initial field trials with raptors and modified blade patterns are scheduled for the summer of 1995. Future consideration will be given to determining behavioral responses to auditory cues.

Controlled flight experiments with pigeons. In an effort to obtain significant numbers of observations of bird flights under natural conditions through segments of the Altamont Pass WRA, homing pigeons have been used as a surrogate species in initial field trials. More than 6,000 flights had been made through September 1994, with more than 2,000 flight records and tracks developed with 3-D tracking equipment. The tracking system is an important tool to measure flight performance before and after the application of specific equipment modification. Preliminary results show that pigeons can detect and avoid turbine strings quite easily. Avoidance response is influenced by weather conditions, wind speed and direction, and different types of wind turbines. Three collisions, one of which resulted in a fatality, were observed during the course of these experimental flights. The information base provides a significant foundation from which to plan and conduct future controlled raptor flights.

Perch guard assessment. Field observations conducted during 1991–1993 by a number of cooperators confirmed a high level of use of the 60-foot tower and the Model 56–100 turbine for perching and roosting by raptors, and limited nest building by a few species. This is a lattice tower with horizontal I-beams. Perching on lattice towers with diagonal struts was much less frequent. Work platforms located just below the nacelle also were used for perching. Following preliminary field testing of potential deterrent devices using captive raptors, installation of a single wire guard placed 9 inches above horizontal crossmembers, and wire screening units for work platforms were installed and monitored on 50 treated turbines in the Altamont Pass WRA. Preliminary results indicated a 54-percent reduction in perching. This study will continue after a review of installation procedures and necessary adjustments are made. Retrofitting of existing turbines and towers with effective perch guards appears to be one practical measure to reduce perching and associated mortality.

The consensus is that one of the most effective means of reducing perching behavior is to install tubular towers. Where appropriate, in all future construction, Kenetech Windpower will utilize tubular towers similar to those in place at the Buffalo Ridge project in Minnesota.

Variable speed technology. Another modification of equipment that looks very promising is the switch to the variable speed technology. a mathematical model developed by one of the ARTF members suggests that the KVS-33 model, when contrasted with the constant speed KCS-56 model turbine, is capable of producing the same amount of energy with nearly a two-thirds reduction in avian mortality. If an effective pattern can be applied to the blades, it is anticipated that avian moralities can be reduced by as much as 80 percent. Preliminary data from the first year of a mortality survey of KVS-33 turbines and the number of KCS-56 model turbines required to generate an equivalent amount of energy appears to confirm this (Vance Tucker, personal communication: 1995). Moreover, as the length of the blades are extended, the level of collision risk per unit of power production appears to diminish even further. If this trend continues to be confirmed by subsequent data, a significant reduction in avian risk will have been achieved.

Regional golden eagle population dynamics. In areas where the number of fatalities associated with a specific windplant raises concerns, three is an increasing need to determine the impact of such losses on the local or regional population of the principal species involved. The Migratory Bird Treaty Act and the Bald Eagle Protection Act currently are being interpreted by the U.S. Fish and Wildlife Service (USFWS) to mean that no losses are permissible regardless of intent. It is recognized, however, that many human activities cause avian fatalities and, thus, pose a critical legal and biological question: what level of loss is acceptable for a given population? This and related questions arose concerning golden eagles at the Altamont Pass WRA. Is there a significant effect of wind turbine-related deaths of golden eagles there, an estimated 40–50 birds annually, on the long-term stability of the regional eagle population involved?

During September 1993, Kenetech convened a special meeting that included representatives of the USFWS, California Department of Fish and Game, CEC, ARTF and other organizations involved in raptor research to help design a population ecology study for the Altamont Pass WRA and surrounding habitats. Population studies implemented during November 1993 were conducted by the Santa Cruz Predatory Bird Research Group (SCPBRG), University of California, and funded jointly by Kenetech and the National Renewable Energy Laboratory (NREL), a research contractor to the U.S. Department of Energy (DOE). The study area established comprises all habitats within an 18.6-mile (30 km) elliptical zone surrounding the Altamont Pass WRA. Transects for aerial population and distribution surveys, and subsequent radio tracking flights were established within this broad area. The team captured and radio-tagged 31 golden eagles during January and February 1994. A total of 54 golden eagle nests were located, from which 25 of the 47 juvenile eagles fledged were radio-tagged. The SCPBRG also established 16 survey routes within the Altamont Pass WRA to monitor seasonal use of habitat types, feeding behavior and other activity in the vicinity of wind turbines.

While 1994 was considered a pilot year, some interesting results have been shared publicly. Indications are that the golden eagle nesting population is large, stable and productive. To date, 60 breeding pairs are believed to occur in the area. This may represent one of the world's largest concentrations of this species. California ground squirrels are one of the primary food sources. Initial observations of marked eagles suggest that most eagles frequenting the WRA are sub-adults (1–4 years old) and floaters (non-breeding adults). Direct field observations also provided additional data to confirm perching and roosting frequencies for different types of towers and turbines. As of November 1994, four deaths of radio-tagged eagles had occurred; one killed by another, one by lead poisoning and two by collision with wind turbines. It is hoped that field investigations will be continued and/or expanded during 1995 (Hunt 1995).

Other Cooperative Research and Development Activities

Remote camera surveillance project. A four-camera integrated video monitoring system was developed in cooperation with EPRI and DOE, with Kenetech providing study sites and project coordination. This remote camera surveillance system (RCSS) was installed at the Altamont Pass WRA in 1994, at locations where multiple bird/turbine collisions had occurred. The surveillance system was operated from dawn to dusk and video tapes were viewed to identify bird interactions. Various events with birds in the field of view around towers and turbines have been identified, but no fatalities were recorded. In theory, capturing collisions on video tape might help researchers understand the circumstances under which collisions occur. In practice, the frequency of interactions is very low and the review of the video tapes is labor intensive. New "Smart camera" techniques need to be built into the system to restrict recording to action events involving birds. The RCSS also is being used to monitor bird response to perch guards on treated towers.

Wildlife response and reporting program. The program was developed in 1989 by Kenetech, with the assistance of the USFWS and the Five Mile Creek Raptor Center at Stockton, California. The company assigned a full-time wildlife response coordinator to administer the program. The primary objective is to standardize actions taken by field employees of the company and cooperating researchers in recording and reporting bird injuries or fatalities encountered within its windplants. A program manual was developed, with specific protocols and forms to facilitate the entry into and the retrieval of information from a central database. At the suggestion of the ARTF, additional details of each fatality have been added to the incident report form. While this has been a commendable and successful effort to date, a larger goal of standardizing throughout the windpower industry remains to be accomplished.

Development of protocols for standardizing biological investigations and siting criteria. Kenetech continues to play a lead role in improving guidelines for data collection on bird populations associated with developments of new windpower projects outside of California. Emphasis is on refining methodology for conducting mortality assessments, including problems associated with observer bias, scavenger rates and carcass decomposition rates; and the development of more rigid windplant siting procedures. Some of these activities are being conducted cooperatively and/or coordinated with the DOE, NREL, EPRI, American Wind Energy Association (AWEA), CEC, USFWS, natural resources departments of participating states, local units of government, utility companies, and private conservation organizations such as the National Audubon Society, Sierra Club and the Izaak Walton League of America. This networking has provided an excellent medium for the exchange of current information and for improving understanding of avian interactions associated with windpower development

Conclusions and Recommendations

During the past five years, there has been an increased awareness and understanding of the broader ecological relationships between birds and windplants, as well as technological advancements in equipment design and development, site selection and windplant operations. While many of the initial investigations were not well coordinated and methodologies used to assess avian interactions were not standardized, the results to date have provided a foundation of biological information on which to build better scientific approaches for the future. Similarly, the improvements in design of wind turbines, the introduction of tubular towers and reduction in other associated external features make new models less attractive to birds and should help reduce vulnerability. As siting plans for new installations become more sophisticated, they may include consideration of providing, where appropriate, greater spacing between turbines, creating gaps in long linear strings and marking end-of-row turbines as measures that may aid birds in avoiding operating turbines. While most early field investigations have focused on mortality of raptors (primarily golden eagles, red-tailed hawks and American Kestrels), threatened and endangered species, and other species of special concern, more recent studies include all migratory birds. Scheduling preliminary biological assessments of potential development sites during the early monitoring of the wind resource will enable developers to identify at the outset any significant environmental risks that may exist. At the risk of simplification, by 1993, we believe that the principal investigators involved in assessing avian interactions with windplants, who represent a cross section of windpower manufacturers and developers, utility companies, private conservation organizations, federal and state environmental and regulatory agencies, generally agreed with the following conclusions and recommendations (Nelson 1993, Kenetech Windpower 1994).

- For purposes of putting the issue in perspective, the number of reported avian fatalities attributed to transmission lines, communications towers and other man-made structures is significantly greater than losses reported to date for windpower installations.
- Avian collisions with wind turbines are statistically rare events.
- It has been difficult to obtain sufficient numbers of observations of avian fatalities to permit a quantitative analysis of specific circumstances contributing to collisions and fatalities. Alternative methods, including automated recording systems, have been marginally useful to date.
- Avian fatalities associated with windplants should be analyzed further to determine what, if any, are the longer term impacts on the population dynamics of the principal species associated with the general physiographic region.
- While raptors continue to be of major concern, population and mortality surveys should be designed to include all birds associated with the wind resource area.
- The higher incidence of raptor mortality generally is attributed to perching and foraging behavior, and the presence of a prey base of small mammals in grassland sites.
- Preliminary observations from several corroborating sources indicate that tubular towers are substantially less attractive to perching and nesting birds than lattice towers.
- Thus far, waterfowl and other waterbirds have not sustained significant losses as previously feared, even where wetland habitats occur within or adjacent to established windplants.
- The incidence of bird collision with wind turbines likely is a function of seasonal species abundance, local flight patterns, food sources available, feeding behavior, other daily activities such as perching and nesting, habitat conditions, and land use.
- Birds in flight apparently can detect rotating blades of turbines, and they tend to avoid them when in operation, but readily fly close to and through turbine strings that are not operating.
- Known traditional migration corridors and local flight lanes used by birds in daily feeding and roosting activities should be carefully assessed and, where possible, avoided.
- Special consideration should be given to the impact of windplant development on native grasslands and associated species of grassland birds that are known to be declining in numbers.
- Siting plans for new windplants should consider allowing maximum spacing between turbines insofar as is environmentally and economically practical.
- Bird losses resulting from electrocution by transmission lines associated with windplants can be reduced by retrofitting overhead electrical systems with bird protection devices, using underground lines when feasible and incorporating bird protection designs in new installations. However, due to the persistence of the birds, system modifications must remain an ongoing activity of the windplant operator.
- There is a recognized need for the development and application of standardized siting guidelines and avian survey methods insofar as is practical.

- There is a need for better databases on bird populations, habitat preferences and other ecological relationships to assist planners and engineers during the early stages of windplant siting. A preliminary biological investigation should be conducted at the earliest possible stage of planning to help identify areas to be avoided and to establish priorities for alternative sites. More comprehensive studies may be required as the planning and siting process advances.
- Ideally, migratory bird populations should be monitored during preconstruction periods for each new windpower installation and continued for at least three years after completion of the first stage of construction. If mortality occurs, applicable corrective measures should be identified and initiated.
- A standardized wildlife incident reporting system and depository should be established for use throughout the windpower industry.

The Future

We believe that the demand for alternative sources of electrical energy will increase dramatically during the next 20 years. Wind-generated electricity offers outstanding environmental and economic benefits. With wind energy, there is no mining or transportation of fuels, zero toxic emissions and no hazardous waste or spent fuel storage issues. As technology improves wind turbine efficiency, production costs will become equal to or less than those associated with most other nonrenewable energy sources.

Most environmental concerns associated with the development and operation of windplants have been addressed and minimized. The avian mortality issue will continue to receive priority attention through present and future research and development programs. The concept of adaptive resource management will receive increased attention in planning and decision-making processes.

As the world's largest manufacturer and operator of wind energy systems, Kenetech is committed to developing and implementing new technologies that will protect and enhance the environment and improve the efficiency of windpower production. A considerable effort is being made to share this philosophy and research results with interested and active partners. We hope this process will guarantee the objectivity and integrity of the research and development program, and establish confidence in mitigation measures that are developed and implemented.

Acknowledgments

Our special thanks to Tom Cade, Chair, ARTF; and Joan Stewart, Kenetech; for technical assistance and review of the manuscript. Many dedicated scientists, managers, administrators, company field personnel and private consultants have made substantial contributions to Kenetech's research and development programs discussed in this paper. We would like to have recognized all individuals and organizations involved, but we could only make reference to some in highlighting the evolution of wind power development, the avian research and development program, and accomplishments to date.

References

Avery, M., P. Springer and F. Cassel. 1978 The composition and seasonal variation in bird losses at a tall tower in southeastern ND. American Birds 32(6): 1,114–1,121.

Avery, M., P. Springer and N. Dailey. 1980. Avian mortality at man-made structures: An annotated bibliography (Rev.) U.S. Fish and Wildlife Service. Biological Services Program. National Power Plant Team. FWS/OBS-80/54. Washington, D.C. 152 pp.

Banks, R. 1979. Human related mortality of birds in the United States. Special Sci. Rept. Wildl. 215. U.S. Fish and Wildl. Serv., Washington, D.C. 16 pp.

Cochran, W. and R. Graber. 1958. Attraction of nocturnal migrants by lights on a television tower. The Wilson Bull. 70(4): 378–380.

EPRI Journal. 1990. Excellent forecast for wind. Elec. Power Res. Inst., Palo Alto, CA. June: 18–25.

Faanes, C. 1987. Bird behavior and mortality in relation to power lines in prairie habitats. Tech. Rept. No. 7. U.S. Fish and Wildl. Serv. 24 pp.

Gartenbein, D. 1993. Something in the wind. The Atlantic Monthly, October 1993 (reprint).

Gauthreaux, S. 1993. Avian interactions with utility structures—background and milestones. Pages 1/1–1/6 *in* Poreceedings : Avian interactions with utility structures, an international workshop. Elec. Power Res. Inst., Palo Alto, CA.

Hansen, P., B. Grant and N. Lange. 1992. Power to spare in the Upper Midwest. Izaak Walter League of America, Minneapolis, MN. 30 pp.

Higgins, K., R. Usgaard and C. Dieter. 1995. Monitoring seasonal bird activity and mortality at the Buffalo Ridge Windplant, MN. South Dakota St. Univ. 64 pp.

Howell, J. and J. DiDonato. 1991. Assessment of avian use and mortality related to wind turbine operations, Altamont Pass, Alameda and Contra Costa Counties, California, Fall 1988 through Summer 1989. Kenetech Windpower, San Francisco, CA 72 pp.

Howell, J. and J. Noone. 1992. Examination of avian use and mortality at a Kenetech Windpower wind energy development site, Solano County, California. Final Rept. to Solano County Dept. Environ. Manage., Fairfield, CA. 41 pp.

Howell, J., J. Noone and C. Wadner. 1991. Visual experiment to reduce avian mortality to wind turbine operations, Altamont Pass, Alameda and Contra Costa Counties, California, April 1990 through March 1991. Kenetech Windpower, San Francisco, CA. 26 pp.

Hunt, G. 1995. A pilot golden eagle population project in the Altamont Pass Wind Resource Area, California. Rept. to The Nat. Renew. Energy Lab., Golden, CO.

Kenetech Windpower. 1994. Avian research program update. R. Curry, Ed., Kenetech Windepower, Inc., Washington, D.C. 22 pp.

Klem, D. 1991. Glass and birds kills: An overview and suggested planning and design methods of preventing a fatal hazard. Pages 99–103 *in* Wildlife Conservation in Metropolitan Environments. Natl. Inst. for Urban Wildl., Columbia, MD. 1991.

McCrary, M., R. McKernan, R. Landry, W. Wagner and R. Schreiber. 1983. Nocturnal avian assessment of the San Gorgonio wind resource study area, Spring 1982. Unpubl. summary for Southern California Edison Co., Rosemead.

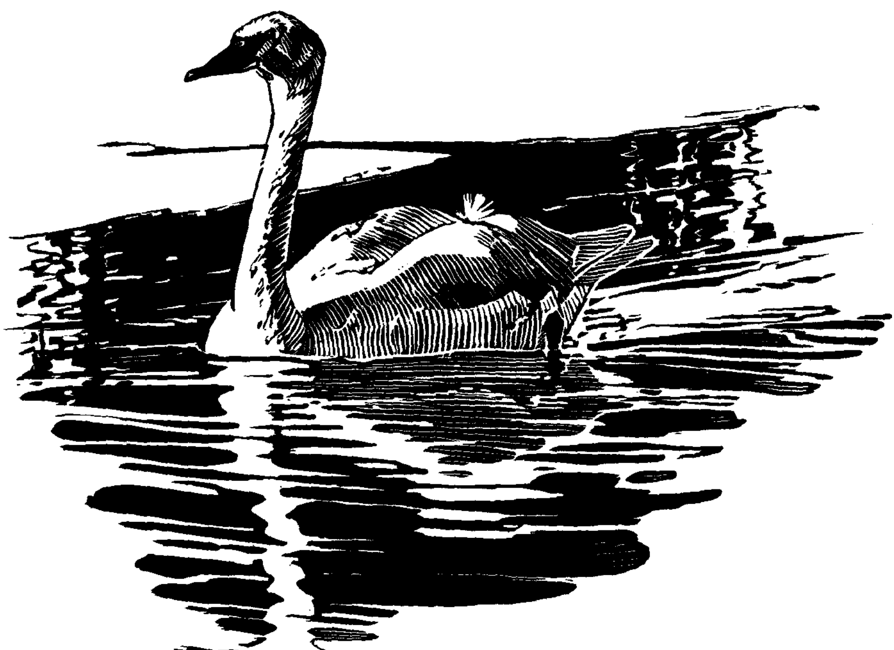
Nelson, H. 1993. A biological reconnaissance of Buffalo Ridge, Lincoln and Pipestone Counties, Minnesota. Rept. to WindRiver Power Co., Davenport, IA. 33 pp.

Olendorff, R., A. Miller and R. Lehman. 1981. Suggested practices for raptor protection on power lines. Raptor Res. Found., Inc., Dept. Vet. Biol., Univ. Minnesota, St. Paul. 111 pp.

Orloff, S. and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas, 1989–1991. Final Rept. to Alameda, Contra Costa and Solano counties and the California Energy Commiss. by Biosystems Analysis, Inc., Tiburon, CA.

Orloff, S. and A. Flannery. 1993. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County wind resource areas. Pages 22/1(22/13 *in* Avian interactions with utility structures, an international workshop. Elec. Power Res. Inst., Palo Alto, CA.

Winkelman, J. 1994. Bird-wind turbine investigations in Europe Unpubl. rept., Inst. for Forestry and Nature. Wageningen, Netherlands. 4 pp.



Special Session 5. *Defining Regional Wildlife Habitat Needs for the 1995 Farm Act*

Chair
TERRY Z. RILEY
Wildlife Management Institute
Chariton, Iowa

Cochair
STEVEN P. RILEY
South Dakota Game, Fish and Parks
Pierre, South Dakota

Opening Remarks

Terry Z. Riley
Wildlife Management Institute
Washington, D.C.

My father was born in a small western Iowa farming community, a stone's throw from the Missouri River. His father was the grandson of one of two brothers who immigrated from Ireland in the 1860s, supposedly to escape legal problems associated with the potato famine. My grandfather, like many present day farmers, needed additional income to supplement income earned on his farm. He operated a small ferry on the Missouri River until a flood in 1912 washed the ferry downriver—never to be seen again.

The farming business always has been characterized by marginal profits. Faced with this dilemma, my father still harbored the dream of owning his own farm as he grew. Even so, he learned early that farm income often was not enough to live on. He often spoke of his early years when he took advantage of wildlife to supplement the meager farm income. He told the story of purchasing his first shotgun. The day that old 10 gauge side-by-side arrived in the mail, he earned enough to pay for both it and a box of shells by collecting crows for bounty at a nickel a foot. The abundance of wildlife on the farm in those days was a tribute to the coexistence of the farmer and nature.

After his four-year stint in the Army Air Corps in WWII, my father returned to Iowa with his English bride finally to fulfill his dream. A lucky night of gambling in Africa during the war left him with enough money to buy a quarter-section of western Iowa farmland. But even with the land paid in full, times were tough. My mother remembers her five years on the farm as being among the most difficult of her life . . . recalling long winters and too many potatoes. There were long days with no days off that ended with potato soup. There were cold winter nights that ended with potato pancakes. It was our American version of the Irish potato famine.

During those times, wildlife populations still were high because farming had come to a standstill, as did everything else during the war, and the land reverted back to exceptionally good wildlife habitat. For a time after the war, while men worked to retame the land, wildlife populations were among the highest levels ever recorded in the Midwest—a result of secondary succession. Once again being the opportunist, Dad took advantage of the abundant wildlife to supplement the farm income as he had done in the early days. Trapping and hunting furbearers in winter kept meat—and potatoes—on the table.

When five years had ended, and there was no hope left in the farming venture, my parents decided to sell the farm and return to the military where the income was at least steady. They, like so many other hopeful farmers, were left with no other choice but to abandon their farming dream. Dad always longed for the farm, like most displaced farmers. Mom never missed the potatoes. Over the next thirty years of his life, Dad always imagined his armchair as a tractor seat and he never missed an opportunity to grow a large garden. To stay in touch with the land, he spent every possible moment afield hunting or at the lake or stream fishing.

The good old days. The good old days. Dad always mused about how many pheasants and other wildlife there once were. Like everyone else, he had his theories as to why. The farmers were farming too much land. The government was meddling too much in the ways farmers farmed the land. But in the end, the reasons didn't matter to him as much as the result. The fact was that farmers and wildlife populations were following one another in a downward spiral with no end in sight.

The consummate pheasant hunter, dad would not let a bad heart hold him back from the chance to chase yet another rooster, even though each year there seemed to be fewer and fewer. Until his death in 1980, Dad spent a lot of time remembering the good old days and wondering if they would—if they could—ever come again.

Today, we are here to discuss the federal farm program and its effects on wildlife. In February 1994, the Soil and Water Conservation Society (SWCS) hosted an historic workshop on the Conservation Reserve Program (CRP) in Washington D.C. Several participants in that workshop identified the need to gather specific information on wildlife benefits of the CRP and other conservation practices of the farm program. Subsequently, SWCS and the Wildlife Management Institute, at the request of the Clinton Administration and Congress, sponsored six workshops to identify regional fish and wildlife needs as they relate to federal farm programs. The question was asked: "In what specific ways have past farm bills benefitted or harmed wildlife populations?"

Our first speaker today is here to express concerns of the Administration as to how much is enough and what kinds of wildlife benefits are related to farm program activities. Our other speakers will identify how these questions were answered at the regional level.

Midwest Wildlife Needs Assessment for the 1995 Farm Bill—A Need to Focus Efforts

David L. Risley and David P. Scott
Ohio Division of Wildlife
Columbus

Alfred H. Berner
Minnesota Department of Natural Resources
Madelia

Introduction

Agriculture has changed in an irreversible way in its attempt to meet the food and fiber demands of the U.S. and the world. An approach to farm policy is needed that balances the need for agricultural production with the needs and demands of society for environmental responsibility. Wildlife interests are criticized for focusing their efforts on idling land; however, farm policy has focused on set-asides to achieve its desired objectives since 1933. Farm policy must recognize that this country has a tremendous capacity to overproduce. This overproduction comes at a cost to our natural resources. Farm policy and weather are the primary influences on crop production. We cannot change the weather, so we must strive for stability in farm policy. Since 1954, an average of 323 million acres has been planted to major crops with a maximum of 363 million acres (U.S. Department of Agriculture [USDA] unpublished data). Set-asides have ranged from 0 to 78 million acres, averaging 30 million acres (Berner 1984, USDA unpublished data). The eight Midwestern states covered in this report have averaged 136.2 million acres planted to major crops and 10.4 million acres of idled land since 1956.

The government's role in idling cropland always has been a point of contention with farm and conservation groups, but two points are obvious. First, many environmental and wildlife needs cannot be met without a sensible approach to reducing excess production capacity through long-term idling of land. Second, more stable agricultural production could benefit farmers, wildlife and the environment. A combination of short-term, long-term and permanent retirement is necessary. Emphasis on permanent retirement would be the most desirable in the long-term interests of the country.

A Conservation Reserve-style program serves as the cornerstone of a wildlife farm bill. Everyone agrees that the Conservation Reserve Program (CRP) has enhanced wildlife habitat, reduced soil erosion and improved water quality. Land retirement, whether through the CRP, commodity programs or a new vision of agriculture policy, is the process that greatly affects wildlife and is what we need to influence the most. There is a consensus among wildlife professionals that these programs need to be focused. Our committee tried to synthesize the best available data, blend in years of field experience and add a little common sense to develop a methodology for setting priorities to distribute wildlife habitat. While there still is a lot to be fine-tuned, this is a starting point.

Statement of Problem

Day-to-day decisions made by farmers greatly affect wildlife habitats and populations. These decisions are greatly influenced by current federal farm policy. This impact is easily demonstrated by changes in the landscape and wildlife populations throughout the Midwest since the first settlements.

Landscape Changes

Agriculture dramatically altered the rural landscape in the Midwestern United States. Presettlement habitats consisted of eastern hardwoods of Ohio blending westward into the prairies of Indiana, Illinois, Iowa, Missouri and southern Minnesota, and the northern forests of Michigan, Wisconsin and Minnesota. Wetlands accounted for nearly a fourth of the acreage in the Midwest (Dahl 1990).

Agriculture was the driving force for land-use change during settlement of the Midwest. Wetlands, prairies and forests all were converted to cropland. By the beginning of the 20th century, nearly all of the native grassland in the Midwest had disappeared. Forestland declined to historic lows. By 1982, one-half to two-thirds of the wetlands in the lower 48 states had been drained (Dahl 1990, USDA 1987), with most of that drainage concentrated in agricultural areas.

Midwest aquatic systems and riparian areas were seriously degraded. Impairment of these systems came from direct in-stream activities, such as channelization, and indirectly from watershed management practices. Most midwestern streams have been channelized for flood control or agricultural production. The result has been a reduction in the productivity and quality of aquatic habitats. Sedimentation continues to be a major problem in the Midwest. The Maumee River, which flows through intensively farmed, prime agricultural land and enters Lake Erie at Toledo, contains the highest sediment and phosphorus load of any river entering Lake Erie.

Cropland and pasture currently comprise nearly 60 percent of the rural land use in the Midwest (USDA 1994), most of which is privately owned. Nearly one-third of all cropland in the U.S. (136 million acres) is in the eight midwestern states. The effect of agriculture on land use in the Midwest is greater than the statistics imply, since the most fertile cropland and agricultural production areas are concentrated in the area that contained most of the original prairies and wetlands.

Federal policy, through farm legislation and tax codes, encouraged the conversion of wildlife habitat to agricultural production. Environmental problems were treated as ancillary issues. Commodity control programs encouraged farmers to plant marginal acres that never should have been in crop production to receive greater farm program payments. Payments were made to encourage conversion of wetlands and forest to cropland.

Wildlife Impacts

Agriculture and other human activities effected a change in the fauna from bison (*Bison bison*), elk (*Cervus elaphus*) and prairie chickens (*Tympanuchus* spp.) to red-winged blackbirds (*Agelaius phoeniceus*), coyotes (*Canis latrans*) and ring-necked pheasants (*Phasianus colchicus*). Before World War II, species that were dependent on large expanses of undisturbed grassland, such as the greater prairie chicken (*Tympanuchus cupido*), were largely eliminated. However, the small, diverse farms of the early 20th century still supported a wide variety of wildlife species dependent on early successional stages and abundant edge habitat.

After World War II, agriculture began to change. Large equipment, large fields and monotypic crop production resulted in dramatic reductions in wildlife species dependent on edge habitats. Grassland-dependent species have declined precipitously throughout the Midwest since the 1940s. Species requiring large grassland and wetland complexes were extirpated from much of the landscape. A few adaptable species, such as white-tailed deer (*Odocoileous virginianus*), began to increase.

Today, most of the grassland available for nesting wildlife is provided by the 8.6 million acres of grassland restored through the CRP. Many grassland-dependent species, such as the grasshopper sparrow (*Ammodramus savannarum*), breed at higher densities and with greater success in CRP fields compared with cropland and other grassland habitats like those found on Waterfowl Production Areas (Johnson and Schwartz 1993, Koford 1993). A variety of upland-nesting birds have been reported to use CRP fields (e.g., Luttschwager and Higgins 1992, Johnson and Schwartz 1993, Koford 1993, Patterson and Best 1993, Reynolds et al. 1994). Localized population responses by pheasants have been shown in Iowa (Riley 1993), Minnesota (Kimmel et al. 1992) and Texas (Berthelsen et al. 1989, Berthelsen et al. 1990).

Despite the CRP's apparent localized success for some grassland-nesting birds, many others continue to decline on a regional basis as indicated by the North American Breeding Bird Survey (BBS). BBS data show long-term declines for grassland species such as dickcissels (*Spiza americana*), bobwhite quail (*Colinus virginianus*) and eastern meadowlarks (*Sturnella magna*) since 1966 (Figure 1). The data also show long-term declines in wetland-dependent species such as spotted sandpipers (*Actitis macularia*) and American bitterns (*Botaurus lentiginosus*). Even before the advent of the BBS, long-term declines in species such as prairie chickens and waterfowl indicated a problem in these specific habitat types.

Wetland drainage and destruction of associated uplands have led to declines of many wetland wildlife species. Much of the wetland acreage that remains today is either forested or degraded. Long-term declines in species such as American bitterns, spotted sandpipers and most waterfowl species are well documented by the BBS. Programs such as the Wetland Reserve Program are too recent and too small to document any wildlife responses.

Forestland needs vary within the Midwest region. In the past 10 years, forested acreage has increased in five states and declined in three. Management needs are addressed under the forestry title, but land retirement under other titles can address reforestation needs. Declines in portions of the range of ruffed grouse (*Bonasa umbellus*) (B. Stoll personal communication) and some neotropical migrant birds dependent on early successional hardwoods indicate a maturation of forestland in some areas. Regional declines in species such as cerulean warblers (*Dendroica cerulea*) suggest problems with forest fragmentation (Robbins et al. 1992). Other problems with forest management in the Midwest include pastured woodlands, low-quality forest stands, replacement of oaks (*Quercus* spp.) by hardwoods with less wildlife value, overharvest of oaks and poor regeneration of oaks due to management practices.

Degradation of aquatic systems has had an impact on most aquatic fauna. Most states within the region have documented the impacts of agriculture on fisheries (American Fisheries Society [AFS] 1994). In Ohio, more than half of the species on the threatened and endangered list are aquatic species.

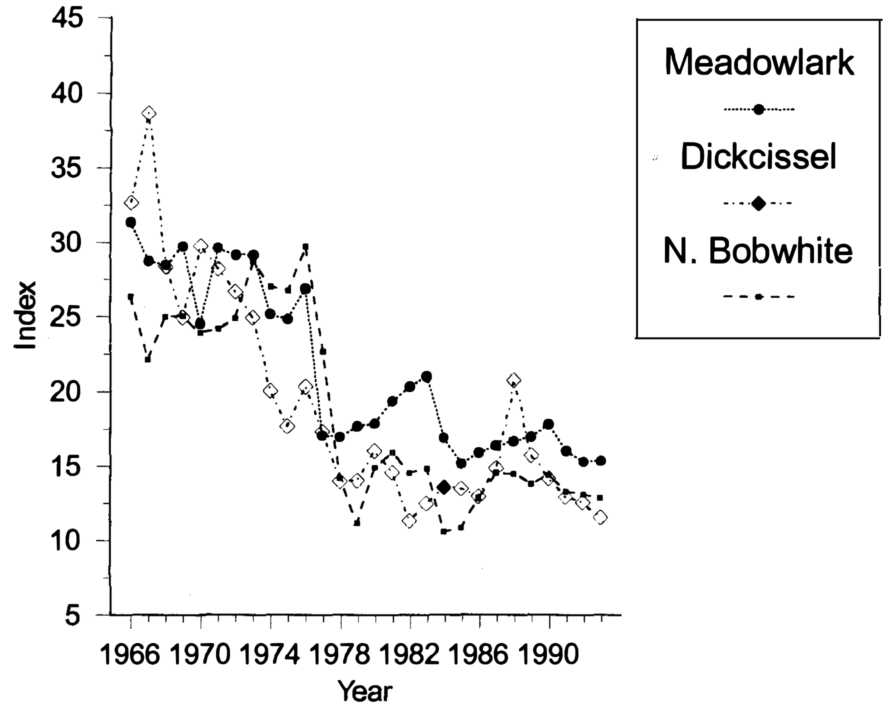


Figure 1. Selected Midwest wildlife population trends (based on North American Breeding Bird Survey data).

Recreational/Economic Impacts

Wildlife furnished food and furs to the early settlers of the Midwest. Very few people rely on wildlife to that extent today. Instead, more than 80 percent of Americans nationwide participate in wildlife-related recreation. These activities contributed $15 billion to Midwest economies in 1991 (U.S. Department of the Interior 1993). Meeting the wildlife goals will result in substantial increases in recreational opportunities, economic growth and overall quality of life in the Midwest.

Wildlife Goals

Reconciling wildlife goals for eight midwestern states is a difficult task at best. Wildlife and habitat data are collected differently and at variable intensities. Even one of the most visible of all farmland wildlife species, the ring-necked pheasant, does not have a uniform regional data source. Where regional plans such as the North American Waterfowl Management Plan (NAWMP) exist, they should, by default, guide regional needs. Where such plans do not exist, maintenance of minimum viable populations in targeted areas and stabilization of declining species are reasonable starting points.

Grassland-nesting Wildlife Goal—to stabilize or increase grassland-nesting species to maintain minimum viable populations in targeted areas.

Wetland-dependent Wildlife Goals—to stabilize or increase wetland-dependent species, meet the waterfowl population goals of the NAWMP, and restore wetland complexes that maintain critical migratory and resident wildlife populations.

Forest Wildlife Goals—to stop the decline of forest-dependent species and maintain viable populations of area-sensitive forest wildlife species.

Riparian/Aquatic Wildlife Goal—to restore self-sustaining populations of recreational fisheries to all streams and rivers degraded by agriculture.

Habitat Needed to Meet Wildlife Goals

Grassland objectives are to convert 13.5 million acres of cropland existing prior to the CRP to relatively undisturbed grassland, and to protect and improve existing grasslands such as permanent pastures, hayfields and remnant prairies.

Targets for grassland restoration should be as follows:

- Long-term or permanent grassland restoration programs should be focused on township-sized (approximately 36 square miles) areas that would result in 20 percent of the land area in acceptable wildlife cover types, including small grains, pasture, wetlands, shelterbelts or winter cover with a minimum of 5-percent grassland. Short-term retirement programs should be designed to provide grassland on more intensively farmed areas.
- Grassland acreage should focus on prairie and wetland soils to approximate distribution of native habitat types.
- Many grassland species are sensitive to the size of habitat blocks. Therefore, long-term programs should give priority to grassland acreage in large blocks (greater than 80 acres) with a minimum width of 600 feet so that 50 percent of the block serves as interior habitat. Priority also should be given to sites that enlarge or connect existing habitat areas, especially wetlands. Contracts should be a minimum of 20 contiguous acres unless used in riparian areas or as corridors connecting other habitats.
- Contracts should optimize other environmental benefits such as water quality when possible. Grasslands become more valuable when associated with other cover types such as wetlands or riparian areas, and grass buffers can reduce sediment and phosphorus loads of adjoining streams or wetlands.
- Grass species selection and management is crucial to maximize wildlife benefits. Specific in-state grassland habitat goals and management practices should be identified by a fully functional State Technical Committee (STC).

Wetland objectives are to protect 16.5 million acres of existing functional wetland systems, including associated uplands, and increase wetland acreage by 470,000 acres.

Targets for wetland restoration should be as follows:

- Wetlands in the prairie region should be restored and managed as nesting habitat complexes that include at least 2 acres of upland habitat (primarily grass) for each wetland acre.
- Wetlands managed as migration habitat require less associated upland habitat and should consist of bottomland hardwoods or open water complexes with buffers of grass or woodland.
- Focus areas of the North American Waterfowl Management Plan should receive priority.
- Bottomland hardwoods and floodplains should be targeted.

- Restoration of wetlands near other wetlands should receive priority to help develop or enhance wetland complexes.

Forestland objectives are to increase woodland acreage by 500,000 acres in selected forest regions and to provide management assistance to the remaining nonindustrial private forestland.

Targets for forest restoration and management should be as follows:

- Central and northern hardwood regions of the Midwest should be prioritized for reforestation programs.
- Hardwoods, particularly bottomland hardwood areas and floodplains throughout the region, should be targeted for reforestation and management assistance.
- Less intensively farmed areas (less than 25-percent cropland) should concentrate on forest restoration.
- Reforestation should focus on reducing fragmentation by developing forest blocks of at least 7,000 acres.

Aquatic habitat objectives are to protect all existing riparian habitats and restore 8,000 miles (at least 128,000 acres) along streams degraded by agriculture.

Targets for aquatic restoration should be as follows:

- Riparian area revegetation should emphasize tree plantings with a minimum of 100 feet on each side of the stream.
- When herbaceous vegetation is used, a minimum of 66 feet per side should be required and native, warm-season grass/forb mixtures should be emphasized.
- The Maumee River drainage should be targeted for watershed sediment control efforts.

Farm Bill Strategies

Most of the wildlife-related strategies developed for the Midwest will apply across the nation. The eight states covered in the Midwest region comprise only 18 percent of the rural land in the lower 48 states, but contain about a third of the acres planted to major crops and, consequently, have about a third of the annual set-asides when implemented. Production policy decisions made by USDA have a disproportionate effect on the Midwest region. As a result, farm programs of the past have resulted in degradation of wildlife habitat, and future farm policy should be used to rectify habitat deficiencies whenever possible. Unlike portions of the Great Plains, the Midwest lacks rangeland and land idled through federal farm programs may be the only source of undisturbed grass nesting cover. It is imperative that farm policy enhance wildlife habitat whenever feasible. Many facets of agriculture and farm policy affect wildlife habitat, but long-term land retirement must remain a strong component of a wildlife-related farm bill.

Most conservation features of the farm bill can be tailored to benefit wildlife at no additional cost, while maintaining the integrity of their intended purpose. Past farm bills have contained features with great wildlife habitat potential, but that potential never was realized. In addition, many wildlife needs are so state-specific that definition of those needs cannot be accomplished in a regional document. Implementation of STCs could become one of the more important features for the Midwest to address those needs. The STC provision of the 1990 Farm Bill provided state and federal wildlife agencies with a well-defined role in USDA policies. This provision must be set in motion.

Another reason for emphasizing the importance of the STC is the rapidly changing ability to evaluate habitat on a landscape scale through the use of geographic information systems. As more information becomes available, the STC would be able to assimilate that information and fine tune recommendations and targets. Management of wildlife on a regional or landscape scale still is in its early stages and our ability to make informed decisions increases as rapidly as the technology.

Many strategies of national importance will benefit wildlife in the Midwest and are detailed in Risley et al. (1995). The groundwork has been done in the 1985 and 1990 Farm Bills. Farm policy must recognize the importance of wildlife to the economic and environmental well-being of the country and should recognize the importance most people place on wildlife. A refinement of conservation provisions of the past two farm bills can make great strides in accomplishing regional wildlife habitat needs.

References

Berner, A. H. 1984. Federal land retirement programs: A land management albatross. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 49: 118–130.

Berthelsen, P. S., L. M. Smith and C. L. Coffman. 1989. CRP land and game bird production in the Texas High Plains, J. Soil and Water Conserv. 44: 504–507.

Berthelsen, P. S., L. M. Smith and R. R. George. 1990. Ring-necked pheasant nesting ecology and production on CRP lands in the Texas southern High Plains. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 55: 74–83.

Dahl, T. E. 1990. Wetland losses in the United States 1780s to 1980s. U.S. Fish and Wildl. Serv., Washington, D.C. 21 pp.

Johnson, D. L. and M. D. Schwartz. 1993. Conservation Reserve Program is a plus for grassland birds. U.S. Fish and Wildl. Serv., Res. Info. Bull. 42. 2 pp.

Kimmel, R. O., A. H. Berner, R. J. Welch, B. S. Haroldson and S. B. Malchow. 1992. Population responses of grey partridge (*Perdix perdix*), ring-necked pheasants (*Phasianus colchicus*) and meadowlarks (*Sturnella* spp.) to farm programs in Minnesota. Pages 797–806 *in* Perdix VI: First international symposium on partridges, quail, and francolins. Gibier Faune Sauvage Vol. 9.

Koford, R. R. 1993. Nest success in Conservation Reserve Program fields in North Dakota and Minnesota. U.S. Fish and Wildl. Serv., Res. Info. Bull. 43. 2 pp.

Luttschwager, K. A. and K. F. Higgins. 1992. Nongame bird, game bird, and deer use of Conservation Reserve Program fields in eastern South Dakota. Proc. South Dakota Acad. Sci. 71: 31–36.

Patterson, M. and L. B. Best. 1993. Avian abundance and productivity on Conservation Reserve Program lands in central Iowa. Proc. Midwest Fish and Wildl. Conf. 55: 171.

Reynolds, R. E., T. L. Shaffer, J. R. Sauer and B. G. Peterjohn. 1994. Conservation Reserve Program: Benefit for grassland birds in the Northern Plains. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 59: 328–336.

Riley, T. Z. 1993. Effects of CRP on ring-necked pheasants in Iowa (1985–91). Proc. Midwest Fish and Wildl. Conf. 55: 172.

Risley, D. L., B. Carmichael, Jr., S. Demarais, R. Evans, S. E. Frazer, L. R. Jahn, G. Jasmer, M. McEnroe, D. McKenzie, J. L. Pease, T. Peterson, T. Remington, E. Schenck and D. P. Scott. 1995. 1995 Farm Bill: Wildlife options in agricultural policy. Wildl. Soc. Tech. Rev. 95–1. 24 pp.

Rivers and Streams Technical Committee, North Central Division, American Fisheries Society. 1994. Agricultural land use and reauthorization of the 1990 Farm Bill. Position Statement. 9 pp.

Robbins, C. S., J. W. Fitzpatrick and P. B. Hamel. 1992. A warbler in trouble: *Dendroica cerulea*. Pages 549–562 *in* Ecology and conservation of neotropical migrant landbirds. Smithson. Inst. Press, Washington, D.C.

U.S. Department of Agriculture. 1994. Summary report 1992 national resources inventory. U.S. Dept. Agric., Washington, D.C. 54 pp.

———. 1987. Summary report 1985 national resources inventory. U.S. Dept. Agric., Washington, D.C. 54 pp.

U.S. Fish and Wildlife Service. 1993. 1991 national survey of fishing, hunting and wildlife-associated recreation. U.S. Fish and Wildl. Serv., Washington, D.C. 124 pp.

Wildlife Habitat Needs Assessment, Southeast Region[1]

Stephen Capel
Virginia Department of Game and Inland Fisheries
Powhatan

Breck Carmichael
South Carolina Department of Natural Resources
Columbia

Mark Gudlin
Tennessee Wildlife Resources Agency
Nashville

David Long
Arkansas Game and Fish Commission
Jonesboro

In the Southeast (SE), many species of wildlife have declined to historic lows in the last 30 years. Despite conspicuous successes in management for deer, wild turkeys and resident Canada geese, wildlife management agencies have been frustrated in their efforts to promote good populations of small game and other wildlife, particularly bobwhite quail. Species associated with wetlands, grasslands and large forest tracts have declined as well. The wildlife bonanza experienced in the plains states due to the Conservation Reserve Program of the 1985 and 1990 Farm Bills has not materialized in the Southeast. It is the considered opinion of wildlife professionals in the Southeast that the Conservation Title of the 1995 Farm Bill should be designed to allow southeastern states to reach their wildlife needs, while, at the same time, satisfying other conservation objectives. By including the program changes outlined below, the broad goal of rescuing our valuable wildlife resources from their decline can be attained.

The two previous Farm Bills (1985 and 1990) have contained conservation titles, primarily directed toward addressing soil erosion and water quality problems. *The 1995 Farm Bill should elevate wildlife to coequal status with soil, water and commodity production control, perhaps even including a specific Wildlife Title.* Language in the bill should recognize that all farmland programs and practices do, in fact, manage for or against various wildlife species. A percentage of farm bill funds should be directed toward restoring declining farm wildlife populations. Although this report pertains to the drafting of the 1995 Farm Bill, many of the concepts apply equally

[1]Biologists contributing data from: AL, Stan Stewart; AR, David Long; FL, Scott Sanders; GA, Todd Holbrook; KY, Jeff Sole; LA, Mike Olinde; MS, Wes Burger; NC, Terry Sharpe; SC, Breck Carmichael; TN, Mark Gudlin; VA, Mike Fies; throughout SE Region, Charles Hunter, Pete Bromley.

and perhaps more directly to the USDA rule making process for the programs under consideration.

Several changes in farm program administration and policy will be needed to accomplish this:

- State Technical Committees (STCs), authorized under the 1990 Farm Bill, should be fully activated and include state natural resource agency representation. These committees should be given broad authority to develop programs and specifications according to local situations.
- The Farm Service Agency (FSA, formerly ASCS) County Committee System should be diversified to include state natural resource agency representation, and decisions of STCs regarding conservation programs should be binding on county committees.
- Funding should be provided to establish State Agency Farm Wildlife Biologists to work within USDA program areas in each state.
- Funding should be provided for development of "Farm or Land Stewardship Plans" (FSP) addressing all natural resources on the land. An FSP should be required for USDA program participation by the year 2000.

The remainder of this report will be devoted to the five major habitat types in the SE (grassland, shrub, forest, wetland and aquatic) and the groups of species that are dependent on the condition of these habitats.

Grasslands

The 1992 National Resources Inventory (NRI) (U.S. Soil Conservation Service [SCS] 1994) showed a 2 percent decline in combined pasture and range acres in the SE between 1982 and 1992; however, range declined more than 20 percent. During the same time, cattle numbers increased more than 25 percent and the cattle per 100 acres increased by 34 percent (extracted from Ag Statistics Services reports in each state 1994). This indicates greatly intensified grazing on remaining acres, including an increase of 10.6 percent of woodlots grazed (Brown 1986). Also, a substantial proportion of range and pasture has been planted to non-native forages (e.g., tall fescue, bermudagrass) of low or no value to most wildlife species. SE grasslands also have been degraded because of a declining use of prescribed fire to maintain their health and integrity.

The Breeding Bird Survey (U.S. Fish and Wildlife Service [USFWS] data, Bruce Peterjohn personal communication) declines in grasshopper sparrows and bobwhite quail (Figure 1) are representative of the general trend of the entire guild of birds dependent on healthy grassland communities. All have suffered a similar fate, including lark and savannah sparrows, eastern kingbirds, meadowlarks and dickcissels, and 10 federally endangered birds, as well as 6 candidates for federal listing (Hunter 1994). These species would greatly benefit (and some even recover) from improved grazing practices and native grassland restoration, particularly in the dry and wet prairies of peninsular Florida, coastal prairies of Louisiana, and the barrens and prairies of Tennessee and Kentucky. Throughout the SE, loss of native grasslands and the reliance on cool-season forages, such as tall fescue, have resulted in steep declines among 10 of 13 familiar grassland birds. Only 1 of these 13 is definitely increasing in the region (upland sandpiper), but even this species has undergone widespread declines in the eastern portions of its range.

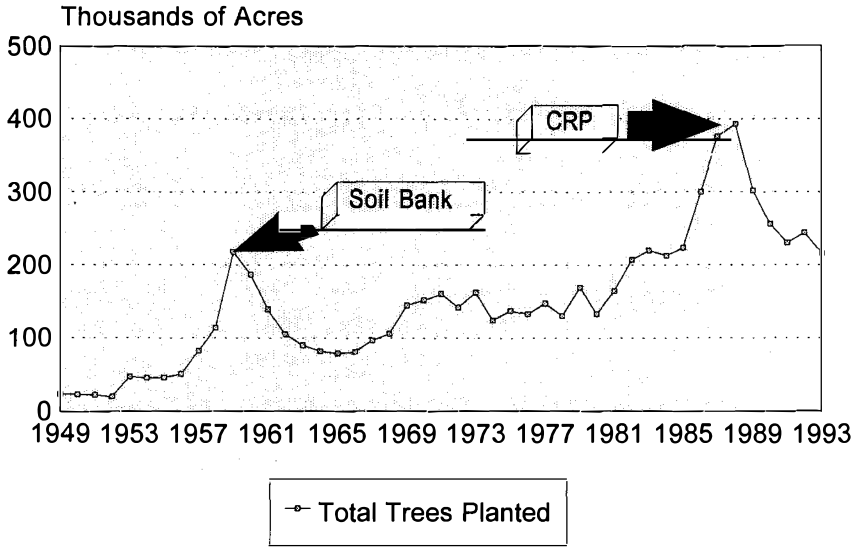


Figure 1. The Conservation Reserve Program in the SE mainly was a loblolly pine and fescue planting program. Examples of this are the obvious peaks in tree (predominantly loblolly pine) planting in Alabama (Alabama Forestry Commission Annual Tree Planting Report 1994) that accompanied the two major land-retirement programs (Soil Bank and CRP). Virtually every southern state had identical peaks, some even more exaggerated. Neither fescue nor loblolly pine provides desirable wildlife habitat.

★ *To restore grassland wildlife populations to 1980 levels, declines in pasture and especially range acreage must moderate. Habitat required to attain this goal includes retention of the existing 4 million acres of range and planting (or conversion from cool-season pastures) 10,231,000 acres of native warm-season grasses (NWSG).* Practices to achieve this include:

- Extend Sodbuster provisions to cover conversion of native rangeland to cropable acres on all lands, not just highly erodible land (HEL) acres.
- Restore/convert 20 to 25 percent of existing cool-season exotic pasture to NWSG. NWSG is more drought-hardy, providing livestock with reliable summer forage, while providing habitat to support viable populations of grassland-dependent wildlife. The SE livestock industry would be much less vulnerable to periodic drought-related economic stress. Research at several southeastern universities demonstrated that 25 percent of a livestock producer's forage base should be in NWSG to fill the summer forage void. NWSG also contributes to improved future soil quality as the only rapid developer of organic matter in topsoil, a major consideration for many SE soils that have been farmed for more than 200 years (Brandt 1993).
- Require 50 percent of the ACR to be in herbaceous, wildlife-friendly cover types that are stable and undisturbed for five years to benefit grassland-oriented species, provide erosion control and improve water quality.
- **Controlled** burning is a valuable tool in maintaining the health of grassy habitats. The use of this ecological management tool has been hindered by unreasoned

fear of fire and restrictive regulation. USDA policy should encourage (not discourage) safe use of this valuable tool. Threatened and endangered species regionally and especially in peninsular Florida have suffered from loss of fire.

Shrub/early Succession

Many species that are considered "typical farm wildlife" are dependent on early succession habitats that may take the form of shrub areas, fallow or idled fields, and other areas that are typically lumped into "odd areas" land classification. Included in this group are many of the more familiar farm wildlife, such as rabbits, bobwhites, cardinals and brown thrashers, as well as many less-familiar species (loggerhead shrike; prairie, blue-winged and chestnut-sided warblers; song sparrow; catbird; indigo bunting; orchard oriole; and yellowthroat). The habitat these species depend on is, by its very nature, ever changing. Disturbance at infrequent intervals (typically once every three to five years) will maintain these habitats. Otherwise, these "old fields" grow into mature forest or become unsuitable habitat. However, too frequent disturbance will not permit successful nesting and brood rearing.

In presettlement times, disturbances such as migrating bison, hurricanes, ice storms and, most notably, fire maintained these areas in early succession. Earlier in this century, small farms with crop rotations, extensive fencerows and inefficient farming methods maintained significant acreages of early succession habitat. The early stages of even-aged forest regeneration also contribute to this habitat type.

From 1950 to 1990, average farm size doubled as the number of farms declined by more than 60 percent (Soil Conservation Service [SCS] 1994). This frequently has resulted in bulldozing of hedgerows, old farmsteads and other "odd areas," as farmers employed larger equipment to till larger fields. At the same time, major fluctuations occurred in the total acreage idled on SE farms. In many parts of the country, the major land-idling programs (Soil Bank and CRP) were a bonanza for farm wildlife. However, in the Southeast, where these acres most often were planted to either tall fescue or loblolly pine, wildlife suffered (Alabama Forestry Commission 1994). These plantings converted what often were suitable habitats into unsuitable ones. On top of this, annual set-aside acres frequently were poor habitat because there was no plant cover or a very late plant cover (often the next year's small grain crop). Required weed control destroyed what plant cover there was. The impact of these and other forces acting together caused major declines in wildlife associated with early succession/shrub habitats. Use of controlled burning declined dramatically during this period.

Bobwhites, for example, have declined by 62 percent from 1966 to 1993, while loggerhead shrikes have experienced well more than a 50-percent population loss (Figure 2) (Breeding Bird Survey 1994). In fact, 18 species are declining, 16 of these steeply, out of 21 SE shrub/early succession-associated birds, including orchard orioles, prairie warblers, indigo buntings and common yellowthroats (Hunter 1994). One of these is federally threatened (Florida scrub jay) and five are candidates for listing.

In 1970, there were more than 1 million quail hunters in the SE. By 1991, quail hunters had declined by 60 percent to 400,000. The number of quail hunting trips had declined from 7,644,000 per year to 2,693,500 (data from individual state agency files). Brennan (1991) projected that the rate of decline would reduce quail numbers to unhuntable levels by 2005. This would result in the loss of an entire way of life

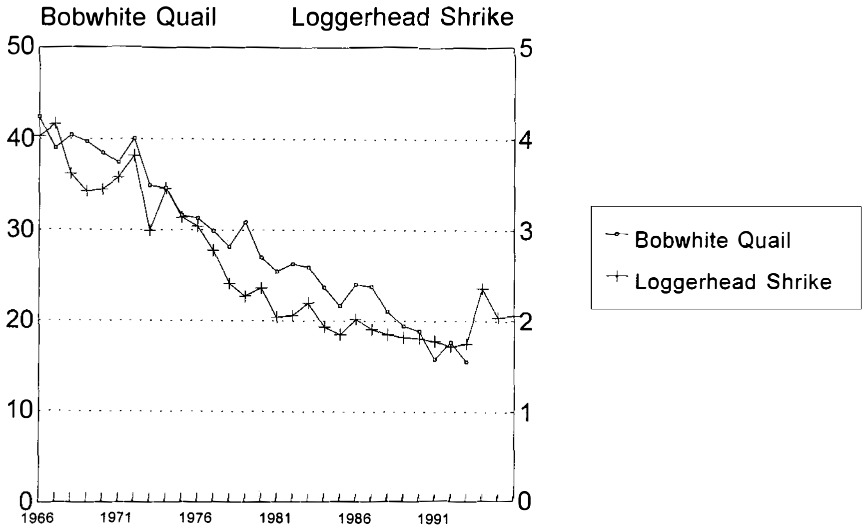


Figure 2. Populations of northern bobwhites and loggerhead shrikes have shown precipitous declines over the past three decades (Breeding Bird Survey data 1994). These species' populations are representative of the guild of early succesion avian species in the southeast. Hunter (1994) indicates that 18 of the 21 species in the guild have declining populations; 16 are steeply declining. Bobwhite declines have resulted in an economic loss of more than $285,114,000 per year to SE rural communities as hunting effort has declined proportionately to bird numbers.

in the south. The bobwhite decline translates into a *loss* to the SE rural economy of $285,114,000 per year since 1980 based on $845 per quail hunter per year [$950/quail hunter/year × 655,910 quail hunters in 1980] – [$845/quail hunter/yr × 405,00 quail hunters in 1990] (USFWS 1993, Fies 1993).

★ *To restore populations of early succession/shrub species to 1980 levels, 2,625,000 acres of five-year idled lands in native vegetation or grass legume mixes, 2,625,000 acres of annual vegetation (forbs or annually established cover) and 4,550,000 acres of long-term (10–20 year) herbaceous/shrub (mostly NWSG) cover are required.* A variety of approaches can achieve this, including:

- Place 50 percent of set-aside acres (5 percent of total cropland or 2,625,000 acres) in "permanent" cover that will not be significantly disturbed for five years (to serve instead of vastly fluctuating ACR) and adjust above this to control production acreage from year to year. If placed as linear cover along lower field edges, this practice would improve water quality (clean-tilled ACR acres in previous programs were subject to significant erosion rates), remove some of the annual uncertainty farmers faced regarding cropped/idled acres and improve the early succession wildlife habitat. In North Carolina, an eight-fold increase in quail numbers was found on acres with 30-foot legume/broomsedge filter strips versus areas with no strips (P. Bromley personal communication).
- For commodity production control, use annual plant cover, with no mowing or disking mandates.
- *Only* state-listed noxious weeds should face mandated control using spot treatments.

- Encourage controlled burning as a management tool, including continued cost share in Forest Stewardship (SIP).
- Long-term acreage reduction programs (e.g., CRP) should utilize wildlife-friendly cover plantings (4,550,000 acres), with an emphasis on multiple-species plantings, not monocultures. Mowing should be replaced as a maintenance practice by controlled burning whenever possible, with no mowing during peak nesting (April 1 to August 15). Landowners should receive from NRCS and FSA personnel a full spectrum of alternatives including wildlife management practices. State Technical Committees should develop state ranking prioritization criteria for new program enrollments and contract extensions.

Wetlands

Wetlands are a group of diverse habitats that have suffered long-term declines in acreage and quality. The North American Waterfowl Management Plan identified key wetland regions (Habitat Joint Ventures) targeted for wetland protection, restoration and enhancement so that wetland-oriented wildlife might be restored to viable populations (USFWS 1994). The Lower Mississippi Valley (LMV) and Atlantic Coast (AC) Joint Ventures are the major regions identified in the SE, with protection goals of 473,000 acres (LMV) and 880,000 acres (AC), and restoration goals of 864,000 (LMV) and 166,000 acres (AC). These wintering habitats for waterfowl also provide vital breeding habitats for neotropical migratory birds (NTMB) and shorebirds (Myers 1994). Although considerably less extensive, the few, isolated wetlands in the Ridge and Valley Province are extremely important habitats for water shrews, bog turtles, numerous salamanders and many federally listed and candidate plants. Peninsular Florida wetlands (Upper St. Johns and Upper Everglades Basin) are wetlands complexes supporting a diverse flora and fauna that also continue to be under assault from conversion (mostly development).

Many wildlife species in the SE rely on wetlands for a portion or all of their habitat needs. Duck populations utilize the Lower Mississippi Valley and Atlantic Flyway in the SE as wintering areas and have experienced long-term declines. Equally dramatic have been the declines in various NTMB populations, as represented by cerulean warblers. Other birds in this guild (utilizing the expansive forested wetlands of the SE) following similar declines include swallow-tailed kites, Swainson's and prothonotary warblers, and the tanagers.

In the Lower Mississippi Valley, more than 80 percent of the original forested and alluvial wetlands have been converted to agriculture. The lower Atlantic Flyway has less than 60 percent of the original wetlands remaining. Although the rate of loss has moderated and agriculture is not the primary cause of loss today, wetlands continue to be lost. The quality of the remaining wetlands continues to decline, due to nutrient overloading, altered hydrology and urban encroachment.

★ *To restore and protect wetlands and their dependent wildlife populations, 1,353,000 wetland acres need protection and 1,030,000 wetland acres need to be restored.* The Farm Bill can contribute with a variety of actions:

- Retain the Swampbuster Provisions of the 1985 Farm Bill.
- Retain and fully fund the Wetland Reserve Program, including all states.
- Reduce nutrient and sediment loads from agricultural point and non-point sources through greater utilization of filter strips, minimum and no-till practices, and

require that ACR lands *not* erode (encourage cover on these acres at least 10 months/year).

- Protect existing large blocks of forested wetlands and target bottomland hardwood reforestation efforts to the Lower Mississippi Valley, with emphasis on combining existing patches of hardwoods to attain larger blocks (at least 10,000-acre minimum size).
- Permit and encourage restoration of dikes in abandoned rice fields to create shallow-water areas for shorebirds and waterfowl. Encourage winter flooding to enhance migratory waterfowl habitat.
- Create an ACP Practice that rebutts rice levees after harvest to capture runoff and, thus, reduces soil and nutrient loss from the field through the winter months.

Forests

The 1992 NRI (SCS 1994) showed a stable forested acreage (<1-percent change) in the SE in the last decade. Although the total acreage has been stable, composition has changed, thus impacting wildlife populations. Neotropical migratory bird populations have been impacted by the decline and fragmentation of *hardwood* acreage. Hardest hit have been species that require large blocks of continuous woodland. Maintenance of forest acreage is not the only factor affecting wildlife. Many wildlife species suffered as hardwood and natural pine stands were converted to monoculture pine plantations. Pine plantations have expanded to the current 15 percent of all woodlands (Figure 3) and more than 21 percent of the vast coastal plain (Bechtold 1988, Hare 1990). In the first few years, these plantations provide habitat for prairie warblers, bobwhite quail and even Bachman's sparrows, but rapidly decline in value for the majority of wildlife species.

Forest size classes have changed over the years, further impacting some species dependent on early growth stages (Waddell et al. 1989). Birds using early forest stages enjoyed the greatest expanse of habitat in the 1960s when seedling/sapling acreage was at its highest point. Since then, a more mature, sawtimber dominated stage has developed.

★ *In order to reverse the decline of these more-sensitive forest wildlife populations, 510,000 acres of bottomland hardwoods, primarily in the Lower Mississippi Valley, need to be reestablished and conversion of other hardwood stands to cropland and monoculture pine should be curtailed.* The Farm Bill should:

- Target tree planting at hardwood restoration, especially tying together smaller patches into larger blocks, rather than funding primarily pine monoculture. If Forestry Incentive Program (FIP) is deleted, Stewardship Incentive Program (SIP) monies should be increased in order that existing SIP funding not be diluted by tree-planting practices.
- Encourage more diverse pine planting by 1) incorporating buffers of shrubs, hardwoods and grass/legume mixtures within and around plantations; 2) only cost sharing on less-dense plantings of 10 by 10 feet (450 seedlings/acre) or less; 3) not cost sharing on extensive (more than 30 acres) pine plantations or, at a minimum, require wildlife openings of at least 1 acre for every 25 acres; and 4) reforest with species native to the site.
- Avoid conversions of crop fields to pine monoculture in landscapes dominated by forested cover types.

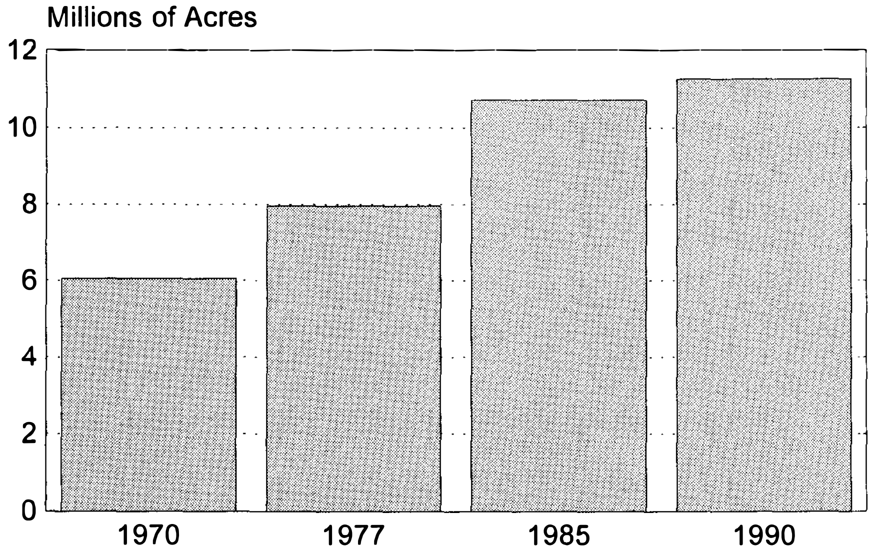


Figure 3. Pine plantation acreage has doubled in the last two decades, often at the expense of farm and early succession species' habitat. Single-species pine plantations displaced more desirable wildlife habitats, unless they were maintained in a long rotation and managed with controlled burning in the understory. Tree planting directed to multiple species or hardwoods and to species native to the sites would improve wildlife habitats. (Data from *The South's Fourth Forest*, USDA Forest Service Research Report 24.)

- Retain use of moderate-sized clearcut harvest techniques.
- Retain and fully fund the Forest Stewardship program to provide private, non-industrial forest owners with solid, multi-resource advice and planning for their forests.
- Encourage use of frequent thinning, controlled burning and longer rotations in pine management to achieve the valuable pine savannah growth form that is essential for such species as Bachman's sparrows, bobwhite quail and red-cockaded woodpeckers. Permanent fire lines should be designed into plantations and cost shared. These practices provide economic benefits to landowners by improving growth and value of pines and greatly enhance wildlife populations.

Aquatic

The primary source of non-point pollution and, in many cases, the major cause of aquatic degradation is agriculture. The 1992 EPA 305b Report (1992) lists 71,663 miles of streams in the 11-state SE Region as significantly impaired, yet, many states have not adequately measured or characterized aquatic habitat degradation, therefore, this figure probably is even higher.

Southeastern aquatic systems support the highest numbers of endemic fishes and freshwater invertebrates in the U.S. (and perhaps the world). Unfortunately, the SE also is infamous for having the highest number of extinct and federally endangered species in the U.S. The loss of southeastern aquatic systems and their entire native faunas truly is a crisis contributing to the decline of global biotic diversity. This loss largely was due to impoundments and channelization, while continuing declines are due primarily to agricultural siltation (Dick Neves personal communication). For example, the high concentration of threatened and endangered organisms in the upper Tennessee River system is nearly all aquatic organisms threatened by dam construction and water-quality degradation, primarily due to agriculture. The Clinch, Powell, Holston River system alone contains 16 federally endangered mussels, other federally protected invertebrates, and 4 federally protected fishes, as well as myriad state-protected and federal candidate species. Initially, the construction of dams isolated many populations, which then became even more vulnerable to pollution. The consensus among aquatic biologists is that chronic siltation is the one ubiquitous factor contributing to the decline of endangered species in the Upper Tennessee River system.

Fisheries resources obviously are dependent on the quality of waters. As discussed above, thousands of miles of streams are impaired, thus reducing their potential for both recreational and commercial fisheries. The National Water Quality Inventory (1992) shows that the states list agriculture as the primary cause of degraded streams by a wide margin over the next cause. Currently, sport fishing alone contributes more than $6.3 billion annually in the Southeast, which produced multiplier benefits of $12.6 billion (USFWS 1993). This outdoor activity supported more than 200,000 jobs with earnings totaling $3.6 billion. Reducing the miles of impaired streams will permit fisheries in these streams to recover, thus stimulating increased recreational opportunities and adding to the considerable value of the economic benefits that fishing produces in the SE.

★ *Stabilizing or improving threatened or endangered aquatic populations and improving fishery quality, as well as reducing the miles of stream impairment from non-point sedimentation and nutrient enrichment, are goals that can be attained by establishing 750,000 miles of filter strips and at least 250 miles of riparian fencing.* Practices to achieve this include:

- Utilize every opportunity to maintain cover on idled acreage; delete loopholes that permit clean tillage. Minimum of 10 months per year with plant cover should be the goal.
- Permit and encourage ACR to be used as filter strips (remove width restriction).
- Provide for fencing to exclude livestock from riparian corridors and fund development of alternative water sources (more than 100 miles of fencing are needed in the Upper Tennessee River system alone to protect federally endangered species).
- Full implementation of BMPs should be required for Forest Stewardship SIP participation.
- Alternative Conservation Systems should be phased out over time (five years) because they do not reduce erosion to an adequate level in most cases. The goal should be to reach "T" in erosion control on cropland acres in all farm plans.

Farm Bill Strategies

Conservation Compliance/Sodbuster

- The 1995 Farm Bill should require that all conservation plans meet the soil loss tolerance "T" value for erosion control. Alternative Conservation Systems frequently allow erosion rates to exceed "T," and should be phased out within five years.

- Greater emphasis should be placed on planting of wildlife-beneficial vegetative species to control soil erosion in conservation plans. Examples: native grass plantings instead of tall fescue; switch tree planting emphasis to hardwoods. Reduce reliance on exotic species that have little value to wildlife.
- Implement a state/federal agency team approach to farmland conservation plan writing, including a wildlife biologist on the team. This is working well in the Forest Stewardship Program.

Forest Stewardship and Stewardship Incentives Programs

- Provide higher cost-share rates for mixed species plantings over single-species plantings to de-emphasize monoculture. Emphasize long-leaf pine and hardwoods. Provide cost-share for establishment of permanent firebreaks.
- Continue and fully fund Stewardship programs within the 1995 Farm Bill. However, should the Forestry Incentives Program (FIP), which has been the primary cost-share program for tree planting, be discontinued, funding emphasis on wildlife, soil and water quality practices should *not* be diluted by tree planting within the Stewardship Incentive Program. Require full BMP implementation to participate in SIP.

Water Quality Incentives Program

- Continue in the 1995 Farm Bill and fully fund as originally intended. A team approach should be utilized for water-quality plan writing, with input from professional wildlife biologists.

Swampbuster

- Utilize a team approach involving state and federal natural resource agencies to ensure consistent enforcement and an appeal process developed to review both negative and positive wetland determinations.
- The trigger for Swampbuster should continue to be the act of drainage, fill or other conversion, and graduated penalties for first-time, unintended violations should be maintained.

Wetlands Reserve Program

- Make available in all states and fully fund.
- Recognize the interdependence of wetland and upland areas, and the need for buffer areas in the associated uplands for water-quality protection and as nesting habitat for many wetland wildlife species. Up to 4 acres of adjacent upland should be allowed to be entered into the program for every 1 acre of wetland.
- Delete the one-year ownership requirement for eligible lands.

Annual Set-aside Program (Acreage Conservation Reserve and 50–85/0–85 Programs)

- Strengthen cover requirements on annual set-aside lands within the 1995 Farm Bill to protect soil from erosion and provide wildlife habitat. Practices that create wildlife habitat should be encouraged.

- Change the 50-percent cover requirement to 100 percent. Place 5 percent of all cropland in a five-year permanently vegetated set aside and make annual set-aside adjustments upward from that acreage. Delete requirement that Acreage Conservation Reserve be whole fields of at least 5 acres in size. This would encourage field borders, filter strips and establishment of natural hedgerows around cropped fields conserving soil, improving water quality and producing wildlife habitat. Consider native vegetation legitimate cover. Give State Technical Committees authority to set cover establishment dates and approved cover types.
- Fully implement multi-year set-asides.
- Discontinue or waive FSA inspection fee for wildlife food plots planted on annual set-aside land.
- Delete weed control mandate. The landowner should be allowed to decide what are and are not weeds on his or her property. Only state-declared noxious weeds should face mandated control.

Agriculture Conservation Program

- Emphasize vegetation plantings that are beneficial to wildlife, while still accomplishing air, soil and water conservation objectives. Examples: increase cost-shares for establishing native grass species and grass/legume mixtures in lieu of fescue and bermuda grasses. Require use of endophyte-free fescue seed when this species must be used.
- Develop new, local (by STC) practices for establishing field borders, maintaining crop stubble through autumn and winter and seasonal flooding of cropland for wildlife purposes locally and added to the program.

Conservation Reserve Program

- Continue the Conservation Reserve Program, but shift toward longer-term contracts and permanent easements. Ten-year contracts still could be offered, but 20-year and permanent easements (similar to WRP) should be encouraged.
- Target new enrollments and extension of existing contracts toward critical resource areas, such as highly erodible lands, native-grass prairies, wetlands, hardwood tree plantings, etc. Targeted priorities should be determined by STCs, but monoculture pine plantations and fescue field contracts should not be extended, nor should these types of cover practices be permitted under new contracts or easements.
- Provide incentives to incorporate wildlife habitat improvements into existing contracts. New contracts or easements should emphasize native vegetation management or multiple-species plantings, with maintenance outlined in a locally approved plan (burning, mowing, light discing). Annual and permanent wildlife food plots should be included in this plan if desired by the landowner.
- Provide for maintenance as an integral part of the CRP farm plan/contract.
- Restrict/prohibit haying and grazing of program lands (use annual set-asides for emergency forage reserves), or use as maintenance practice in accordance with a written plan.
- Permanently retire crop bases from any land placed in a long-term retirement program, or when an existing contract is extended.

Farmers Home Administration Fee Title Transfers and Debt Restructuring Easements

- Continue, but clearer directions need to be given to the Farmers Home Administration on policies and operation.
- Establish the Debt Cancellation Conservation Easement Program as a high priority on all FmHA loans.
- Review all lands being sold by FmHA, regardless of inventory status, for adding conservation easements on environmentally sensitive areas prior to sale.
- Consider giving the U.S. Attorney prosecution responsibility for violation of easements, rather than encumbering state natural resource agencies, since it is a federal program.

References

Alabama Forestry Commission. 1994. Forest resource analysis: Annual tree planting report. Unpubl. report, Montgomery, 6 pp mimeo.

Agricultural Statistics Services. 1993. Crop and livestock report. Various publ. dates.

Bechtold, W. A. and G. A. Ruark. 1988. Structure of pine stands in the Southeast. Southeast For. Ex. Sta. Res. Pap. SE–274, Asheville, NC. 185 pp.

Brandt, D. K. 1993. Soil properties under warm season grasses and continuous cultivation. MS thesis, Univ. Missouri—Columbia. 233 pp.

Brennan, L. A. 1991. How can we reserve the northern bobwhite population decline? Wildl. Soc. Bull. 19: 544–545.

Environmental Protection Agency. 1992. National Water quality inventory: 1992 Report to Congress. Washington, D.C. 460 pp.

Fies, M. L. 1993. Virginia quail hunter survey. Unpubl. report. Virginia Dept. of Game and Inland Fish., Richmond. 8 pp.

Hare, D. 1990. The South's fourth forest: Alternatives for the future. USDA For. Serv., Forest Resour. Rept. 24, Washington, D.C. 512 pp.

Hunter, W. C. 1994. Southeast regional wildlife needs assessment for the 1995 Food Security Act (Farm Bill) reauthorization and related private land partnership activities (Draft). U.S. Fish and Wildl. Serv., Atlanta. 14 pp.

Myers, G. 1994. Status report on the development of a regional wetland and migratory bird conservation plan for the Lower Mississippi River Alluvial Valley. No. Amer. Wetland Conserv. Coun., Washington, D.C. 8 pp.

U.S. Fish and Wildlife Service and U.S. Department of Commerce, Bureau of Census. 1993. 1991 National survey of fishing, hunting and wildlife-associated recreation. Washington, D.C. 124 pp.

U.S. Soil Conservation Service. 1994. Summary report, 1992 national resources inventory. Washington, D.C. 54 pp.

Waddell, K. L., D. D. Oswald and D. S. Powell. 1989. Forest statistics of the United States, 1987. USDA For. Serv., Resour. Bull. PNW–RB–168. 106 pp.

Northeast States Wildlife Needs Assessment for the 1995 Farm Bill

Carl Schwartz
U.S. Fish and Wildlife Service
Cortland, New York

Peter Jaynes
Maryland Department of Natural Resources
Wye Mills

Paul Peditto
Maryland Department of Natural Resources
Annapolis

In *A Sand County Almanac*, Aldo Leopold wrote, ''Every farm is a textbook on animal ecology. . . .'' Perhaps it is more appropriate, in the 1990s, to say every farm could be a textbook on animal ecology. Today, as in Leopold's time, wildlife biologists recognize the impact that farmers, and the land they manage, has on many species of wildlife. As residential and commercial development have increased, the open space that farmland preserves is of greater importance to the survival of the many creatures that occupy the remaining habitat.

Agricultural Impacts on Wildlife Habitats—Land-use Patterns/Trends

Agriculture has brought massive change to the landscape in the Northeast. Originally, most of the Northeast was cloaked in forest; hardwood, softwood and mixed stands with the scattered grasslands, glades, bogs, marshes and other primarily herbaceous stands being about 20 percent of the habitat according to some early records. Beginning in the early 1600s, settlers from Europe cleared the original forests to create fields in which to grow crops. Today, much of the landscape is dominated by habitats altered to meet some agricultural need (row and truck crops, dairy and meat production, timber and fiber to name a few).

Along with this immense change to the landscape, the wildlife populations have changed dramatically as well. Although not all changes were habitat driven, land-use changes are nevertheless the dominant factor overall. Much of this change on a gross scale was completed prior to the middle of the twentieth century. More recently, acres dedicated to agriculture actually have declined in many states, as farmland is lost to residential and commercial development and reforestation.

The acres remaining in agriculture still are undergoing change, often with dramatic impacts on wildlife habitat and related populations. The past 30 years have seen a change in the average farming operation from a ''family farm'' to ''agri-business.'' The typical family farm was based on a relatively small acreage and was a diverse operation. Fields were small, equipment modest and overall management intensity low. The benefits to many wildlife species were great. Indeed, several small game species, such as bobwhite quail, cottontail rabbits and ring-necked pheasants, often were termed farm game, due to this close association with agriculture.

However, the economy of farming changed and the small operation became less and less viable. Farmers reaped smaller and smaller profit margins per acre, as their costs rose and commodity prices stagnated. Producers were forced to quit farming or turn to more efficient methods, farming larger fields with larger, more sophisticated equipment. Hence, many smaller fields coalesced into fewer large ones with the intervening hedgerows, treelines and woodlots removed or fragmented. Too much diversity became a liability as farmers began to focus on fewer crops in an effort to streamline operations. These changes again brought massive change to wildlife habitat.

Another result of changing farm economies is the abandonment of fields as row-crop producers remove land from production. Some abandoned fields were permitted to revert into woodland without management and others were intentionally planted to tree species, often in monotypic stands. Although forested tracts are critical to many species, there is a loss of species richness compared with the diverse habitat interactions typical of farmed tracts or acres logged to promote stands of differing age classes.

Some habitat changes were obvious, as hedgerows and treelines disappeared to create larger, more efficiently managed fields. The amount of edge decreased, minimizing habitat for certain species. However, some crucial changes were more subtle. One of these is the loss of idle acres dominated by herbaceous vegetation. The concept of fallow rotation became economically impossible and the practice of idling fields to improve soil conditions every few years disappeared. Double cropping increased in popularity as soybeans were planted immediately after small grains were harvested. The stubble fields that once lay fallow through the summer months now are sprayed and planted. Smaller equipment prevented farmers from tilling all available acres every year as some sites were wet, sloped or otherwise temporarily untillable. This resulted in fallow sites that were farmed intermittently, keeping them in either crops or early succession stage volunteer vegetation.

Pasture management has changed dramatically also. Some pasture acres disappeared as no-till equipment permitted the row cropping of fields that formerly were suitable only for grazing or haying. Intensive management of hay, especially alfalfa, has resulted in earlier and more frequent mowing. Mowing rotations long enough to permit successful nesting by most species are a thing of the past.

The impacts on wildlife populations have been enormous. Some species, like the Canada goose (*Branta canadaensis*), have adapted well to the changes and can thrive on a modern, agri-business farm with large fields, double cropping, etc. Other species have been decimated, especially those dependent on undisturbed herbaceous stands and edge habitat. Ironically, many of the species once termed farm game have lost their niche on the farm and have undergone severe population crashes.

On a localized level, species like the meadowlark (*Sturnella magna*), bobwhite quail (*Colinus virginianus*) and ring-necked pheasant (*Phanianus colchicus*) have suffered from the loss of critical nesting, brood-rearing and wintering habitat components. However, a larger scale problem also has developed at a landscape level. The fragmentation and isolation of habitat components can work to reduce populations beyond what is immediately measurable at a local level. The landscape concerns include issues such as healthy genetic flow and population enhancement via the pioneering of individuals into newly created or improved habitats.

The complexity of the interrelationships of wildlife habitat and land-use patterns is exemplified by the group of migrant birds termed Forest Interior Dwelling birds (FIDs). Suitable habitat for these species is declining in the southern portions of the Northeast Region, as remaining woodlots are fragmented by agricultural, commercial and residential development. Fragmentation reduces the percentage of any woodlot free of edge-nesting species that out-compete the FIDs for breeding territories. Ironically, as these edge species invade the forest interior, they, too, are undergoing loss of habitat on a landscape scale. As mentioned above, the amount of edge has decreased alarmingly, as many small fields have grown into fewer large ones.

To complicate the issue further, one of the primary concerns in the upper reaches of the Northeast Region is the loss of non-forested habitats. Large tracts of woodlands typically host far fewer species than a similar area containing a mix of woodland, agriculture and herbaceous stands. Agricultural lands are being lost to woodlands, as farm fields are abandoned to revert to forest or are intentionally planted to trees for fiber production.

The impacts of agricultural practices on wildlife habitat in the Northeast are immense. Accordingly, the potential for agricultural programs to affect habitat also is enormous. This potential is illustrated by the now legendary changes wrought by the Conservation Reserve Program included in the 1985 Farm Bill. The millions of acres idled nationally under CRP have been directly correlated to the dramatic recovery of numerous species, particularly grassland-nesting wildlife. Unfortunately, the boom years are numbered, as CRP contracts generally are for ten years. Preliminary forecasts are for only around 7 percent of the enrolled acres to remain in wildlife habitat once the contracts expire. This would have devastating impacts on those wildlife populations that thrived as a result of the idled acres.

Existing Wildlife Habitats in Agricultural Landscapes

Despite the many large changes mentioned above, farming practices still provide for the survival and well being of a wealth of wildlife species and many populations are inexorably tied to agriculture in the Northeast. Though, perhaps reduced from the past, these practices still create a diversity of wildlife habitat components, some of which are critical to the presence of a species or group of species with similar needs (guilds). Key among these components are ones critical to wildlife, those which often are limited and, thus, work to restrict populations. Typically, critical habitat types focus on breeding, migration on wintering needs.

An example of critical habitat components in agricultural landscapes involves forestry operations in the Northeast. Large, monotypic plantings managed as even-aged stands minimize diversity and, thus, wildlife. A better management practice for wildlife interests includes managing smaller stands on different rotations to create a mosaic of sites varying from clearcuts to early regeneration to mature stands. This approach creates more diverse habitat conditions, providing for the critical components of numerous species or guilds.

More conventional farming methods, such as row crops, pasture and hayfields, also provide critical habitat components for a variety of species. Due to relatively frequent disturbance rates, these operations usually are better suited to provide wintering or migration habitat. Waste grain and autumn-planted small grain crops are used extensively by wildlife on winter and spring migrations and as wintering habitat.

Of particularly short supply in the Northeast are undisturbed herbaceous or very early succession woody stands. These stands provide critical breeding habitat for several species or guilds, many of which are experiencing population declines. Few farming management practices promote this type of habitat and those acres that do exist often are the result of idled-acres programs designed by government agencies to limit soil loss or commodity production. Further, placing these stands in close proximity to other habitat types can dramatically increase response by wildlife.

In short, agricultural practices in the Northeast today support a huge array of wildlife populations and communities. Indeed, as the predominate land use in many Northeastern states, agriculture plays host to more wildlife numbers than any other interest. However, not all species fare equally well within the confines of modern management practices. Critical habitat components are lacking for certain species or guilds, thus, limiting populations or communities. Some of these critical habitats will become part of the agricultural landscape only through the means of incentive programs, such as the ACR, CRP, etc. Further, the parameters of these programs can be modified to create tremendous gains in critical wildlife habitat *without compromising their primary goals related to agriculture.*

Wildlife Populations Status, Trends and Association with Agriculture

An example of the potential for agricultural programs to impact wildlife populations occurred some years ago in the Midwest. From 1955 to 1970, the federal government paid farmers to leave a portion of their land idle. This program, known as the Soil Bank, was designed to reduce soil loss by removing those acres designated as potentially erodible. An unintentional side effect of these idled acres as a dramatic increase in ring-necked pheasants and other upland grassland-nesting birds (see Erickson and Wiebe 1973). This demonstrates the dramatic effect that removing even a small percentage of tillable ground from production can have on birds such as the pheasant or bobwhite. The Conservation Reserve Program of the 1985 Farm Bill has had no less dramatic impact on wildlife.

Grassland and Early Successional Stage Wildlife

As was previously mentioned, many species depend on the upland habitat associated with agricultural land. However, perhaps the worst victim of the degradation of this ecosystem has been upland wildlife, especially ground-nesting birds and bird species associated with open country. The U.S. Fish and Wildlife Service reported the following in a recent summary of the annual Breeding Bird Survey: ''Native birds in North America's upland grasslands have suffered steeper, more consistent, and more widespread declines over the past 25 years than any other U.S. bird group.''

Furthermore, two of the most significant game birds in North America, the ring-necked pheasant and bobwhite quail, have suffered dramatic declines in their traditional range. These species traditionally occupy habitat similar to many of the birds in the report above. The northern bobwhite remains the most widely distributed North American quail. Despite this wide distribution, populations throughout the continent have undergone significant declines in 75 percent of their geographic range (Brennan 1991). The Breeding Bird Survey data for Maryland shows a 72 percent decline in bobwhites tallied since 1966. The Eastern meadowlark is faring no better. Delaware and New Jersey have experienced similar declines, necessitating dramatic changes in harvest strategies. Pheasant declines are even more dramatic, with the population crashing more than 95 percent in Maryland over the past 20 years. This is especially disturbing because many of the states in the Chesapeake Bay focus area historically have been associated with good upland game management programs and abundant populations.

Wetland Wildlife Species

According to nesting surveys, the autumn flight of ducks in the Atlantic Flyway will be one of the largest in decades. Many of these ducks successfully nested in the grasslands surrounding the potholes on the prairie nesting grounds. Though pothole water levels are of prime importance in duck nesting success, the habitat surrounding the potholes is equally important. Studies show the extensive grasslands present work to reduce nest predation, increasing success. Many of these grasslands exist due to provisions contained in the 1985 Farm Bill.

As wildlife diversity supersedes game management as the main focus of state wildlife agencies, the importance of wetland habitats has become even more critical. The wealth of reptile and amphibians that require wetland sites for various life stages is immense and adds greatly to species richness values.

Rare, Threatened and Endangered Species

The plight of rare, threatened and endangered species is well understood by many Americans. Agricultural habitats can play key roles in reversing the declines of some listed species. Conversely, agricultural practices can work to hasten the decline of some species. Of particular note in this category is the guild of birds requiring grassland habitats for survival. As mentioned above, these species are declining at alarming rates. Compensating farmers to idle acres as grasslands may be the most effective way to address this critical habitat need.

Conclusion

Tom Horton, a recognized Chesapeake Bay environmentalist, stated in a recent article discussing the merits of biodiversity and tolerance toward "variety" (weeds) in our backyards, "The biggest gain from choosing more natural landscapes would not be cleaner runoff, significant as that is. The greater gain would be an improved ability to relate to and participate in the natural world around us." These same words certainly can apply to the farmland of the Northeast. Lasting solutions to many of the environmental problems of our planet won't be addressed adequately addressed until more of us are able to relate to and understand the natural world that surrounds us. Education, not regulation, probably will go a long way to changing the public's perception.

Wildlife-associated Recreation Patterns, Trends and Expenditures

The status of hunting and outdoor recreation in the Northeast mirrors that of the entire U.S. Human participation in outdoor activities has increased in certain categories and declined dramatically for others.

Non-consumptive outdoor recreation—feeding, photographing or observing wildlife—has seen a dramatic increase across the United States. Similar data can be identified for our 12 Northeastern states. This presents an opportunity to work with private landowners (agricultural lands being larger tracts) to increase wildlife habitat for non-consumptive use. More emphasis in this arena, not only could increase human appreciation for wildlife needs, but also increase hololistic management that can address biodiversity issues.

Similarly, the changes in hunting efforts throughout the U.S. parallel the changes in the Northeast. Unfortunately, these data appear to define the problems/changes with wildlife habitat in the Northeast. Moose, deer, wild turkey and even bear populations are on the rise in the Northeast. These species have adapted to the changing landscape and are thriving. Unfortunately, many other species, especially the traditional small game animals and many non-game species that maintain similar habitat needs have suffered severe declines. The data show declines from 60 to 75 percent for many of these species throughout their traditional range. Concomitantly, as their populations have declined, the number of hunters pursuing these species has declined. Likewise, the number of hunters pursuing our thriving big game populations has increased. This trend can be expected to continue unless there are dramatic changes in habitat conditions for small game species.

Options to Address Wildlife Needs

The primary need for agricultural wildlife in the Northeast is to protect as much existing farmland as possible because there is more wildlife habitat on farmland than the developed shopping malls and other development. There are great opportunities for wildlife agencies and groups to work with agricultural interests in the Northeast to protect and enhance both farmland and wildlife habitat.

Forests

Wildlife needs not only vary between regions, but also within regions. The New England states are about 80 percent forested and have different habitat needs from the Mid-Atlantic states, such as Maryland, Delaware and New Jersey, where there is a shortage of large contiguous forest. A program that could address wildlife needs of forested areas could be a timberland reserve program, similar to cropland reserve, to protect important habitats such as white-tailed deer winter yards or pine marten habitat. This program could be administered through the Forest Incentive Program (FIP) or Stewardship Incentive Program, where a state or federal biologist would review potential projects and make recommendations to the Department of Agriculture as to what priority should be assigned.

This program also could help address needs for forest corridors and contiguous forest tracts of the Mid-Atlantic states. Here, habitat for forest interior species appears to be declining at a rate that could have serious impacts on some migratory bird species, as well as some amphibians.

Another habitat type that is losing out is the early successional forest habitat (scrub-shrub). This habitat needs to be recognized and addressed through the FIP to provide species such as ruffed grouse (*Bonasa umbellus*), woodcock (*Philohela minor*), brown thrasher (*Toxostoma rufum*) and rufous-sided towhee (*Pipilo erythrophthalmus*).

Grasslands

Grassland habitats are in need of major attention in the Northeast. Species such as harrier (*Circus cyaneus*), Henslow's sparrow (*Passerherbulus henslowii*), vesper sparrow (*Pooecetes gramineus*), bobwhite quail and other grassland nesters are shown to be in decline. A program that focuses attention on grasslands in the Northeast is needed to address breeding habitat for these species. Particularly, grasslands of at least 50 acres are needed for Henslow's sparrow. A program that could work with landowners so that set-aside parcels could be juxtaposed to make up larger fields for these grassland nesters is needed. This habitat is needed throughout the region, including New England. DeGraaf et al. (1989) showed that forest alone had 18 species using it, as compared with areas that have two habitat types of forest and non-forest (146 species). There needs to be about a 20 percent increase in managed grassland habitat in the Northeast.

Wetland and Riparian Habitat

Along with forest habitats and wetlands, riparian habitats need additional attention, with streambank fencing and/or plantings that provide wildlife habitat and reduce sediment and nutrient loading in the streams. With the exception of Maine, the Northeast states have lost about half of the wetlands since colonial times. The restoration of 10 to 30 percent of these areas would be a realistic expectation to contribute substantially toward goals of the North American Waterfowl Management Plan. These wetlands would contribute to improved water quality, as well as any other wildlife species along with waterfowl. An expanded Wetland Reserve Program would contribute toward the goal of reversing the decline of many waterfowl populations. Riparian habitat has been shown to have bird populations up to twice that of surrounding nonriparian zones. The inclusion of riparian areas in an expanded Wetland Reserve Program also could help arrest the decline of many avian species.

Another project that is need to protect valuable wetland habitat is a cost-share program, such as an ACP project to put in beaver flowage regulators that allow the beaver flowage to be maintained at a level that does not interfere with agricultural activities. Currently, many beaver dams that could be kept, but at a lower water level, are removed by agricultural operators.

References

Brennen, L. A. 1991. How can we reverse the northern bobwhite population decline? Wildl. Soc. Bull. 19: 544–555.

Degraaf, R. M., M. Yamasaki, W. B. Leak and J. W. Lanier. 1989. New England wildlife: Management of forested habitats. Rep. NE–144, USDA For. Serv.

Horton, T. 1994. ". . . neglect reconnects us to earth." Baltimore Sun. April 16, 1994.

Leopold, A. 1949. A Sand County almanac. Oxford Univ. Press, New York, NY. 226 pp.

Smith, C. R., D. M. Pence and R. J. O'Connor. 1993. Status of neotropical migratory birds in the Northeast: A preliminary assessment. Pages 172–188 *in* Finch, D. M. and P. W. Stangel, eds., Status and Management of neotropical migratory birds. USDA For. Serv. Rept. RM–229. 422 pp.

The Northern Great Plains—Wildlife Goals and Objectives for the 1995 Farm Bill

Lloyd A. Jones
Delta Waterfowl Foundation
Bismarck, North Dakota

Arnold D. Kruse
U.S. Fish and Wildlife Service
Jamestown, North Dakota

Introduction

Farm Bill legislation has created the opportunity for significant gains in natural resource restoration, protection and management. For example, the Conservation Reserve Program (CRP), created under the 1985 Farm Bill, restored approximately 10 million acres of highly erodible cropland to grassland in the five northern Great Plains (NGP) states of North and South Dakota, Montana, Wyoming and Nebraska (Table 1). This restoration effort reduced soil erosion, improved water quality and restored high-quality wildlife habitat. With one program, in a few years, the U.S. Department of Agriculture exceeded the total, historic land restoration and protection accomplishments of wildlife agencies, by a magnitude of several times.

Ironically, where opportunities for natural resource advancement have existed through other programs, such as CRP, wildlife interests have been lax in identifying clear objectives for wildlife population and habitat needs. A general position often is "we'll take all we can get," or "we need all that they'll give us." In today's world of greater public awareness, understanding and demands for greater accountability, those types of responses no longer are defensible. We must advance the scientific profession of wildlife management to have clear goals, objectives and a high level of accountability.

Wildlife professionals from the NGPs were convened to establish goals and objectives for wildlife and the opportunities to accomplish those goals under the 1995 Farm Bill. Those professionals, in their respective areas of expertise were: *big game*—Jeffrey Herbert, Montana Fish, Wildlife and Parks; *non-game*—Doug Johnson, National Biological Service, and Randy Kreil, North Dakota Game and Fish; *prairie*

Table 1. The acreage of highly erodible cropland and CRP in the five northern Great Plains states.

State	Highly erodible cropland	CRP
Montana	9,505,900	2,815,032
Nebraska	6,059,700	1,395,761
North Dakota	4,625,200	3,169,988
South Dakota	2,311,800	2,099,595
Wyoming	1,132,100	257,022
Total	23,634,700	9,737,388

grouse—Jerry Kobriger, North Dakota Game and Fish; *waterfowl/wetland birds*—Robert Meeks, Ducks Unlimited, and Ron Renyolds, U.S. Fish and Wildlife Service; *pheasants*—Steve Riley, South Dakota Game, Fish and Parks, and Ken Solomon, Pheasants Forever; *fisheries*—Dennis Unkenholz, South Dakota Game, Fish and Parks; *gray partridge*—John Schultz, North Dakota Game and Fish; and *raptors*—Robert Murphy, U.S. Fish and Wildlife Service. This report was compiled with the assistance of these highly qualified individuals.

Current Status

Prior to settlement, the northcentral plains region was primarily a grassland-dominated ecosystem. Tallgrass prairie vegetation in the eastern portion changes into mixed grass, then to shortgrass prairie in the western portion of the region. Riparian areas and some wetland basins where characterized by patches of brush and woody vegetation. Large forested tracts mostly were restricted to certain geological areas, such as the Black Hills in South Dakota and Wyoming.

Vegetation in the grassland areas constantly was undergoing successional change due to frequent natural events, such as fire, drought, grazing by wild ungulates and the severe winter climate. These factors created a diverse landscape dominated by a mix of grasses and forbs, and interspersed with woody draws and riparian zones.

The most recent glacier created the Prairie Potholes, an area with a high density of isolated wetlands interspersed among the tall- and mixed grass prairies. The Prairie Pothole Region comprises approximately 300,000 square miles of the NGP in the United States and Canada. This region is one of the most ecologically rich areas in the world. Its unique combination of habitats supported the evolution of a great diversity of ground-nesting wildlife, particularly migratory birds. The Potholes are the most important breeding ground for waterfowl in North America. All states in the region had wetlands that provided important migration habitat for ducks, geese and other wetland birds.

Since settlement of the NGP, agriculture activities have impacted the landscape more than any other factor. In the eastern portion of the Dakotas and Nebraska, less than 1 percent of the tallgrass prairie remains. In this region, two-thirds of the mixed grass prairie and 20 percent of the shortgrass prairie has been lost. Conversion to cropland and intense grazing pressure have fragmented the remaining shortgrass prairie and reduced the structure and quality of its vegetative cover. In North Dakota, more than 60 percent of the original grasslands has been converted to annual crop production. Of those grasslands remaining, about 95 percent are intensively grazed or hayed annually for forage.

The conversion of native prairie continues today. USDA's 1992 National Resources Inventory estimated that, between 1982 and 1992, 3 million acres of native grassland (rangeland) were lost, presumably to cropland. At least another 20.3 million acres have medium to high potential for conversion to cropland in the next 10 years.

Agricultural activity also has drained and degraded wetlands. Nearly half of the original wetlands in the Prairie Pothole region have been drained for planting to small grains. Of those wetlands remaining, most are cropped when weather permits, or are otherwise negatively impacted by agricultural practices that cause sedimentation, reduce wetland vegetation, and add chemicals and fertilizers. Runoff from unprotected cropland is filling many wetlands with silt.

Farther west, sagebrush, an important shrub to numerous species of prairie wildlife, most notably sage grouse, has been altered or eliminated on at least 10 percent of its range.

Surface water constitutes approximately 4.6 million acres of this five-state region. Aquatic resources are threatened by drainage, development, siltation, channelization, dams, levees, increased water temperature, riparian habitat loss, degraded water quality and decreased water quantity. However, the single largest issue facing fish managers is decline in water quality caused by non-point source pollution. The long-term security of fisheries is dependent on long-term protection and enhancement of water quality.

Many lakes have become degraded over the years due to nutrient enrichment, siltation and/or loss of sufficient inflow due to water depletions. Nutrient enrichment and siltation ultimately shorten the lives of lakes and reservoirs.

In summary, the NGP is one of the most ecologically altered regions in the country.

Wildlife Impacts

The combined losses of wetland, grassland and aquatic habitats have resulted in reduced populations of many prairie wildlife species.

Extensive grassland conversion in the Prairie Pothole region is primarily responsible for the substantial decrease in populations of pintail, mallard and blue-winged teal. Although this region comprises only 10 percent of the available waterfowl nesting habitat in North America, it provides more than 50 percent of the waterfowl production in an average year and a greater amount in years with good water conditions.

Several species of ducks have declined sharply between 1970 and 1985, and currently are below population goals of the North American Waterfowl Management Plan (NAWMP). The percentage of upland nesting ducks (e.g., mallards, pintails, blue-winged teal) able to nest successfully is too low for many populations to sustain themselves because nests located in small fragments of grass scattered among cropland are vulnerable to predators. In addition, the survival rates of the small portion of upland-nesting duck broods that do hatch are decreased.

Because of drainage and degradation of wetlands, diving ducks and other birds that nest in the wetlands are declining in this region (Table 2). During 1966–1991, wetland-nesting species in this region showed the highest percentage of species with decreasing populations compared with other regions in the U.S.

Pheasant and gray partridge are the most important game birds in this region. Populations of both fluctuate dramatically with the amount, extent and distribution of cropland and cropland retirement programs. The Soil Bank, which retired cropland in the 1950s to early 1960s, resulted in dramatic increases in pheasants and partridges. When that program expired, populations quickly plummeted. Similar population surges currently are being experienced by both species due to CRP.

Of all North American birds, those that occupy grasslands throughout the Great Plains are experiencing the steepest, most consistent and most widespread declines (Table 3). Approximately 83 percent of these species have decreasing population trends from 1966 to 1993. The lark bunting and grasshopper sparrow, for example, declined by about half during that period. Conversion of perennial grassland to annually tilled cropland is the dominant factor causing these declines.

Table 2. Wetland bird species which showed negative average annual change greater than 1 percent in North Dakota, 1966–86.

Species	Percentage Annual Change
Western grebe	–31.3
Pied-billed grebe	–9.1**
California gull	–5.0*
Ring-billed gull	–10.6***
Franklins gull	–6.9
Black tern	–7.1
American bittern	–1.2
Black-crowned night heron	–4.3***
Virginia rail	–1.4*
Sora rail	–1.2
American coot	–4.5
Wilson's phalarope	–5.6***

$^*P = 0.10$, $^{**}P = 0.05$, $^{***}P = 0.01$

As top food chain consumers, raptors are considered excellent biological indicators. They generally require large areas of habitat with an adequate prey base. Because of their sensitivity to environmental perturbation, raptors are over-represented among vertebrates on lists of endangered and threatened species. Agriculture has profoundly reduced the quantity and quality of habitats and, hence, populations of several species of raptors in the NGP.

In NGP states, at least 28 species of raptors nest, 8 of which are nearly endemic to the Great Plains or depend on this region for most of their breeding habitat in North America. Five of these eight ''prairie raptors'' are listed as endangered, threatened or candidate species by the U.S. Fish and Wildlife Service (FWS) or NGPs states. Another, the northern harrier, is a FWS ''species of special management concern,'' due mainly to vulnerability of its habitat. All NGP states consider the burrowing owl to be a species of special concern.

Prairie grouse (sharp-tailed grouse, sage grouse and greater prairie chickens) once were commonplace and reached peak abundance prior to 1930. Prairie grouse numbers

Table 3. Estimated change in breeding pairs, in North Dakota, with CRP converted cropland.

Species	Trend	Percentage change in population if all CRP returned to cropland[a]
Lark bunting	-4.22	–17.0
Grasshopper sparrow	–4.58	–20.5
Savannah sparrow	+0.63	–18.8
Western meadowlark	–0.34	-5.1
Bobolink	–2.74	–10.7
Clay-colored sparrow	–2.08	–9.1
Common yellowthroat	–0.32	–9.3
Dickcissel	–1.44	–17.1
Sedge wren	–0.97	–25.8
Baird's sparrow	–2.58	–3.6

[a]Percentage change per year from Breeding Bird Survey.

are governed by the amount and distribution of native mixed prairie grasslands. In Nebraska, from 1965 to 1978, acres of land in irrigated cropland increased more than 800 percent, and nearly 85 percent of those acres came from grassland that had supported prairie grouse. Consequently, the breeding range of both species has been greatly restricted and populations of both species are much below those prior to 1930.

Eradication of large areas of sagebrush have resulted in decreases and sometimes elimination of sage grouse. When sagebrush cover drops below 5 percent, sage grouse no longer use those areas for nesting.

Generally, fish populations mirror long-term trends in habitat quality. Thus, degraded water quality and habitat have reduced or eliminated native species, produced fish populations of less desirable species and caused fisheries managers to rely on hatchery stocks to maintain populations and sport fisheries. In addition, more and more fish species are becoming threatened and endangered.

Wildlife Goals

The conservation provisions of the 1985 Farm Bill provided a unique and unprecedented opportunity to advance the accomplishment of wildlife goals. A prerequisite, however, is having identified wildlife goals, which, to this point, have not been developed for the habitat opportunities within the Farm Bill. The following are goals for the various groups of wildlife addressed in this report.

Waterfowl

Goal: A breeding population in the Prairie Pothole region of the NGP of 6.8 million ducks, and an autumn flight of 13.6 million ducks.

Other Wetland Birds

Goal: Reverse the declines sufficient to achieve a positive ten-year average change that equals or exceeds the long-term average annual decline.

Gray Partridge

Goal: Since population estimates for gray partridge are not available, a total desired harvest level of 410,000 birds per year is the benchmark for gray partridge restoration (Table 4).

Pheasants

Goal: A peak annual population totalling 21 million pheasants in the five-state region (Table 4).

Prairie Grouse

Goal: Maintain a total population sufficient to sustain an annual harvest of 500,000 birds (Table 4).

Raptors

Goal: Stabilize and restore raptor populations sufficient to remove them from sensitive, threatened or endangered status.

Table 4. Goals for gray partridge, pheasants and prairie grouse in the northern Great Plains.

State	Gray partridge harvest	Pheasant population	Prairie grouse harvest
North Dakota	200,000	2,500,000	180,000
Montana	100,000	1,500,000	85,000
South Dakota	85,000	10,000,000	104,000
Nebraska	20,000	6,000,000	69,200
Wyoming	5,000	1,000,000	69,600
Total	410,000	21,000,000	507,800

Nongame Birds

Goal: Restore and maintain populations equal to the average population indicated by the 1966–68 FWS Breeding Bird Survey.

Fisheries

Goal: Enable individual states to achieve established fisheries objectives in the Northern Great Plains.

Big Game

Goal: Provide sufficient habitat for individual states to achieve established big game management objectives in the Northern Great Plains.

Habitat Needs

The following assessment estimates habitats needed to meet the previously identified goals. These habitat estimates are relative to baseline conditions in 1985, before CRP was implemented.

CRP converted more than 9 million acres of cropland to relatively undisturbed grass and wetland cover in the NGP. This cover is highly attractive to and productive of wildlife. Nesting intensity and success for a wide array of birds are higher than that recorded on those acres prior to CRP. CRP is the single most important large-scale land-use change to positively influence bird productivity ever developed and implemented.

Wildlife biologists project that, to accomplish wildlife goals, considering the existing 1985 land-use conditions, a total of 15 million acres of cropland need to be converted to undisturbed grass cover in the NGP. This acreage would require, for example, that the current 9.7 million CRP acres be continued and supplemented, by some means, with an additional 5.3 million acres of undisturbed grass cover (Figure 1). Undisturbed grass cover is defined as ''previous cropland restored to grassland that receives manipulation only for identified wildlife management purposes.'' The breakdown of treatment practices in short-, mid- and long-term duration is shown in Table 5.

Grassland Objectives

- Stop the conversion of remaining native prairie rangeland to cropland.

Table 5. Program description for 15 million (M) acreage goal in the northern Great Plains.

Program	Description	Percentage of total	Total
Short-term	3–10 years	20	3M
Mid-term	10–20 years	70	10.5M
Long-term	more than 20 years	10	1.5M
Total			15M

- Improve the vegetative structure of native prairie rangeland to foster suitable nesting cover. Grassland with an average visual obstruction reading of 6 inches or greater will provide adequate nesting and brooding habitat.
- Restore 8 million acres of grassland in the Prairie Pothole region, especially in association with abundant, functional wetland complexes. One million acres are needed in the Prairie Pothole region of Montana, 4.25 million acres in North Dakota and 2.75 million acres in South Dakota.
- Restore 5.5 million acres of undisturbed grass/forb cover within the pheasant range.
- Restore 1 million acres of undisturbed grass/form cover in the eastern and southern portions of the Nebraska sandhills.
- Restore 50,000 acres of undisturbed grass/forb cover in eastern Wyoming.
- Restore 1.5 million acres of undisturbed grass/forb cover throughout the remaining areas not already delineated.
- Discourage reduction of sagebrush where live sagebrush crown cover is less than 20 percent, or on steep upper slopes where big sagebrush is 12 inches or less in height.

Wetland Objectives

- Protect all remaining wetlands—including small, temporary wetlands—from drainage or filling by sedimentation.
- Restore or create 600,000 acres (approximately 10 percent of the wetland acreage previously drained) of temporary, seasonal and semi-permanent wetlands in the Prairie Pothole region within areas of secure nesting habitat.

Riparian/Aquatic Areas Objectives

- Continue to promote no-till and minimum till.
- Eliminate or reduce summer fallow.
- Improve riparian zone management by developing filter strips and protecting existing habitat and permanent cover around wetlands and waterways.
- Minimize or control livestock access to shoreline areas.

Summary

The profession of wildlife management has taken a large step forward with this effort to describe wildlife goals and objectives. The probability of success is increased, the ability to evaluate progress is improved and the level of accountability is elevated.

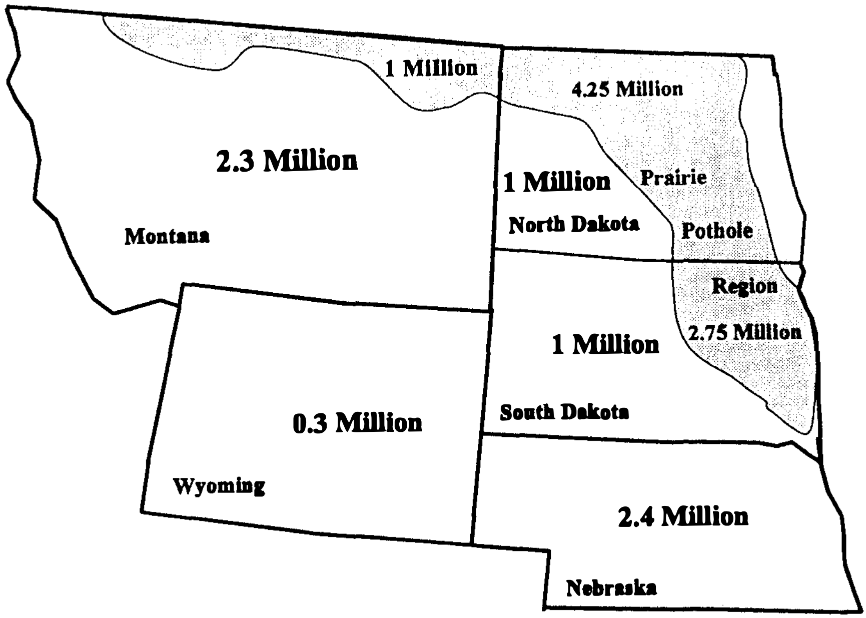


Figure 1. Desired location of 15,000,000 acres of undisturbed vegetation in the northern Great Plains.

For the NGP, wildlife goals are established and the best available information and professional judgment are that 15 million acres of cropland restored to undisturbed grassland is needed to accomplish these wildlife goals. This is an increase of 5.3 million acres in various duration programs in the NGP over what currently is being provided by CRP. The prerequisite of maintaining pre-farm bill existing habitat conditions, such as with native prairie and the restoration of wetlands, is an essential component of this process. The benefits to society are far reaching, both in environmental and financial considerations. For example, with pheasants reaching the goal population, economic activity would increase from the current $80 million annually to an estimated $140 million annually in the NGP states. Environmentally, numerous wildlife species would improve in population status, and benefits would help certain species avoid the ''train wreck'' of conflict from becoming listed as endangered or as species of special management concern.

Agricultural development has been the primary cause of habitat loss and the current troubling status of many wildlife populations in the NGP. However, contrary to many ecosystems throughout the world that have been degraded, the NGP is a region where recovery is attainable. What agriculture has done in terms of development and subsequent environmental impact, it has shown it can successfully restore, as is evident by the restoration of cropland to grassland in the NGP and the significant benefits that CRP has provided. With established wildlife goals and objectives, the probability of that success continuing certainly is much greater.

Wildlife Needs of the Southern Great Plains[1] for the 1995 Farm Bill Discussions

Charles D. Lee
Kansas Department of Wildlife and Parks
Manhattan

Statement of Problem

In the southern Great Plains (SGP), intensive agriculture has altered the landscape. These changes first became apparent in the mid 1900s and intensified in the 1960s. The conversion of habitats by agriculture and industry, reliance on pesticides, expansion of exotic plant species, and advancements in agricultural technology (i.e., sprinkler irrigation and new pesticides), accelerate landscape change. As a result of such change, many wildlife populations have declined or suffered range reductions to the point of the species becoming threatened or endangered, or even extirpated. Most wildlife species which are habitat specialists in grasslands, those that cannot adapt to edge or fragmented habitat, have exhibited population declines. Data from the Breeding Bird Survey (1966–89) suggest the greatest decline of bird populations is in the shortgrass prairie obligate species. Lesser prairie chicken (*Tympanuchus pallidicinctus*), grasshopper sparrow (*Ammodramus savannarum*), loggerhead shrike (*Lanius ludovicianus*) and mountain plover (*Charadrius montanus*) are some grassland specialists that exhibit rapidly declining trends.

Wildlife benefits will be lost when many Conservation Reserve Program (CRP) contracts are returned to cropland. Ring-necked pheasant (*Phasianus colchicus*) populations, once very dynamic, have remained relatively stable due to the improved winter cover and improved nesting habitat. CRP has improved for meadowlarks (*Sturnella magna*) in much of the range. White-tailed deer (*Odocoileus virginianus*) have expanded in range. Wetlands created on CRP lands have provided benefits for waterfowl, shorebirds, small mammals, reptiles and amphibians. Loss of such lands will result in dramatic reductions of what is mostly excellent habitat. Despite important gains by the CRP, wind erosion can be a significant factor reducing soil, air and water quality in the SGP. The 1992 National Resources Inventory (NRI) showed the SGP still is losing more than 7.2 tons per acre per year (16.25 metric tons/ha) of soil to wind erosion.

More than 11 million acres (4.4 million ha) of wetlands have been lost in the five-state area during the last 200 years. The loss of acreage and the decreased quality of existing wetlands and associated upland buffers in areas such as, but not limited to, playas or seasonal depressional wetlands, saline lakes and riparian corridors, results in declining wildlife populations, decreased water quality and increased flooding. The North American Waterfowl Management Plan lists loss and degradation of habitat as the major waterfowl management problem in North America. The Playa Lake Joint Venture reports protection and improvement of playas is vital to ensure the continued

[1]Kansas, Oklahoma, Colorado, Texas and New Mexico

accommodation of waterfowl overwintering in, migrating through and breeding in the region.

Aquatic communities have been altered. Pollutants, including pesticides, nutrients and soil particles, have caused major habitat losses in both streams and impoundments. Watershed dam construction continues to compromise the integrity of many streams through altered stream flows and the blocking of fish movements. Improper disposal of agricultural wastes has impaired streams and reservoirs, and caused numerous fish kills.

Annual commodity programs and the resultant set-aside requirements result in a planning horizon that is too short for effective total resource management. The number of different conservation programs and their complexity leads to landowner and resource professional frustrations and general inefficiency. Current conservation programs seem to provide some disincentives for wildlife management. For example, payments to a project from entities other than the landowner may be considered as ineligible contributions, and some county offices charge fees for inspection of wildlife food plots.

Suppression of fire and chronic overgrazing of domestic livestock has decreased the value of rangelands. Invasion of woody species such as junipers (*Juniperus* spp.) in native rangeland, particularly in the southern portion of this region leads to increasing pesticide use and alteration of native ecosystems.

Desired Future Conditions

Approximately 95 percent of the SGP land is privately owned. Current land stewardship is not sufficient to reverse the decline in some wildlife species. Federal farm policy is a significant factor influencing land stewardship. Excess cropland requires the conversion of cropland into a long-term land retirement program that could include easements. Some cropland management practices negatively impact wildlife in certain sensitive areas. Reduction of cropland acres and conversion to permanent native vegetation will improve wildlife habitat. An estimate of 9 million acres in a long-term land retirement program is needed to reverse some of these declining wildlife population trends. Three million acres in short-term programs will be necessary. Future improved conditions should rely on grassland habitats that mimic historical conditions. Current revegetation plans generally lack diversity in plant form and growth characteristics. No new acres of exotic grass are needed. Additionally, exotic grass removal and establishment of native species should be encouraged.

Native vegetation is being converted at a rapid rate. The NRI shows the loss of almost 5 million acres (2.0 million ha) of rangeland in SGP since 1982. This has led to the reduction and fragmentation of native habitats. Protection of current biological diversity and species of special concern should receive some priority. Grassland wildlife is limited by quality and extent of native grasslands. About 90 million acres of well-managed rangeland would be enough to reverse the declining trend in grassland wildlife species.

Future farm policy needs to increase quantity and quality of wetlands. "Dewatering," alteration, degradation, vegetation destruction and sedimentation of wetlands still occurs, despite current wetland protection strategies. In the SGP, restoration of 250,000 acres of wetland on private lands needs to occur. Wetlands require 500,000 acres of upland as buffers on borders (which is a 2:1 managed buffer area). Attention must be focused on state-defined priority wetland areas. The Playa Lakes Joint Venture Region, Cheyenne Bottoms (a wetland of international importance), Lake Ria Blanca, Cactus Lake and Hackberry Flats are such areas.

The total acreage of woodlands has remained static over the last ten years, however, overall quality of the woodlands has declined. Improvements in the location and management of woodlands would provide additional environmental benefits. Generally, a lack of economic incentives to prevent conversion and degradation of such areas has led to decreased quality of woodlands. Although acreage of specific types of woodlands is difficult to determine, about 1.5 million acres in hardwoods and 130,000 acres in shelterbelts are needed to maintain woodland species. Riparian areas are among the regions most vulnerable. Permanent aquatic ecosystems will benefit from the management of such woodlands and riparian areas. Current degradation of rivers, streams, impoundments and associated riparian habitats has decreased water quality and reduced value to wildlife. Increased quality of riparian areas on the 14,000 miles of streams in the region would improve water quality and increase impoundment life. Filter strips 100 feet in width would assure some water-quality improvements and improve wildlife benefits by providing habitat corridors and linkages.

Strategies

Modification of existing programs seems to be an easy manner to achieve the desired conditions. Some common programs and the recommended changes are listed below.

Conservation Compliance

Wind and water erosion compliance should be monitored during all seasons. Require best management practices for wildlife habitat as part of conservation compliance.

Conservation Reserve Program

Wildlife should be considered equally as important as soil and water conservation objectives. Prepare priority ranking criteria for re-enrollment or new contracts. Criteria should include wildlife benefits provided, type of vegetative cover, percentage of county in cropland, association with wetlands and land erodibility. Allow extension of most contracts. Allow partial field enrollments for such areas as grass-backed terraces, field borders, contour grass strips, windstrips, waterways or conservation headlands. Promote accepted habitat management practices such as grazing, burning, mowing, food plots, woody vegetation and strip discing, as approved by the State Technical Committee. Remove county acreage cap limitations. Limit mandatory weed control to state-listed noxious weeds. Allow critical or environmentally sensitive area enrollments, such as playas, riparian corridors and native prairies, to receive priority. Allow emergency haying and grazing only upon approval by State Technical Committee, not to exceed 25 percent of CRP acres in any one county and no more than once per year. Promote use of conservation practices (CPs) that improve wildlife habitat. Do not allow exotic grasses for any new contracts. Promote vegetative diversity in plantings. Develop incentive programs to encourage retention of permanent vegetation after contracts expire.

Water Quality Improvement Program

Carry out the program.

Stewardship Incentive Program/Forest Incentive Program

Increase funding. Remove acreage limitation for eligibility. Alter fencing regulations to provide payment for modifications to meet wildlife needs.

Agriculture Conservation Programs and Great Plains Contracts

Require 50 percent of program dollars for non-structural developments that benefit wildlife. Require native vegetation to be planted. Do not fund level terraces.

Acreage Conservation Reserve

Extend planning horizon to promote multi-year set-aside. allow natural vegetation as acceptable cover. Limit mandatory weed control to state-listed noxious weeds.

Wetland Reserve Program and Water Bank

Implement the programs in all states. Increase the percentage of upland area as a buffer strip (use a 2:1 ratio). Offer long-term easements, including perpetual and shorter-term easements with reduction of payment.

New programs also could be designed to achieve the desired conditions for the future. Such programs would rely on coordination by the State Technical Committees to assure total resource management. States should be given the flexibility to modify programs to meet state or local needs. Develop funding sources for conservation programs by taxing farm machinery, fertilizer, pesticides, etc. Limit lands eligible to participate in USDA crop programs to those lands that were cropped, or considered cropped, on January 1, 1995.

Total Farm Management Program

Provide ''Green Payments'' for achievement of ecosystem management plans. Such payments would not be tied to ''base acres,'' but could include payments for moist soil management or total farm wildlife habitat improvements. These payments would be distributed if a certain wildlife criteria standard had been met. The program is not to replace existing program payments. Allow payments for implementation of best management practices on former CRP lands to maintain environmental benefits. Develop resource stewardship plans that combine all conservation programs. Implement and fund mandatory, multidisciplinary (state wildlife agencies included) State Technical Committees. Exempt such committees from the Federal Advisory Committee Act. Require concurrence on decisions.

Riparian Corridor Program

Provide incentives for protection, enhancement and management of riparian areas.

Wildlife Conservation Reserve Program

Provide payments for acreage specifically managed for wildlife.

Social Benefits

Meeting wildlife objectives will mean reducing cropland on marginal lands and returning them to uncultivated land uses, maintaining and improving existing native habitats, and maintaining and improving CRP acres. Reduction in crop subsidy payments should provide funds that could be available for conservation purposes. Long-term economic benefits should be achieved when crop production is maintained on highly productive land. It is less expensive to maintain natural systems than it is to alter and maintain artificial systems. Improved water quality will result with application of the proposed desired conditions. Permanent native vegetation slows water flows and traps sediments and pollutants. Buffer areas, such as field borders, around each cropfield will greatly reduce the pollutant load of our aquatic ecosystem. Improved air quality will result with the planting of native vegetation. Wind erosion on cropland results in increased sediment loads in aquatic systems, increased crop disaster payments, and increased health and safety concerns. Wind strips provide excellent wildlife habitat and improve crop yields. Increased wildlife populations are the result of improved habitat conditions. Hunting, fishing, wildlife observation, photography and other related recreational opportunities will be enhanced.

Ecosystem stabilization values result from maintaining species numbers and diversity. Recovery of threatened and endangered species is a high-risk and high-cost program.

Increased quantity and quality of wetlands provide public benefits that include economic, health, aesthetic and educational opportunities. Reduced flooding and decreased erosion will improve water quality. Wetlands have values of augmenting or providing wastewater treatment and increase wildlife habitat.

Acknowledgments

Randy Clark, Kansas Department of Wildlife and Parks; Gene T. Miller, Texas Parks and Wildlife; Ron Klataske, National Audubon Society; Bruce Morrison, New Mexico Game and Fish; Roger Wells, Quail Unlimited; Terry Riley, Wildlife Management Institute; Connie Shreiner, Kansas Department of Wildlife and Parks; Rod Smith, Oklahoma Department of Wildlife Conservation; Don Wilson, Texas Parks and Wildlife; and Jim Ray, Texas Parks and Wildlife.

Agriculture/Wildlife Relationships in the Western Region[1]

Marc Liverman
Oregon Department of Fish and Wildlife
Portland

Tom Hemker
Idaho Department of Fish and Game
Boise

Western Agriculture

Agriculture is the primary use of most western lands not administered by the federal government. More than 182 million acres (40 percent) of the total mainland area (excluding Alaska and Hawaii) are affected, including 95 million acres of grazing land, 54 million acres of woodlands and 33 million acres of cropland (U.S. Department of Agriculture [USDA] 1989). Physiographic diversity and lack of water preclude crop production on all but the most fertile, well-watered sites.

Characteristics of farms in the Western Region mainland have changed dramatically over time (Haystead and Fite 1955, Bureau of the Census 1994). The number of farms in the region grew from 40,900 in 1870 to 347,700 in 1930, then declined to 185,200 farms in 1992. During the same period, the average size of western farms grew from 200 acres to a peak of 1,800 acres in 1959, and decreased to an average size of 1,600 acres. Development of irrigation technology and reclamation projects played a crucial role in this process. More than 121,000 western farms and 16.7 million acres of farmland were irrigated in 1992, approximately half of all western cropland.

Agriculture/Wildlife Relationships

The great diversity of agricultural practices and wildlife species found in the Western Region limit generalities about their interrelationships. Nonetheless, conditions in Oregon offer some insight into region-wide concerns. Like other western states, most of Oregon's land base is managed by federal agencies, agriculture is the primary non-federal land use and livestock grazing is the most widespread agricultural activity.

Of 639 wildlife species that regularly are found in Oregon, 543 (85 percent) meet part or all of their habitat needs on private agricultural lands. Grazing lands (including rangeland, native pasture and grazable woodlands) are the primary habitat for 134 species (25 percent). Many species occurring on agricultural lands are the focus of intensive management attention. These include species designated as game or furbearers (96), species on state lists of sensitive, threatened or endangered species

[1]Includes: Alaska, Arizona, California, Hawaii, Idaho, Oregon, Nevada, Utah and Washington.

(91), and on federal lists of candidate, threatened or endangered species (54) (Oregon Department of Fish and Wildlife [ODFW] 1993). The quality of data used to support state-listing of species as sensitive varies, but forestry and farming practices, stream barriers, livestock grazing and wetland loss are among the most frequently cited causes (ODFW 1993).

Because rangeland is the most widespread agricultural land use in the West, non-federal rangeland conditions provide another important sign of agriculture/wildlife relationships. Throughout the mainland Western Region, the former Soil Conservation Service (SCS) estimated that only 19.0 million acres (24.4 percent) of the non-federal rangeland was "adequately protected" to sustain productive uses, 50.6 million acres (65 percent) "needed treatment" to conserve soil and water resources, and 8.2 million acres (11 percent) were so degraded that cost-effective treatments were judged to be "not feasible."

Water-quality data provide another indication of the impact that agriculture has on wildlife in Oregon. Oregon's rivers have been rated for their ability to support beneficial uses, including maintenance of fish and wildlife populations (Oregon Department of Environmental Quality 1992). Beneficial uses were found to be "fully supported" on only 43 percent of the river miles sampled in Oregon, "partially supported" on 27 percent and "not supported" on the remainder. The severity and relative contribution of agricultural practices compared with other nonpoint pollution sources are not precisely known. However, range, agriculture and forestry practices were named as suspected contributors to poor water quality for 36 percent more stream miles statewide than all other sources of nonpoint pollution combined.

Oregon had lost almost 1.4 million acres (38 percent) of its original wetlands as of the 1980s, a process primarily associated with clearing and draining of wetlands for agriculture (National Wildlife Federation 1987). Because wetlands have high habitat values for many species and play an important role in critical ecological processes, their loss represents an enormous toll on wildlife. Several western states have lost a greater proportion of original wetlands than Oregon, and the mainland Western Region as a whole has lost more than 4.6 million acres, 61 percent of its original wetland area.

Only 120 of more than 400 stocks of anadromous fish in the Northwest and California are secure, 214 are considered "at risk," and 106 are extinct (Nehlsen et al. 1991). In March 1994, four stocks were federally listed as threatened or endangered. Economic consequences of decline have been severe (Pacific Fisheries Management Council 1994). In 1993, the total personal income value of commercial salmon harvest for coastal communities was barely $14 million compared with a multi-year average of $75 million for the years 1976–1992. The 1993 recreational salmon harvest provided those same communities with $22 million in 1993, down from the 1976–1992 multi-year average of $39 million. In 1994, large areas of the coast were closed entirely to ocean salmon fishing and other areas faced severe fishing season limitations. Although agriculture was only one factor influencing the decline of this fishery, improved agricultural practices can make an important contribution to salmon restoration.

Data on the impact that agriculture has on participation in wildlife-associated recreation overall are unavailable. We do know, however, that more than 32 million people over the age of 16 (55 percent) participated in wildlife-associated recreation in the Western Region in 1991, and that they spent more than $10 billion while doing so (U.S. Fish and Wildlife Service 1992).

Desired Future Conditions

The desired future condition for wildlife habitat in agricultural landscapes in the Western Region is a diverse landscape ranging from urban-industrial-croplands to ecologically viable wildland preserves interspersed among spacious multiple-use zones. Achieving this condition requires a shift in management away from fragmentation of landscapes and toward balanced regard for ecological, social and economic factors. Management intensity largely will determine where agricultural uses fit into this landscape. Croplands tend to be more single-use or industrial in focus, while range and woodlands are compatible with many wildlife habitat values.

Rangeland

General goals of future rangeland management include maintenance or restoration of soil stability and watershed function (National Research Council 1994). Achieving these conditions will reduce bare soil and soil movement, stabilize old erosion areas, conserve native plant communities, restrict closely cropped or high-impact conditions to small areas necessary for corrals, water crossings and other special management situations.

Recommendations. Promote rangeland management that increases grazing unit and landscape-level diversity. This includes use of ecologically appropriate stocking levels and grazing systems, range development as necessary for site-specific resource protection, and re-evaluation of grazing suitability in areas at high risk of resource damage and with poor recovery potential.

Examples of priority rangeland habitats include: riparian areas region-wide; native grassland and prairies (all types); alkali sink scrub in California, the Snake River Plain in Idaho, and Palouse and shrub steppe habitats in Idaho, Oregon and Washington. Target species and population goals include: maintenance of kit fox, long-billed curlew and waterfowl; reversing the decline of desert fish, burrowing owl, ring-necked pheasant, sage grouse, Columbian sharp-tailed grouse, loggerhead shrike, willow flycatcher, yellow warbler, lark sparrow, western meadowlark and pygmy rabbit; and increasing populations of beaver and river otter.

Farm Bill habitat needs. (1) Provide incentives to protect 870,000 acres of rangeland riparian areas. (2) Provide incentives to improve the condition of 1.5 million acres damaged by overgrazing. (3) Establish or maintain 3.5 million acres of relatively undisturbed grassland in blocks of at least 80 acres in the range of sage and Columbian sharp-tailed grouse and nesting waterfowl.

Cropland

Goals for sustainable cropland systems to optimize wildlife benefits include tighter cycling of nutrients, lower inputs of energy and materials, larger habitat units, and restoration of aquatic systems adversely impacted by crop production (Barrett et al. 1990). The Conservation Reserve Program (CRP) is an example of a specific program that plays a critical role in reducing big game damage complaints by private landowners and maintaining viable populations of Columbian sharp-tailed grouse in Idaho and Oregon. Idaho has the largest existing population and they are being used for reestablishing populations in other states.

Recommendations. Promote cropping practices that increase field and landscape diversity, hold soil and build soil quality, maintain continuous vegetative cover, and adjust nutrient input to match crop requirements and reduce weeds and pests. Key practices include multiple cropping, minimum tillage, agroforestry, integration with animal husbandry systems and integrated pest management (Rodenhouse et al. 1992, Gard et al. 1992, Stiner and Blair 1990). Irrigation practices that better meet the needs of aquatic ecosystems will provide a minimum quantity, quality and timing of in-stream flows; remove and prevent obstructions to fish passage; and prevent entrainment of fish into intake systems.

Priority cropland habitats located region-wide include prime pheasant range and ''aquatic biological hotspots'' that provide crucial fish spawning and rearing habitat for Pacific salmonids and native trout, spotted frog, Preble's shrew, and other species. The population goals are to increase pheasant populations and generally reverse the decline of aquatic species.

Farm Bill needs: (1) Re-authorize existing Conservation Reserve Program acreage that benefits sage and Columbian sharp-tailed grouse. (2) Provide incentives to establish at least three 10-acre blocks of multi-year (five-year minimum) permanent cover per section. Develop 1.5 miles of strip cover per section to allow better wildlife movement between cover blocks. (3) Provide incentives and easements to implement 27,300 miles riparian filter strips associated with ''biological hotspots.'' (4) Provide incentives and easements to restore and protect 1 million acres of small, cropland floodplains in ''aquatic biological hotspots.'' (5) Install 7,500 fish screens on irrigation intakes. (6) Remove 600 fish passage obstructions.

Woodland

Wildlife habitat goals for woodland management include greater representation of early, late and old growth seral stages, mixed tree species, multi-storied canopies, retention of dead and downed material, and fewer habitat fragmenting and eroding roads.

Recommendations. Promote silvicultural methods that increase stand and landscape-level diversity through development of uneven age stands, longer rotations, reforestation with mixed conifer and hardwood species, fewer stand entries, reduced chemical use, and an appropriate blend of permanent and temporary forest roads (see Thompson et al. 1992).

Priority woodland habitats include coastal redwoods in California, tropical forests in Hawaii, the Clearwater Basin in Idaho, and mature and old-growth conifer in Oregon and Washington. Target species and population goals include maintenance of Cooper's hawk and northern oriole, and reversing the decline of Pacific-slope flycatcher, western wood peewee, Bell's vireo, yellow-billed cuckoo, yellow-breasted chat, apapane, elepaio and omao (Hawaiian thrush).

Farm Bill needs. (1) Provide incentives to restore/maintain mature forest conditions on 2.7 million acres of upland forests. (2) Provide incentives to restore/maintain mature forest conditions on 600,000 acres for forested riparian areas on fish-bearing streams. (3) Provide a demonstration of sustainable, tropical agroforestry in Hawaii.

Wetlands and Aquatic Habitats

These areas are highly variable in size and complexity. Yet, the wildlife goal simply is the timely recovery and maintenance of functional wetland and aquatic habitat characteristics in agricultural areas. These include normal channel variability, stable streambanks, corridors of natural streambank vegetation, reduced sediment loads and, in wooded riparian areas, abundant instream large woody debris.

Recommendations. Promote site-specific treatments that restore habitat functions. For rangelands, these may include riparian pastures, special grazing systems or nonuse. For croplands, filter strips, areas of minimal vegetation management and drainage systems removal may be necessary. For woodlands, special riparian/wetland management areas with standards for canopy retention and limitations on ground-disturbing activities are called for. Areas with specific localized problems may require active restoration.

Examples of priority wetland-riparian areas include cienegas (marshes) in Arizona, coastal and Central Valley wetlands in California, inland wetlands and brackish ponds in Hawaii, low elevation wetlands in Idaho, riverine wetlands in Nevada, and freshwater and Coos Bay wetlands in Oregon. Target species and population goals include: maintenance of white pelican, white-faced ibis, sandhill crane and waterfowl; reversing the decline of clapper rails and Hawaiian gallinule; and improved numbers of wintering waterfowl in California's Central Valley.

Farm Bill needs. (1) Reauthorization of Wetland Reserve and Water Bank programs, and their extension to all states. (2) Incentives and/or easements to restore natural productivity to 740,000 acres of lost wetlands. (3) Incentives and/or easements to maintain 500,000 acres of existing wetlands.

Special Status Species

The vast majority of wildlife species in the Western Region would benefit from practices which provide greater diversity in agricultural landscapes. However, special status species often have additional needs for particular habitat elements or site-specific management actions.

Recommendations. Emphasize actions necessary to maintain, restore or enhance their habitat as part of the agricultural landscape.

Priority habitats include essential or critical habitat for special status species. Target species and population goals include reversing the decline and contributing to recovery of Pacific salmonids, native trout, marbled murrelet, spotted owl, crested honeycreeper and other at-risk Hawaiian birds.

Farm Bill needs. (1) Special compensation to protect native wildlife habitat that is essential or critical for special status species in a farm context. (2) Priority consideration for incentives and easement programs.

Many factors beyond agriculture affect the fate of wildlife populations. In cases where agriculture has had a significant impact, we recognize that what was harm to one species may have been a benefit for others. We also acknowledge that most ranch, farm and woodland producers are dedicated, educated, idealistic and competent professionals. Nothing in this report should be read as criticism of their intentions or ideals. Indeed, care for wildlife often is among their primary concerns and has inspired many substantial, voluntary modifications of land-use practices to benefit wildlife. Still, it is our professional opinion that the direct, cumulative impact of most agricultural practices has been and will continue to be negative for the majority of species affected by agriculture unless producers are provided with major new incentives to adopt practices that benefit wildlife.

It is essential to renew the spirit of cooperation between wildlife managers and agricultural producers in order to maintain wildlife populations impacted by agriculture. It is in that spirit that we offer our recommendations for consideration during discussions of the 1995 Farm Bill. In particular, we urge adoption of a Farm Bill program that respects the rights of private landowners and relies primarily on incentives to increase cooperation among all interested parties.

Equally important, the next Farm bill should adopt a landscape or ecosystem approach to protect wildlife habitat values. This means dedicating some Farm Bill programs to achieving landscape diversity goals, including restoration and protection of critical riparian-wetland corridors in all agricultural landscapes. Finally, we would urge that all Farm Bill programs include a strong monitoring program to accumulate scientific knowledge about the relationships between agricultural practices and wildlife, and to allow careful evaluation of how efficient and effective Farm Bill programs ultimately are in achieving wildlife habitat goals.

Because the Western Region has so much natural and cultural diversity, the importance of particular wildlife issues varies from state to state, and even within states. The 1995 Farm Bill is an opportunity to maintain or increase habitat values for several groups of wildlife that currently are struggling to maintain a place in the agricultural landscape. Pheasants and Columbian sharp-tailed grouse in many areas, wintering waterfowl in California's Central Valley, salmon and resident fish throughout the Region are just a few examples of species that have large economic values and could be nurtured by the 1995 Farm Bill.

Acknowledgments

We thank the representatives of numerous agencies and organizations in the West that provided input to this paper. In particular, we thank Chris Frissell, Clayton Hawkes, Dean Mitchell, Hiram Li, David Lockwood, Glen Rollins, Mary Scurlock, San Stivers, Ron Walker and Dave Ware for their encouragement, ideas and guidance.

References

Barrett, G. W., N. Rodenhouse and P. J. Bohlen. 1990. Role of sustainable agriculture in rural landscapes. pages 624–636 *in* C. A. Edwards, R. Lal, P. Madden, R. H. Miller and G. House, eds., Sustainable agricultural systems. Soil and Water Conserv. Soc., St. Lucie Press, Delray Beach, FL.

Gard. N. W., M. J. Hooper and R. S. Bennett. 1992. Effects of pesticides and contaminants on neotropical migrants. Pages 310–314 *in* D. M. Finch and P. W. Stangel, eds., Status and management of neotropical migratory birds. U.S. For. Serv., Gen. Tech. Rept. RM–229.

Haystead, L. and G. C. Fite. 1955. The agricultural regions of the United States. Univ. Oklahoma Press, Norman. 288 pp.

National Research Council. 1994. Rangeland health: New methods to classify, inventory, and monitor rangelands. Nat. Acad. of Sci., Washington, D.C. 180 pp.

National Wildlife Federation. 1987. Status report on our nation's wetlands. Washington, D.C. 46 pp.

Nehlsen, W., J. E. Williams and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho and Washington. Fisheries 16(2): 4–21.

Oregon Department of Environmental Quality. 1992. Oregon's 1992 water quality assessment report: 305(b). 2nd printing. Portland, OR.

Oregon Department of Fish and Wildlife. 1993. Oregon wildlife diversity plan. 2nd Ed. Portland, OR.

Pacific Fisheries Management Council. 1994. Review of 1993 ocean salmon fisheries. Portland, OR.

Rodenhouse, N. L., L. B. Best, R. J. O'Connor and E. K. Bollinger. 1992. Effects of temperate agriculture on neotropical landbirds. Pages 280–295 *in* D. M. Finch and P. W. Stangel, eds., Status and management of neotropical migratory birds. U.S. For. Serv., Gen. Tech. Rept. RM–229.

Stiner, B. R. and J. M. Blair. 1990. Ecological and agronomic characteristics of innovative cropping systems. Pages 123–140 *in* C. A. Edwards, R. Lal, P. Madden, R. H. Miller and G. House, eds., Sustainable agricultural systems. Soil and Water Conserv. Soc., St. Lucie Press, Delray Beach, FL.

Thompson, F. R., III, J. R. Probst and M. G. Raphael. 1992. Silvicultural options for neotropical migratory birds. Pages 353–362 *in* D. M. Finch and P. W. Stangel, eds., Status and management of neotropical migratory birds. U.S. For. Serv., Gen. Tech. Rept. RM–229.

U.S. Bureau of the Census. 1994. 1992 Census of agriculture, Washington, D.C.

U.S. Department of Agriculture. 1989. The second RCA appraisal: Soil, water, and related resources on nonfederal land in the United States, analysis of conditions and trends. Washington, D.C. 280 pp.

U.S. Fish and Wildlife Service. 1992. 1991 national survey of fishing, hunting, and wildlife-associated recreation: State overview—preliminary findings. Washington, D.C.

CRP: Icon of a New Age

Steven Peter Riley
South Dakota Department of Game, Fish and Parks
Pierre

If my father had only lived a few more years he would have seen the return of the *good old days*. I often imagine hunting with my Dad in these days, with big bluestem or tall wheatgrass up to our necks and roosters flushing en masse on the horizon. What would he have thought? How would the changes that came with CRP have affected his old idea that the good old days would never come again?

I would be remiss if I didn't mention that there are those who haven't seen CRP as a change for the better. I know that some regions of the United States have not been benefactors of the CRP experience. It also is true that these regions want in on the action. Although conservationists lack unanimity as to the success of CRP, there is no question that it has captured our attentions and imaginations. Let me focus, for a moment on what the onset of CRP represents and why its negatives are absolutely paled by its positives.

Think of the American people as a sleeping giant. Content in slumber, the giant fritters away his time while the kingdom is allowed gradually to deteriorate. But the giant seems to be waking. There have been signs—Earth Day, Project Wild and Project Learning Tree in our schools. You easily can add a host of similar milestones to the list: all signs that the giant is stirring. CRP may be the first sign of the giant's actual awakening. Is it possible that he has come to reclaim the kingdom?

CRP embodied the awakening of our environmental consciousness. Americans have been craving sweeping changes in the way our government involves itself in matters of the environment. In the early '80s, wildlifers asked what could be done to bring back the good old days. They remembered the Soil Bank. So, when the 1985 Farm Bill was being designed, great strides were made to include vast acreages of land in order to recreate the effects of Soil Bank. The result has been dramatic and the positive public response has been deafening. CRP is an icon of what future federal farm programs ought to be. Because of its historical importance, all regions of the country have reason to support CRP.

Nothing really has changed for farmers though—that is, unless things have worsened. However, CRP gave some farmers a reprieve from their financial difficulties and the complexities of the farm program. But the threat remains that they again will be thrust into the backwards pattern—a pattern of thinking that is bent on producing more and more crops for less and less profit. It is what farm programs always have imposed on farmers and their families.

Past farm programs have tended to force farmers to break up more ground and grow more bushels per acre to be considered productive. Incentives largely have been afforded to less conservation-minded farming practices. I'm not an economist, but from a simple supply and demand standpoint, the farm program commonly has been a disaster waiting to happen. Here's the scenario: in the past, we have told our farmers to produce as much as possible and not to worry about the fact that demand for grain—in a monetary sense—actually is very stagnant. Although the human population is growing and it is intuitive that demand for grain, therefore, should be directly correlated to that growth, the problem is that there are too many people who can't afford to buy American grain at any price.

From that perspective, the underpinning of our national farm policy—"feeding the world"—has not led to a good business plan. And it looks even worse in the face of GATT, NAFTA and an increasingly demanding world economy.

But there is a glimmer of hope nestled in our current farm program. Hope for our farmers and hope for our environment. I believe we are on the threshold of a better farm economy—at the doorstep of an expansion period for conservation. CRP has shown us that we can develop programs that mutually benefit farmers and the public. It is the tip of the iceberg.

Imagine a farm program that makes the farmer—the small, family farmer—a partner in the program rather than a hostage to it. Consider the possibilities of programs designed to make small farms more lucrative and environmentally secure by making the farming business leaner and more competitive in the world market. The American people appear more than willing to invest their tax dollars in the long-term public benefits of farming. They *no longer* are willing to spend billions annually that provide them no apparent benefits. Similarly, farmers no longer are willing to stomach the stereotype that they are only able to remain in business because of federal subsidies.

I wonder, if we had crossed this threshold 50 years ago, would my father have realized his dream of owning and operating the family farm? Would my brother and I have grown up in a thriving Midwest farming community instead of a host of Air Force bases? I can only imagine the three of us spending countless hours walking long rows of tall corn behind Brittany spaniels on our *own* farm. But no . . . over those last 50 years, countless farms and farming communities have either died or been left mortally wounded by federal policies that have not worked.

The tendency is to look back and ask "what if?" What if Soil Bank had been the catalyst for this "new time?" Well, "there's no use in crying over spilled milk," as Dad would have said. The time has come to make the change. As a farmer and a conservationist, Dad readily would have seen the benefits of CRP. And he would have told you—like so many other Americans have told you—that we need more of the same in the rest of the Farm Bill.

Dad always had a way with words. He could always craft just the right words to convey exactly what he meant for people to hear.

I thought long and hard about how I could use my father's gift to make my point clear to you, so that there could be no mistaking my meaning: a wagon train, Dad would have used the image of a wagontrain to persuade you that now is the time—the opportunity—to make a monumental change.

One can easily visualize the way America has gone about developing the 1995 Farm Bill as the drawing together of a wagontrain. The train is made up of many simple and diverse wagons that have come from far and wide. The train is made up of people, people who have a dream of how to make America better. Wagons have joined this train from the most remote prairie villages and the most populous urban centers. Our wagontrain is a symbol of our hope and faith, our strength and perseverance.

The wagontrain is assembled now; many of its members are here in this room. We have almost reached our destination, but the most difficult part of the trail lies just ahead of us. In my anticipation, I find myself searching for the words of the wagon master through the voice of my father. I can almost hear him—perhaps you can, too, if you listen closely—"Either get those wagons in line, or get the hell out of the way . . . this train is comin' through."

Special Session 6. *Conserving Grasslands: North America's Most Endangered Ecosystem*

Chair
FRED B. SAMSON
USDA Forest Service
Missoula, Montana

Cochair
MERLIN SHOESMITH
Manitoba Department of Natural Resources
Winnipeg, Manitoba

In Praise of Prairie

Fred B. Samson
USDA Forest Service
Missoula, Montana

Merlin Shoesmith
Manitoba Department of Natural Resources
Winnipeg

Introduction

The prairie appears almost monotonous in the general uniformity of its plant cover. Its main features are the absence of trees, the scarcity of shrubs, the dominance of grasses, and a characteristic xeric flora.

J. E. Weaver (1968)

Grasslands rank among the most biologically productive of all ecosystems; their high productivity stemming from the high retention of nutrients, efficient biological recycling and a structure that provides for a vast array of animal and plant life (Estes et al. 1982). Understanding the biological resources of the grasslands, however, is a problematic process (Samson and Knopf 1994). The exact areal estimate of grassland in North America is unknown and has undergone significant alteration from descriptions provided in early accounts. Many impacts—agriculture, urbanization, mineral exploration, suppression of natural ecological processes—have local and regional, if not global, effects on biological resources.

On the other hand, grasses have contributed the germ plasm for the principle human food crops—rice, wheat and corn, among others (Estes et al. 1982). Worldwide, the production of such cereal grains exceeds, in terms of amount, all other food crops combined. Grasslands have immense watershed values and provide both forage and habitat for large numbers of domestic wild animals. Nevertheless, today agricultural erosion in North America exceeds the prairie soil's capacity to tolerate loss, threatening an essential resource to sustain future generations (Sampson 1981). In addition, overgrazing and other human-induced stresses have reduced the amount and diversity of the social values, as well as commodities that can be produced western rangelands and such degradation may be irreversible (National Research Council 1994).

Prairie—Past and Present

The prairie, in all its expressions, is a massive, subtle place, with a long history of contradiction and misunderstanding. But it is worth the effort of comprehension.
William Least Heat-Moon (1993)

In North America, prairie—the tallgrass, mixed grass and shortgrass ecosystems—represents the largest vegetative province on the continent. Yet, in recent years, a great deal of attention has been paid to the issue of temperate (Harris 1984) and tropical deforestation (Whitmore and Sayer 1992) in part because of deep worldwide concern for the sustainable use of resources (IUCN/UNEP/WWFN 1991) and conservation of biological diversity. Despite a broad consensus in support of sustainability and conserving diversity (Raven 1991), native prairie, an area that once extended from Canada to the Mexican border and from the foothills of the Rocky Mountains east to Indiana, is largely neglected in this effort, both in Canada and United States.

Why is North American prairie conservation important? Consider for example:

- Surveys suggest that declines in area of native prairie since European settlement range as high as 99.9 percent (Samson and Knopf 1994). Many subtle impacts, e.g., loss of the highly developed ecotypic variation, often go undetected (Risser 1988).
- One-third of species considered endangered by the Committee on the Endangered Wildlife in Canada are found on grasslands (World Wildlife Fund Canada [WWFC] 1988) and strategies are needed to sustain native prairie and agricultural landscape (Tyrchniewicz and Wilson 1994).
- Grassland birds in the United States have shown more consistent and steeper, geographically widespread declines than any other grouping of North American birds (Knopf 1994)—55 species are threatened or endangered.
- The impounding and alteration of running waters, depletion of aquifers, and increase in waterborne chemical pollutants also threaten prairies and their soils (The Conservation Foundation [TCF] 1988). Upwards to 90 percent of the endemic to small prairie streams in the United States are on the decline (Tabor 1993), and a number of fish taxa either are listed or candidates to be listed under the Endangered Species Act.
- Large amounts of stored organic carbon reflect fundamental differences between grasses and trees (Seastadt and Knapp 1993). Such differences favor grasslands to meet challenges ranging from global warming to adequate human nutrition.

Time and limited information curtail our ability to review the status and trends and wildlife (more than 550), fish (more than 286) and invertebrate (unknown number) species found on the prairie. Rather, the most prudent and immediate approach is to consider the character, maintenance and ecological requirements for conservation of their habitats. Specifically, how scale-dependent ecological processes (Steinauer and Collins 1995), history and herbivory (Bragg and Stueter 1995), and climate-dependent gradients frame a basis for management (Weaver and Bergeron 1995).

The Future

Prairie looms as large as the universe, as intimate as a village.
William Least Heat-Moon (1991)]

In the larger context, conservation of grasslands extends beyond national borders (Samson and Knopf 1994) and, in fact, worldwide, the grassland has declined in area more than any other major vegetative type, raising a global conservation concern (Jerry Harrison personal communication). Today, the sustainability of agriculture and other biological resources including fish and wildlife is being challenged as the result of developments both within and outside the Great Plains region and in Canada (Tyrchniewicz and Wilson 1994) and the United States (Barnes 1993).

Often, the "economy versus the environment" regresses into a public debate, benefitting neither side and simplifying the issues.

About 95 percent of the lands that fall within the tallgrass, mixed grass and shortgrass prairie are in private ownership. Yet, in no other North American ecosystem are so many cooperative ecosystem management efforts, whether by state, provincial, or national agencies and organizations, underway.

Ecosystem planning must recognize scale (Odum 1992) from bioregion to site (Samson and Knopf 1994). Each planning level is unique but should not remake other scale-dependent responsibilities. Planning should provide a sense of place from the universe to village. As a start, the Great Plains Initiative (Clark 1995), the first broad-scale ecosystem management effort in the United States, seeks to demonstrate that both economic and environmental interests are served by preventing declines in prairie species numbers and their host ecosystems. In Canada, the broad and innovative prairie conservation plan (Dyson 1995) identifies ecological, economic and policy requirements for sustainability.

Knopf (1992) argues the joint venture concept, as promulgated under the North American Waterfowl Management Plan, is the effective framework for ecosystem conservation; in other words, an ecosystem joint venture. Lessons in prairie conservation can be learned from joint ventures in Canada (Anderson et al. 1995) and the United States (Kresl et al. 1995).

The usefulness of the concepts in prairie conservation is enhanced by identifying examples of success, particularly in the prairie agricultural landscape where native grasslands and agriculture form a mosaic. The challenge is particularly significant if those lands are of biological significance (Bueseler 1995). How the local environment is treated ultimately impacts essential resources that appear distant and is the gist of "think globally, act locally." An example is the conservation of one of America's most unique ecosystems, the Sandhills of Nebraska (Mack 1995), whose importance stretches far beyond northwest Nebraska.

Almost a half century has passed since Weaver (1954) noted that the disappearance of a major unit of vegetation—the North American Prairie—is an event worth considering. The intent of this session, albeit a half century late, is to bring a measure of prairie conservation to the forefront as a first step in the reorientation of environmental concern and policy to one beyond that of forest and forest-related ecosystems—a more rational approach to the management of natural resources across North America.

References

Anderson, M. G. and J. W. Nelson. 1995. Northern grassland conservation and the Prairie Joint Venture. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.

Barnes, R. L. 1993. The U.C.C.'s insidious preference for agronomy over ecology in farm lending decisions. Univ. Colorado Law Rev. 64: 457–512.
Bragg, T. B. and A. A. Steuter. 1995. Mixed-grass prairies of North America. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
Bueseler, P. 1995. Sustainable grassland utilization and conservation in prairie agricultural landscapes. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
Chaplin, S. J., W. R. Ostlie, R. E. Schneider and J. S. Kenney. 1995. Conservation planning within the Great Plains. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
Clark, J. 1995. The Great Plains Initiative. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
Dyson, I. W. 1995. Canada's Prairie Conservation Action Plan: New directions for the millennium. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
Estes, J. R., R. J. Tyrl and J. N. Brunken. 1982. Grasses and grasslands. Systematics and ecology. Univ. Oklahoma Press, Norman. 312 pp.
Harris, L. D. 1984. The fragmented forest: Island biogeographic theory and preservation of biotic diversity. Univ. Chicago Press, Chicago, IL. 218 pp.
International Union for Conservation of Nature and Natural Resources, United Nations Environmental Program, and World Wide Fund for Nature (IUCN/UNEP/WWFN). 1991. Caring for the earth. A strategy for sustainable living, Gland, Switzerland.
Knopf, F. L. 1994. Avian assemblages on altered grasslands. Studies in Avian Biol. 15: 247–257.
———. 1992. Faunal mixing, faunal integrity, and the biopolitical template for diversity conservation. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 57: 330–342.
Kresl, S., J. Leach and C. A. Lively. 1995. Working partnerships for conserving the nation's prairie pothole ecosystem. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
Mack, G. 1995. The Sandhill Management Plan: A partnership initiative. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
National Research Council. 1994. Rangeland health. New methods to classify, inventory, and monitor rangelands. Nat. Acad. Press, Washington, D.C. 180 pp.
Odum, E. P. 1992. Good ideas in ecology for the 1990's. BioScience 42: 542–545.
Raven, P. H. 1991. The politics of preserving biodiversity. BioScience 40: 769–774.
Risser, P. G. 1988. Diversity in and among grasslands. Pages 176–180 *in* E. O. Wilson, ed., Biodiversity. Nat. Acad. Press, Washington, D.C.
Sampson, R. N. 1981. Farmland or wasteland. A time to choose: Overcoming the threat to America's farm and food future. Rodale Press, St. Emmous, PA. 418 pp.
Samson, F. B. and F. L. Knopf. 1994. Prairie conservation in North America. BioScience 44: 418–421.
Seastedt, T. R. and A. K. Knapp. 1993. Consequences of nonequilibrium resource availability across multiple time scales: The transient maxima hypothesis. Amer. Natural 141: 621–633.
Steinauer, E. M. and S. L. Collins. 1995. Disturbance as management component in tallgrass prairie. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
Tabor, V. M. 1993. Declining fishes characteristic to the Great Plains. Unpubl. mimeo. U.S. Fish and Wildl. Serv., Manhattan, KS. 17 pp.
Tyrchniewicz, A. and A. Wilson. 1994. Sustainable development for the Great Plains-policy analysis. Int. Inst. for Sustain. Develop., Winnipeg, Manitoba. 35 pp.
The Conservation Foundation (TCF). 1988. Protecting America's wetlands. An action agenda. The Conserv. Found., Washington, D.C. 17 pp.
Weaver, J. E. 1954. North American prairie. Johnson Publ. Co., Lincoln, NE. 348 pp.
———. 1968. Prairie plants and their environment. A fifty-year study in the midwest. Univ. Nebraska Press, Lincoln. 276 pp.
Weaver, T. and P. Bergerron. 1995. Adequacy of conservation for the shortgrass prairie. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 60: current volume.
Whitmore, T. C. and J. A. Sayer. 1992. Tropical deforestation and species extinction. Chapman and Hall, New York, NY.
William Least Heat-Moon. 1993. Prairyerth. Houghton Mifflin Co., Boston, MA. 624 pp.
World Wildlife Fund Canada (WWFC). 1988. Prairie conservation action plan. World Wildl. Fund Canada, Toronto. 52 pp.

Mixed Prairie of the North American Great Plains

Thomas B. Bragg
Department of Biology
University of Nebraska
Omaha

Allen A. Steuter
The Nature Conservancy
Niobrara Valley Preserve
Johnstown, Nebraska

Introduction

The mixed prairie occupies the central third of the North American Great Plains. It is bounded by tallgrass prairie to the east, shortgrass to the west, aspen parkland to the north and juniper/oak (*Juniperus/Quercus*) savanna to the south (Küchler 1985). The semi-arid land is characterized by seasonal moisture and temperature extremes typical of a continental climate. In the northern mixed prairie, annual precipitation increases from 12 inches (30 cm) in the west to 24 inches (60 cm) in the east; the southern precipitation gradient increases from 16 to 32 inches (40 to 80 cm) (Bryson and Hare 1974). Two-thirds of the annual precipitation occurs during the growing season, although regional droughts are common. The west-to-east elevation in the north ranges from 4,000 to 1,300 feet (1,130 to 400 m).

During most of the Holocene, mixed prairie uplands and lowlands have been dominated by herbaceous vegetation with woodlands restricted to isolated buttes, scarps and riparian habitats protected from fire (Axelrod 1985, Wells 1965). Perennial grasses dominate above- and below-ground resources and primary production, but forbs are largely responsible for community diversity. In a typical mixed prairie, grasses are represented by tens of species, while forb species will number in the hundreds. The distribution and abundance of forbs also is more dynamic and diagnostic of changes in moisture, grazing and fire regimes than is the perennial grass matrix (Biondini et al. 1989, Steuter et al. 1995). Interestingly, with the exception of blowout penstemon (*Penstemon haydenni*), there are no widely recognized plant species endemic to the mixed prairie (Stubbendieck et al. 1993). Blowout penstemon is uniquely adapted and confined to the most actively wind-eroded sites in the Nebraska sandhills prairie.

Largely through their use of fire, humans have played a major role in the evolutionary history of mixed prairie (e.g., Moore 1972, Higgins 1986). Other keystone species include the wolf (*Canis lupus*), North American bison (*Bos bison*), prairie dog (*Cynomys ludovicianus*) and pocket gopher (*Geomys bursarius*). Historically, the mixed prairie formed the central portion of the primary bison range (McDonald 1981). It was the mixed prairie that attracted the vast summer breeding herds of bison due to the region's openness, high-quality forage and relatively abundant water (Hansen 1984). The faunal component of the mixed prairie, however, extended beyond terrestrial herbivores. The mixed prairie landscape is characterized by broad river valleys with gently rolling interfluvial plains. The regular sequence of rivers flowing through the mixed prairie, the prairie potholes of the Dakotas and Canadian provinces, and the sandhill lake regions of Nebraska form a dispersed and redundant system of critical water and wetland habitats for a diverse array of migratory and non-migratory species. Indeed, the mixed prairie region also is a central feature of the Great Plains Flyway—a migratory water bird spectacle rivaling that of the great bison herds.

We consider the mixed prairie to consist of three types based on plant community structure and function. These three types are the Northern Mixed Prairie, the Sandhills Prairie and the Southern Mixed Prairie.

Mixed Prairie Ecology and Management

The evolutionary history of the mixed prairie has resulted in biota that are well adapted to grazing (Mack and Thompson 1982, Milchunas et al. 1988) and fire (Wright and Bailey 1982). Indeed, it is largely a product of these two forces, interacting with regional soils, weather and climate, particularly periodic drought (Weaver and Albertson 1956). The effects of grazing, whether by bison or cattle (*Bos taurus*), generally are similar in that they reduce standing crop (Table 1). Fire also reduces standing crop (Hopkins et al. 1948), as well as reducing litter (Willms et al. 1993), altering species diversity patterns (Biondini et al. 1989), modifying grazing patterns (Coppock and Detling 1986) and variously affecting animals (Bragg 1995). The interaction of fire and grazing, however, often has different effects than either process alone (Pfeiffer and Steuter 1994). In addition, fire and grazing magnify drought stress on mixed prairie vegetation (Milhbacher et al. 1989). Of the principal plants of the mixed prairie, the adverse effects of drought are most severe on little bluestem (*Andropogon scoparius*), and less so on sideoats grama (*Bouteloua curtipendula*), blue grama (*Bouteloua gracilis*), buffalograss (*Buchloë dactyloides*) and western wheatgrass (*Agropyron smithii*) (Weaver 1968). Dynamic shifts in the plant community also occur with fertilization (Rauzi and Fairbourn 1983), woody plant removal (Vallentine 1980), mechanical disturbance of soil (Haferkamp et al. 1993) and mowing (Launchbaugh 1973). As with fire, mowing tends to reduce production during all but high-rainfall years. Fertilization, mostly used in the northern mixed prairie, generally is not economically feasible (Wight and Black, 1979).

Northern Mixed Prairie

The original northern mixed prairie covered approximately 94 million acres (38 million hectares) in Nebraska, North and South Dakota, and Canada. Plant communities included the wheatgrass/bluestem/needlegrass (*Agropyron/Andropogon/Stipa*) and the wheatgrass/needlegrass associations of Küchler (1985). Cool-season grasses become increasingly more dominant from Nebraska to Canada. Mesic associations of taller species generally occur on lower slopes transitioning to mid-height, and then to shorter species associations on the dry hilltop (Barnes et al. 1983). These grasslands occur primarily on loamy glacial tills and clay to clay-loam soils.

Western wheatgrass is the common denominator of the northern mixed prairie type, even though it is not always a dominant (Gartner 1986). Other common grass species include blue grama, needle-and-thread (*Stipa comata*), green needlegrass (*Stipa*

Table 1. Representative standing crop from mixed prairies of the North American Great Plains.

Location and treatment	Standing crop (pounds/acre) Treated	Untreated	Reference
Northern mixed prairie			
Grazed	1,893	2,150	Hofmann and Ries 1989
	1,116–2,179	1,241–2,028	Brand and Goetz 1986
	929–1,964	1,464–2,268	Sims et al. 1978
Burned	1,445	1,585	Gartner et al. 1986
	1,945–2,197	2,228	Gartner et al. 1978
Nebraska Sandhills prairie			
Grazed	991[b]	1,893[b]	Bragg 1978
Burned	714–2,143	991[a]–2,399[a]	Bragg 1978
Southern mixed prairie			
Grazed	992	1,036	Sims et al. 1978
	1,321	2,295	Tomanek and Albertson 1953
Burned	4,464	4,688	Nagel 1983
	1,076[a]	2,124[a]	Hopkins et al. 1948
	2,419	1,179	Adams and Anderson 1978

[a]Treatment includes grazing.
[b]Treatment includes burning.

viridula) and porcupine-grass (*Stipa spartea*). Without burning, Kentucky bluegrass (*Poa pratensis*) and smooth brome (*Bromus inermis*), cool-season exotics, increase in the northern mixed prairies (Kirsch and Kruse 1972). Forb productivity ranges from 0–40 percent of total net primary production (Hadley 1970, Lura et al. 1988), but may vary considerably with heavy grazing (Whitman 1974). Several woody species, such as western snowberry (*Symphoricarpos occidentalis*), fringed sagebrush (*Artemisia frigida*) and eastern redcedar (*Juniperus virginiana*), have been shown to replace herbaceous species in the region (Wright and Bailey 1982, Kaul 1993).

Grazing in the northern mixed prairie. In general, grazing favors short-statured or rhizomatous species, such as western wheatgrass and blue grama, over taller or bunch grass species, such as little bluestem (Mack and Thompson 1982). It appears that shifts in species composition are more a function of grazing intensity and plant species morphology and reproductive mechanisms, than whether they are cool- or warm-season species (Ode et al. 1980, Singh et al. 1983, Brand and Goetz 1986, Schacht and Stubbendieck 1985). Grazing also decreases litter, although, in the northern mixed prairie, litter accumulation did not appear to limit productivity (Dix 1960). Moderate grazing also increases decomposition, although heavy grazing or the exclusion of grazing did not (Shariff et al. 1994), and affected soil chemical properties (Dormaar and Willms 1990). Grazing, thus, is important to maintaining the ecosystem processes that occurred when a large number of bison dominated the great plains grasslands. Grasses that decrease with grazing include big bluestem (*Andropogon gerardii*) and indiangrass. Sedges (e.g., *Carex filifolia* Nutt. and *C. heliophila* Mack) and leadplant (*Amorpha canescens*) are among other species declining with grazing. Blue grama, ironweed (*Vernonia baldwinii*), western ragweed (*Ambrosia psilostachya*) and curlycup gumweed (*Grindelia squarrosa*) increase with increased grazing intensity (Branson and Weaver 1953, Brand and Goetz 1986).

Fire in the northern mixed prairie. Ignited by lightning or Native Americans, fire was a frequent event in the northern mixed prairie (Higgins 1986). In general, fire reduces standing crop of both cool- and warm-season species during dry years while maintaining or increasing standing crop in wet years (Engle and Bultsma 1984, Whisenant and Uresk 1990). Fire also improves herbage quality (Willms et al. 1980), decreases litter (Willms et al. 1986 and 1993) and increases bare ground allowing more light to penetrate the canopy during the growing season (Dix 1960). Recovery of mulch structure to pre-burn amounts may take at least three years. Reductions in net and individual species' primary production caused by fire are due to lower plant and soil water potentials on burned sites (DeJong and MacDonald 1975), climatic conditions, the attraction of grazers to recently burned areas (Gartner et al. 1986), site productivity (Dix 1960, DeJong and MacDonald 1975, Whisenant and Uresk 1990), the presence of significant amounts of native warm-season species (Schacht and Stubbendieck 1985), and topographic location. The response to fire also varies depending on the season in which the fire occurs (Dix 1960, Coupland 1973, Engle and Bultsma 1984, Schacht and Stubbendieck 1985, Gartner et al. 1986, Steuter 1987, Whisenant and Uresk 1990, Redmann et al. 1993). In general, autumn burning has the most adverse effect on herbage production, favoring cool-season species over warm-season species. Spring burns decrease some cool-season species (e.g., Kentucky bluegrass and green needlegrass) and increase others (e.g., western wheatgrass, blue grama and buffalograss). Although fire may reduce standing crop, community composition and diversity, patterns following fire are indicative of a grassland well adapted to its effects (Biondini et al. 1989). Indeed, the range of variability in plant composition between spring, summer and autumn burns is similar to that caused by annual fluctuations in weather (Biondini et al. 1989). Complete fire suppression, however, results in accumulation of mulch and conditions that favor cool-season, exotic species (Ode et al. 1980, Whisenant 1990). In addition, the absence of fire most likely accounts for the active invasion of woody plants in the southern portion of the northern mixed prairie (Kaul 1993).

Sandhills prairie

Sandhills Prairie (*Andropogon/Calamovilfa*) Küchler 1985) is a distinct mixed prairie type originally encompassing approximately 14 million acres (7 million hectares). The Nebraska sandhills prairie accounts for approximately 12 million acres (5 million hectares), while most of the remaining sandhills mixed prairie occurs in central Kansas. The Nebraska sandhills prairie developed on the largest stabilized sand-dune complex in the Western Hemisphere (Bleed and Flowerday 1990). The substrate often has not undergone sufficient pedogenesis to be classified as a soil, but those that have developed are primarily fine sands for fine sandy loams.

Warm-season grasses dominate primary production and, once again, there is distinct community zonation based on slope position (Barnes and Harrison 1982). Dominant grasses include prairie sandreed (*Calamovilfa longifolia*), sand bluestem (*Andropogon hallii*), big bluestem, little bluestem, blue grama, hairy grama (*Bouteloua hirsuta*), needle-and-thread and sand dropseed (*Sporobolus cryptandrus*) (Weaver 1965). Sedges are ubiquitous even though they make up only a small component of standing crop. Forbs, such as western ragweed, skeletonweed (*Lygodesmia*) and plains sunflower (*Helianthus petiolaris*) may represent 10–25 percent of the regional species standing crop. In addition to regional variations in dominant species, substantial differences in species composition occur between uplands, slopes and lowlands (Barnes et al. 1984). Woody plants are actively invading, especially along the prairie margins, presumably because of recent fire suppression (Steinauer and Bragg 1987, Steuter et al. 1990).

Grazing in the Nebraska Sandhills Prairie. The sandhills prairie has been subjected to large herbivore grazing, at least during more stabilized periods. Bison, for example, occurred in the Nebraska sandhills for at least the last 11,000 years (Loope 1986). Presently, however, cattle grazing is the principal use of sandhills prairie. As with other mixed prairie communities, grazing reduces standing crop (Bragg 1978). Among the sandhills plant species most heavily grazed are blue grama, little bluestem, needle-and-thread and switchgrass. Sandhill muhly (*Muhlenbergia pungens*) and sand dropseed do not appear to be affected by grazing (Bragg 1978). The current bunchgrass composition of sandhills prairie appears dependent on fire exclusion (Pfeiffer and Steuter 1994), since large herbivores intensively graze burned bunchgrasses such as little bluestem. In general, bunchgrasses are less tolerant of grazing than rhizomatous species. For example, fragmentation of little bluestem plants into scattered clumps with high tiller density occurs with heavy grazing pressure (Butler and Briske 1988). Grazing also effectively prevents litter accumulation. While this accumulation has no significant effect on overall standing crop, it may affect individual species (Potvin and Harrison 1984).

Fire in the Nebraska Sandhills Prairie. Historic fires in the Nebraska Sandhills prairie occurred as frequently as every four to five years (Bragg 1986). As in other mixed prairie types, fire causes an initial decline in plant standing crop (Table 1), although the decline may not persist longer than one to two years (Bragg 1978), depending largely on weather conditions. Both standing crop and species composition are variously affected by different combinations of burning, grazing and topographic location. The decline in standing crop, for example, is greater with combined fire and grazing than with fire alone (Bragg 1978).

Burning also has the potential to significantly affect surface stability in the sandhills, although there is no direct evidence of this even with autumn burns that leave the soil surface exposed for several months (personal observation). A large reduction in bunchgrass composition due to the interaction between fire and grazing, however, may increase the risk of wind erosion (Pfeiffer and Steuter 1994).

Sand lovegrass (*Eragrostis trichodes*), sandhill muhly, small soapweed (*Yucca glauca*) and sand bluestem are among the species that decline with burning (Bragg 1978). Other species, including Missouri spurge (*Euphorbia missurica*) and plains sunflower, increase with burning as do interstitial forbs (Pfeiffer and Steuter 1994). Sand dropseed cover is increased with summer burns while the standing crop of larger bunchgrasses is reduced. Rhizomatous grasses maintain or increase their standing crop following fires in years with normal or above-normal precipitation.

Southern Mixed Prairie

We consider the original extent of the southern mixed prairie to have encompassed approximately 60 million acres (24 million hectares). It includes the bluestem-grama (*Andropogon/Bouteloua*) and mesquite-buffalograss (*Bouteloua/Buchloë/Prosopis*) associations of Küchler (1985). Southern mixed prairie soils typically range from loams to clays. Southern mixed prairie becomes increasingly dominated by a wide variety of warm-season grasses of mid- to short stature as one proceeds from Kansas to Texas. Shrubs become a significant component of the mixed prairie on the Rolling Plains of Texas.

The Kansas/Oklahoma component of the southern mixed prairie is dominated by blue grama, sideoats grama, western wheatgrass, little bluestem, junegrass (*Koeleria pyramidata*), green needlegrass, porcupine-grass, Kentucky bluegrass, tall dropseed (*Sporobolus heterolepis*), Canada wildrye (*Elymus canadensis*) and sedges (Weaver and Albertson 1956, Wright and Bailey 1982). Forbs make up approximately 25 percent of total standing crop and include locoweed (*Astragalus* and *Oxtropis* spp.), heath aster (*Aster ericoides*), aromatic aster (*Aster oblongifolius*), penstemon *Penstemon* spp), scarlet gaura (*Gaura coccinea*), annual sunflower (*Helianthus annuus*) and dotted gayfeather (*Liatris punctata*). Dominant invaders include yellow sweetclover (*Melilotus officinalis*), gumweed (*Grindelia squarrosa*) and foxtail barley (*Hordeum jubatum*). Diversity is relatively high: 236 vascular plants were recorded in a 610-acre (259 hectares) site in southern Nebraska (Nagel 1979).

The Rolling Plains and western Edwards Plateau regions of the Texas component of the southern mixed grass prairie are characterized by a scattered overstory dominated by honey mesquite (*Prosopis glandulosa*), with lotebush (*Ziziphys obtusifolia*) an important subdominant. The herbaceous component is variously dominated by buffalograss, sideoats grama, tobosagrass (*Hilaria mutica*), little bluestem and Texas wintergrass (*Stipa leucotricha*). Many annual forbs and some annual grasses (e.g., broomweed [*Gutierrezia*], bitterweed [*Hymenoxys odorata*], Carolina canary grass [*Phalaris carolinensis*] and little barley [*Hordeum pusillum*]) are abundant during wet winters. Perennial forbs include blanket flower (*Gaillardia*), primrose (*Oenothera*), lazy daisy (*Aphanostephus*), Lamb's quarter (*Chenopodium*), butterfly weed (*Gaura*), sunflower (*Helianthus*), plantain (*Plantago*), nightshade (*Solanum*) and globe mallow (*Sphaeralcea*) (Wright and Bailey 1982). Breaks throughout the Rolling Plains region contain large amounts of redberry juniper (*Juniperus pinchoti*) (Küchler 1964, Wright and Bailey 1982). The western Edwards Plateau is similar in composition, although common curlymesquite (*Hilaria belangeri*), and stoloniferous shortgrasses like buffalograss, also are prevalent.

Drought and topography affect species composition throughout the southern mixed prairie. Mesic conditions favor taller grasses (e.g., little bluestem and big bluestem) and drier conditions favoring shorter grasses (e.g., sideoats grama, blue grama and buffalograss) (Albertson and Tomanek 1965, Mihlbacher et al. 1989). Disturbances, such as grazing and wallowing of bison and prairie dog diggings increase grassland diversity (Collins and Barger 1985).

Grazing in the southern mixed prairie. As in other mixed prairies, most studies indicate that grazing in the Kansas/Oklahoma portion of the southern mixed grass prairie reduces standing crop (Milchunas and Lauenroth 1993), although there are exceptions in which long-term changes appear unrelated to grazing (Mihlbacher et al. 1989). In most instances, mid- and tallgrasses decrease with grazing while shortgrasses, especially buffalograss, increase as much as 90 percent. While heavy grazing reduces standing crop, moderate grazing may only slightly reduce, or even increase, production over ungrazed areas (Tomanek and Albertson 1957). With no grazing, however, litter accumulation may cause grass-stand degeneration and reduced production (Hopkins 1951). In the absence of fire, ashe juniper (*Juniperus ashei*), redberry juniper (*Juniperus pinchotii*) and honey mesquite invade grasslands and suppress the herbaceous component, thus lowering forage availability (Wink and Wright 1973, Steuter and Wright 1983).

One effect of the interaction of fire and grazing is that reported by Ring et al. (1985). Their study showed that an area repeatedly grazed throughout the grazing season resulted in overgrazed patches within a matrix of lightly to ungrazed pasture. Subsequent fires in these patchy fuels would burn unevenly and result in a patchy burn that has been hypothesized to increase prairie diversity (Biondini et al. 1989).

Fire in the southern mixed prairie. Fires ignited by lightning and by Native Americans occurred throughout the southern mixed prairie, just as they did elsewhere throughout the Great Plains (Moore 1972). For the Kansas/Oklahoma component, most of the dominant grass species are tolerant of fire, although they may require two to three growing seasons to recover to pre-burn productivity (Launchbaugh 1973, Nagel 1983). Summer fires are most detrimental, followed by spring and then by autumn burning. Buffalograss, blue grama, sideoats grama and Kentucky bluegrass are most severely reduced with spring burning in Kansas and Oklahoma (Launchbaugh 1964). At least three growing seasons are required for recovery of these species to pre-burn amounts. Decreases are greatest where litter is heaviest (Launchbaugh 1964). Several broadleaved plants increase with spring burning, including western ragweed (*Ambrosia psilostachya*) (Hopkins et al. 1948). In Texas, species that seem to thrive up to about three growing seasons after a fire include vine-mesquite (*Panicum obtusum*), tobosagrass (*Hilaria mutica*), Arizona cottontop (*Digitaria californica*), little bluestem, plains bristlegrass (*Setaria leucopila*) and Texas cupgrass (*Eriochloa sericea*) (Wright 1974). Generally, these are the species that accumulate the most mulch and, thus, would be most affected by adverse effects of such an accumulation (Launchbaugh 1964, 1973). A species' response to fire also is affected by climate. Most grasses tolerate fire during years with normal to above normal precipitation but are adversely affected during dry years (Hopkins et al. 1948, Wink and Wright 1973, Wright 1974). When subjected to fire in dry years, some species, such as sideoats grama, Texas wintergrass and little bluestem, have been shown to decrease productivity by as much as 40–58 percent, requiring up to three years to recover to pre-burn standing crop. Yet, during wet years, little bluestem increased as much as 81 percent (Wink and Wright 1973). While fire is a natural component of the mixed prairie, burning more frequently than every five to eight years will result in a decline in standing crop of the dominant herbaceous species (Heirman and Wright 1973, Sharrow and Wright 1977, Neuenschwander et al. 1978). The response to burning also depends on species composition. Where annual, cool-season grasses are few, Texas wintergrass standing crop declines. Where cool-season grasses are abundant, fire increases production of these species, although the increase is greater with autumn than spring burning (Whisenant et al. 1984). The standing crop of cacti, an abundant group of plants in the southern mixed prairie, also are reduced by burning (Wright and Bailey 1982).

In the absence of burning (and grazing) and the concomitant increase of mulch, significant reductions in the Kansas/Oklahoma southern mixed prairie occur for the dominant grasses (e.g., blue grama, buffalograss and sideoats grama), while other species (e.g., sedges, smooth brome and tall dropseed) increase dramatically (Nagel 1994). In the Texas mixed prairie, however, fire is particularly important as a control against the invasion of honey mesquite, juniper and other woody species (Wink and Wright 1973, Neuenschwander et al. 1978, Steuter and Wright 1983). Presumably because of fire suppression efforts, honey mesquite, for example, is considerably more dense now than is indicated from historical records (Michler 1850 *in* Wright et al. 1976). The invasion of these species reduces forage and causes a deterioration of the native prairie habitat. Woody plant encroachment is of sufficient concern that various means have been pursued to control them (e.g., Bryant et al. 1983).

Changes in the Mixed Prairie Ecosystem

Contemporary management has altered the mixed prairie structure and function by:

- reducing or eliminating keystone species;
- cultivating large areas;
- redistributing surface and ground water;
- altering fire frequency;
- developing extensive transportation corridors;
- introducing exotic species;
- promoting the development of woodlands; and
- establishing long-term management unit boundaries.

Changes in Extent

As a result of management activities, there has been a substantial reduction in mixed prairie (Samson and Knopf 1994). Klopatek et al. (1979) estimated the reduction of Küchler's (1985) potential mixed prairie vegetation based on a set of land-use variables collected by county during the late 1960s (Table 2). Their estimates do not account for the expansion of cropland which occurred during the 1970s, nor the conversion back to perennial vegetation which occurred under the Conservation Reserve Program in the 1980s. We compared the Klopatek et al. (1979) local data with a recent analysis of remotely sensed data (Table 2) (U.S. Geological Survey 1993). These data were derived from the land-cover characteristics data base created at the EROS Data Center (U.S. Geological Survey 1993). The data base portrays regions composed of similar land-cover mosaics, as defined by a multi-temporal Advanced Very High Resolution Radiometer (AVHRR) Normalized Vegetation Index obtained from a National Oceanic and Atmospheric Administration (NOAA) satellite during 1990, and attributes such as terrain, climate and ecoregion (Loveland et al. 1991). The land-cover product has been resampled from a 0.683-square mile (1.1 km^2) resolution to a 0.621-square mile (1 km^2) resolution. Although there are 159 land-cover types defined in the data base, we selected only those identified with native vegetation typical of the five mixed prairie types of Küchler (1985).

The lower estimates of extant mixed prairie provided by the EROS data set may be the result of additional mixed prairie loss, although it also is likely that they represent differences due to masking of small tracts and edges when analyzed at the resolution used. This is suggested by the relatively large differences between the estimates in the two most intensively farmed types (wheatgrass/bluestem/needlegrass

Table 2. Percentage of remaining mixed prairie area (extant ÷ original) based on estimates by Klopatek et al. (1979) and the EROS Data Center, Sioux Falls, South Dakota (1995).

Mixed prairie type	Percentage remaining	
	Klopatek et al.	EROS/DC
Northern mixed prairie		
Wheatgrass-bluestem-needlegrass	31	17
Wheatgrass-needlegrass	64	61
Nebraska Sandhills prairie	94	72
Southern mixed prairie		
Bluestem-grama	35	8
Mesquite-buffalograss	73	58

and bluestem/grama). The EROS data emphasize the larger, less fragmented tracts of remaining mixed prairie, while the Klopatek et al. (1979) estimates include large native prairie tracts, as well as small isolated tracts surrounded by croplands. These two estimates, therefore, have significantly different implications for conservation since ecosystem function differs greatly between expansive grasslands with few abrupt discontinuities and small grasslands surrounded by croplands (Shafer 1995).

Changes in Function

The percentage of land surface remaining in native mixed prairie vegetation is relatively large compared with the tallgrass prairie. Yet, this is a very different mixed prairie ecosystem than the one that European settlers took from the Plains Indian cultures. The native vegetation still is a dynamic reflection of the interaction between climate, soils, weather, grazing animals and fire. But the present grazing and fire regimes are determined by a very different set of ecosystem rules. These new rules operate at smaller (individual landowner) and larger (national and international commerce) scales than the mixed prairie of 500 years ago. Relatively few species have been extirpated by current management practices. However, major changes in community composition and landscape pattern have resulted from the replacement of bison with cattle, and the addition of croplands, transportation corridors and urban areas. Although changes that followed European settlement have significantly reduced critical grassland and wetland habitats, they have significantly expanded the woodland habitats. Mixed prairie woodlands are expanding due to changes in river flows (Johnson 1994), grazing and fire regimes (Steuter et al. 1990) and directly from shelterbelt planting. The presence of many large browsing mammals in the pre-Holocene fossil record (Voorhies 1990) suggests that woodlands were more common in the mixed prairie region prior to the arrival of humans around 12,000 or more years ago. We expect that mixed prairie will continue to undergo change and that humans will continue to manage the changing ecosystem.

The semi-arid climate of the mixed prairie ecosystem places a premium on the linkages between the uplands and the riparian and wetland parts of the landscape. The major functional linkage between uplands and lowlands, then, is water. Both highly mobile and sedentary species using the mixed prairie were adapted to the temporal and spatial patterns of available moisture. Surface water storage, drainage for crop production and flood control have altered the landscape pattern too rapidly for many migratory species to adapt. Thus, water conservation has become central to many management considerations.

Mixed Prairie Conservation Issues

Our understanding of mixed prairie ecology and management suggests a conservation strategy based on:

- land use and management which acknowledge the ecosystem's adaptations to limited water availability, grazing and periodic fire;
- maintaining habitats for migratory and non-migratory species; and
- taking advantage of new habitat opportunities provided by expanding woodlands.

We expect the demands on mixed prairie water resources will continue to outpace supplies. In the future, municipalities and recreation interests will compete with wildlife conservation interests for water currently allocated to agriculture. Groundwater, as well as surface water supplies, will need to be used more efficiently with emphasis on water quality. Mixed prairie communities can play a natural role in meeting these water quantity and quality objectives. When properly managed, they are a renewable source of high-quality water, food and habitat for a wide range of species and uses. Although limited in extent, wetland and riparian areas have been, and will continue to be, critical to a healthy mixed prairie ecosystem.

The vagaries of climate dictate that a dispersed and redundant system of upland and wetland habitats is available for migratory species. It should be possible to manage for non-migratory species habitat as well, if these landscapes are integrated by the critical water resource (Figure 1). The mixed prairie is predominantly privately owned and managed. Except for the Sandhills prairie, cropland acreage is regionally similar to perennial grassland. A successful strategy will need to move land management of

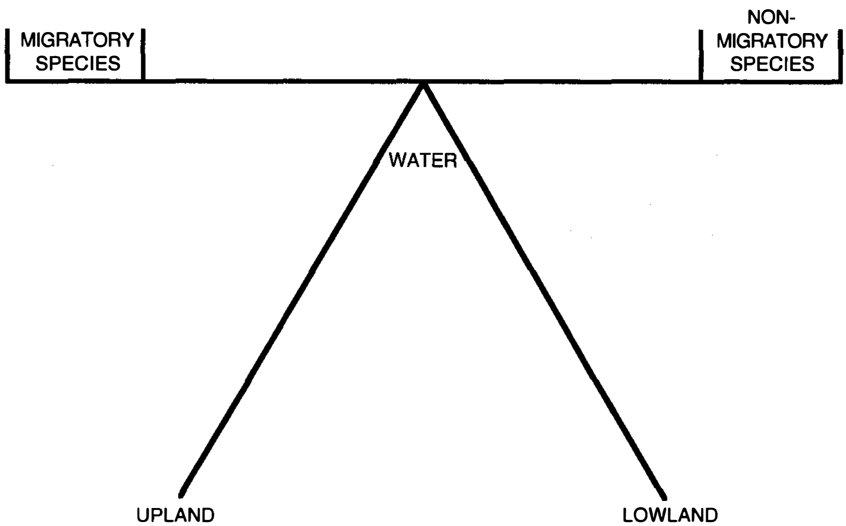


Figure 1. Schematic representation of a conservation program which acknowledges the critical role of water resources in balancing both migratory and non-migratory species protection.

both croplands and grasslands towards a more conservative use of resources. Several private/public efforts are underway through the U.S. Fish and Wildlife Service Partners for Wildlife Program, and through joint ventures by landowners, state and federal agencies, and private conservation organizations.

The impulse to remove or exclude woodlands from the mixed prairie is strong among most prairie enthusiasts. This impulse has a very real basis in recent evolutionary history. However, the mixed prairie ecosystem has changed, as have the larger ecosystems of which it is a subset. The expanding woodlands of the mixed prairie appear to be providing opportunities for offsetting habitat declines in other regions (e.g., western woodland birds). For those of us managing mixed prairie, this issue presents many dilemmas.

Certainly, mixed prairie preservation is best approached with a humble and open mind, rather than a dogmatic focus on a vision of the past or present.

References

Albertson, F. W. and G. W. Tomanek. 1965. Vegetation changes during a 30-year period in grassland communities near Hayes, Kansas. Ecology 46: 714-720.

Axelrod, D. I. 1985. Rise of the grassland biome, central North America. The Botanical Review 51: 163–201.

Barnes, P. W. and A. T. Harrison. 1982. Species distribution and community organization in a Nebraska Sandhills mixed prairie as influenced by plant/soil-water relationships. Oecologia 52: 192–201.

Barnes, P. W., L. L. Tieszen and D. J. Ode. 1983. Distribution, production and diversity of C_3- and C_4-dominated communities in a mixed prairie. Can. Jo. Botany 61: 741–751.

Barnes, P. W., A. T. Harrison and S. P. Heinish. 1984. Vegetation patterns in relation to topography and edaphic variation in Nebraska Sandhills prairie. Prairie Natural. 16: 145–158.

Biondini, M. E., A. A. Steuter and C. E. Grygiel. 1989. Seasonal file effects on the diversity patterns, spatial distribution and community structure of forbs in the northern mixed prairie. Vegetatio 85: 21–31.

Bleed, A. and C. Flowerday, eds. 1990. An atlas of the Sand Hills, Second Edition. Resour. Atlas No. 5a, Conserv. and Survey Div., Inst. Ag. and Natur. Resour., Univ. Nebraska, Lincoln. 265 pp.

Bragg, T. B. 1978. Effects of burning, cattle grazing, and topography on vegetation of the choppy sands range site in the Nebraska Sandhills prairie. Pages 248–253 *in* D. N. Hyder, ed., Proceedings of the First International Rangeland Congress. Denver, CO. 742 pp.

Bragg, T. B. 1986. Fire history of a North American Sandhills prairie (Abstract). Program of the IV Int. Cong. of Ecol. St. Univ. New York, Syracuse.

Bragg, T. B. 1995. Climate, soils and fire: The physical environment of North American grasslands. Pages 49–81 *in* K. Keeler and A. Joern, eds., The Changing Prairie. Oxford Univ. Press, New York, NY.

Brand, M. D. and H. Goetz. 1986. Vegetation of exclosures in southwestern North Dakota. J. Range Manage. 39: 434–437.

Branson, F. and J. E. Weaver. 1953. Quantitative study of degeneration of mixed prairie. The Botanical Gazette 114: 397–416.

Bryant, F. C., G. K. Launchbaugh and B. H. Koerth. 1983. Controlling mature ashe juniper in Texas with crown fires. J. Range Manage. 36: 165–168.

Bryson, R. A. and F. K. Hare, eds. 1974. World survey of climatology Volume 11: Climates of North America. Elsevier Scientific Publ. Co., New York, NY. 420 pp.

Butler, J. L. and D. D. Briske. 1988. Population structure and tiller demography of the bunchgrass *Schizachyrium scoparium* in response to herbivory. Oikos 51: 306–312.

Collins, S. L. and S. C. Barber. 1985. Effects of disturbance of diversity in mixed-grass prairie. Vegetatio 64: 87–94.

Coppock, D. L. and J. K. Detling. 1986. Alteration of bison and black-tailed prairie dog grazing interaction by prescribed burning. J. Wildl. Manage. 50: 452–455.

Coupland, R. T. 1973. Producers: I. Dynamics of above-ground standing crop. Matador Project, Can. IBP Program Tech. Rept. 27. Saskatoon, Saskatchewan. 159 pp.
DeJong, E. and K. B. MacDonald. 1975. The soil moisture regime under native grassland. Geoderma 14: 207–221.
Dix, R. L. 1960. The effects of burning on the mulch structure and species composition of grasslands in western North Dakota. Ecology 41: 49–56.
Dormaar, J. F. and W. D. Willms. 1990. Effect of grazing and cultivation on some chemical properties in the mixed prairie. J. Range Manage. 43: 456–460.
Engle, D. M. and P. M. Bultsma. 1984. Burning of northern mixed prairie during drought. J. Range Manage. 37: 398-401.
Gartner, F. R. 1986. The many faces of South Dakota rangelands: Description and classification. Pages 81–85 *in* G. K. Clambey and R. H. Pemble, eds., The prairie—Past, present and future: Proceedings of the ninth North American prairie conference. Tri-College Univ. Ctr. for Environ. Studies, North Dakota St. Univ., Fargo. 264 pp.
Gartner, F. R., R. I. Butterfield, W. W. Thompson and L. R. Roath. 1978. Prescribed burning of range ecosystems in South Dakota. Pages 687–690 *in* D. N. Hyder, ed., Proceedings of the First International Rangeland Congress. Denver, Colorado, 742 pp.
Gartner, F. R., J. R. Lindsey and E. M. White. 1986. Vegetation responses to spring burning in western South Dakota. Pages 143–146 *in* G. K. Clambey and R. H. Pemble, eds., The prairie—Past, present and future: Proceedings of the Ninth North American prairie conference. Tri-College Univ. Ctr. for Environ. Studies, North Dakota St. Univ., Fargo. 264 pp.
Haferkamp, M. R., J. D. Volesky, M. M. Bormon, R. K. Heitschmidt and P. O. Currie. 1993. Effects of mechanical treatments and climatic factors on the productivity of northern Great Plains rangelands. J. Range Manage. 46: 346–350.
Hansen, J. R. 1984. Bison ecology in the northern plains and a reconstruction of bison patterns for the North Dakota region. J. Plains Anthropological Soc. 29: 93–113.
Higgins, K. F. 1986. Interpretation and compendium of historical fire accounts in the northern Great Plains. U.S. Fish and Wildl. Serv. Resour. Publ. 161. 39 pages.
Hofmann, L. and R. E. Ries. 1989. Animal performance and plant production from continuously grazed cool-season reclaimed and native pastures. J. Range Manage. 42: 248–251.
Hopkins, H. H., F. W. Albertson and A. Riegel. 1948. Some effects of burning upon a prairie in west-central Kansas. Trans. Kansas Acad. Sci. 51: 131–141.
Hopkins, H. H. 1951. Ecology of the native vegetation of the loess hills in central Nebraska. Ecological Monogr. 21: 125–147.
Johnson, W. C. 1994. Woodland expansion in the Platte River, Nebraska: Patterns and causes. Ecological Monogr. 64: 45–84.
Kaul, R. B. and S. B. Rolfsmeier. 1993. Native vegetation of Nebraska. Map 1:1,000,000. Conserv. and Surv. Div., Inst. Ag. and Natur. Resour., Univ. Nebraska, Lincoln.
Kirsh, L. M. and A. D. Kruse. 1973. Prairie fires and wildlife. Proc. Tall Timbers Fire Ecol. Conf. 12: 289–303. Tall Timbers Res. Sta., Tallahassee, FL.
Klopatek, J. M., R. J. Olson, C. J. Emerson and J. L. Jones. 1979. Land-use conflicts with natural vegetation in the United States. Environ. Conserv. 6: 191–199.
Küchler, A. W. 1985. Potential national vegetation. National Atlas of the United States of America, U.S. Geological Survey. Reston, VA. Map.
Launchbaugh, J. L. 1964. Effects of early spring burning on yields of native vegetation. J. Range Manage. 17: 5–6.
———. 1973. Effect of fire on shortgrass and mixed prairie species. Proc. Tall Timbers Fire Ecol. Conf. 12: 129–151. Tallahassee, FL.
Loope, D. B. 1986. Recognizing and utilizing vertebrate tracks in cross section: Cenozoic hoofprints from Nebraska. Palaios 1: 141–151.
Loveland, T. R., J. W. Merchant, D. O. Ohlen and J. F. Brown. 1991. Development of a land-cover characteristics data base for the conterminous U.S. Photogrammetric Engineering and Remote Sensing 57: 1,453–1,463.
Lura, C. L., W. T. Barker and P. E. Nyren. 1988. Range plant communities of the Central Grasslands Research Station in south central North Dakota. Prairie Natural. 20: 177–192.
Mack, R. N. and J. N. Thompson. 1982. Evolution in steppe with few large, hoofed mammals. Amer. Natural. 119: 757–773.

McDonald, J. N. 1981. North American bison, their classification and evolution. Univ. California Press. 316 pp.
Michler, N., Jr. 1850. Routes from the western boundary of Arkansas to Santa Fe and valley of the Rio Grands. House Executive Document 67, 31st Congress, 1st Session, Public Document 577. Washington, D.C. 12 pp.
Mihlbacher, B. S., F. E. Smeins, G. W. Thomas and C. A. Taylor. 1989. Long-term grass dynamics within a mixed-grass prairie. Pages 25–28 *in* T. B. Bragg and J. Stubbendieck, eds., Proceedings of the Eleventh North American Prairie Conference. Univ. Nebraska Printing, Lincoln. 293 pp.
Milchunas, D. G., O. E. Sala and W. K. Lauenroth. 1988. A generalized model of the effects of grazing by large herbivores on grassland community structure. Amer. Natural. 132: 87–106.
Milchunas, D. G. and W. K. Lauenroth. 1993. Quantitative effects of grazing on vegetation and soils over a global range of environments. Ecol. Monogr. 63: 327–366.
Moore, C. T. 1972. Man and fire in the Central North American Grassland 1535–1890: A documentary historical geography. Ph.D. diss., Univ. California at Los Angeles. 155 pp.
Nagel, H. G. 1979. Analysis of invertebrate diversity in a mixed prairie ecosystem. J. Kansas Entomological Soc. 52: 777–786.
———. 1983. Effect of spring burning date on mixed-prairie soil moisture, productivity and plant species composition. Pages 259–263 *in* C. L. Kucera, ed., Proceedings of the Seventh North American prairie conference. Southwest Missouri St. Univ., Springfield. 321 pp.
———. 1994. Willa Cather Memorial Prairie: 17 years of vegetative change with limited grazing and fire. Fourteenth No. Amer. Prairie Conf. (abstract).
Neuenschwander, L. F., H. A. Wright and S. C. Bunting. 1978. The effect of fire on a tobosagrass-mesquite community in the rolling plains of Texas. The Southwestern Natural. 23: 315–338.
Ode, D. J., L. L. Tieszen and J. C. Lerman. 1980. The seasonal contribution of C_3 and C_4 plant species to primary production in a mixed prairie. Ecology 61: 1,304–1,311.
Pfeiffer, K. E. and A. A. Steuter. 1994. Preliminary response of Sandhills prairie to fire and bison grazing. J. Range Manage. 47: 395–397.
Potvin, M. A. and A. T. Harrison. 1984. Vegetation and litter changes of a Nebraska Sandhills prairie protected from grazing. J. Range Manage. 31: 55–58.
Rauzi, F. and M. L. Fairbourn. 1983. Effects of annual applications of low N fertilizer rates on a mixed prairie. J. Range Manage. 36: 359–362.
Redmann, R. E., J. T. Romo, B. Pylypec and E. A. Driver. 1983. Impacts of burning on primary productivity of *Festuca* and *Stipa-Agropyron* grasslands in central Saskatchewan. Amer. Midland Natural. 130: 262–273.
Ring, C. B., II, R. A. Nicholson and J. L. Launchbaugh. 1985. Vegetational traits of patch-grazed rangeland in west-central Kansas. J. Range Manage. 38: 51–55.
Samson, F. and F. Knopf. 1994. Prairie conservation in North America. BioScience 44: 418–421.
Schacht, W. and J. Stubbendieck. 1985. Prescribed burning in the loess hills mixed prairie of southern Nebraska. J. Range Manage. 38:47–51.
Shariff, A. R., M. E. Biondini and C. E. Grygiel. 1994. Grazing intensity effects on litter decomposition and soil nitrogen mineralization. J. Range Manage. 47: 444–449.
Sharrow, S. H. and H. A. Wright. 1977. Proper burning intervals for tobosagrass in west Texas based on nitrogen dynamics. J. Range Manage. 30: 343–346.
Sims, P. L., J. S. Singh and W. K. Lauenroth. 1978. The structure and function of ten western North American grasslands. I. Abiotic and vegetational characteristics. J. Ecol. 66: 251–285.
Singh, J. S., W. K. Lauenroth, R. K. Heitschmidt and J. L. Dodd. 1983. Structural and functional attributes of the vegetation of northern mixed prairie of North America. Botanical Rev. 49: 117–149.
Steinauer, E. M. and T. B. Bragg. 1987. Ponderosa pine (*Pinus ponderosa*) invasion of Nebraska Sandhills prairie. Amer. Midland Natural. 118: 358–365.
Steuter, A. A. 1987. C_3/C_4 production shift on seasonal burns—Northern mixed prairie. J. Range Manage. 40: 27–31.
Steuter, A. A. and H. A. Wright. 1983. Spring burning effects on redberry juniper-mixed grass habitats. J. Range Manage. 36: 161–164.
Steuter, A. A., B. Jasch, J. Ihnen and L. L. Tieszen. 1990. Woodland/grassland boundary changes in the middle Niobrara valley of Nebraska identified by $d^{13}C$ values of soil organic matter. Amer. Midland Natural. 124: 301–308.

Steuter, A. A., E. M. Steinauer, G. L. Hill, P. A. Bowers and L. L. Tieszen. 1995. Distribution and diet of bison and pocket gophers in a sandhills prairie. Ecol. Applications 5: in press.

Stubbendieck, J., T. R. Flessner, C. H. Butterfield and A. A. Steuter. 1993. Establishment and survival of the endangered blowout penstemon. Great Plains Res. 3: 3–19.

Tomanek, G. W. and F. W. Albertson. 1953. Some effects of different intensities of grazing on mixed prairies near Hays, Kansas. J. Range Manage. 6: 299–306.

Tomanek, G. W. and F. W. Albertson. 1957. Variations in cover, composition, production, and roots of vegetation in two prairies in western Kansas. Ecol. Monogr. 27: 267–281.

U.S. Geological Survey. 1993. Prototype 1990 conterminous United States land cover characteristics data set CD-ROM, EROS Data Center, U.S. Geological Survey CD-ROM Set 9307, 1 disk.

Vallentine, J. F. 1980. Range development and improvements, 2nd Edition. Brigham Young Univ. Press. Provo, UT.

Weaver, J. E. 1965. Native vegetation of Nebraska. Univ. Nebraska Press, Lincoln. 185 pp.

———. 1968. Prairie plants and their environment: A fifty-year study in the Midwest. Univ. Nebraska Press, Lincoln. 276 pp.

Weaver, J. E. and F. W. Albertson. 1956. Grasslands of the Great Plains, Johnson Publ. Co., Lincoln, NE. 395 pp.

Wells, P. V. 1965. Scarp woodlands, transported grassland soils, and the concept of grassland climate in the Great Plains region. Science. 148: 246–249.

Whisenant, S. G. 1990. Postfire population dynamics of *Bromus japonicus*. Amer. Midland Natural. 123: 301–308.

Whisenant, S. G. and D. W. Uresk. 1990. Spring burning Japanese brome in a western wheatgrass community. J. Range Manage. 43: 205–208.

Whisenant S. G., D. N. Ueckert and C. J. Scrifres. 1984. Effects of fire on Texas wintergrass communities. J. Range Manage. 37: 387–391.

Whitman, W. C. 1974. Influence of grazing on themicroclimate of mixed grass prairie. Pages 207–218 *in* Plant Morphogenesis at the Basis for Scientific Management of Range Resources. U.S. Dept. Ag. Misc. Publ., 1,271.

Wight, J. R. and A. L. Black. 1979. Range fertilization: Plant response and water use. J. Range Manage. 32: 345–349.

Willms, W., A. W. Bailey and A. McLean. 1980. Effects of clipping or burning on some morphological characteristics of *Agropyron spicatum*. Can. J. Botany 58: 2,309–2,312.

Willms, W. D., S. Smoliak and A. W. Bailey. 1986. Herbage production following litter removal on Alberta native grasslands. J. Range Manage. 39: 536–540.

Willms, W. D., S. M. McGinn and J. F. Dormaar. 1993. Influence of litter on herbage production in the mixed prairie. J. Range Manage. 46: 320–324.

Wink, R. L. and H. A. Wright. 1973. Effects of fire on an ashe juniper community. J. Range Manage. 26: 236–329.

Wright, H. A. 1974. Effect of fire on southern mixed prairie grasses. J. Range Manage. 27: 417–419.

Wright, H. A. and A. W. Bailey. 1982. Fire ecology: United States and southern Canada. John Wiley and Sons, New York, NY. 501 pp.

Wright, H. A., F. M. Churchill and W. Clark Stevens. 1976. Effect of prescribed burning on sediment, water yield, and water quality from dozed juniper lands in central Texas. J. Range Manage. 29: 294–298.

Conservation Planning Within the Great Plains

Stephen J. Chaplin, Wayne R. Ostlie, Rick E. Schneider and John S. Kenney
The Nature Conservancy
Minneapolis, Minnesota

Introduction

In conservation planning, the issue of scale is important. The protection of all species, including the variability within species, eventually demands attention to fine-scale patterns and processes, i.e., what stresses are affecting the dynamics of individual populations of threatened species. On the other hand, if the goal is to conserve the biodiversity of the grasslands of midcontinental North America, the sheer magnitude of the task forces conservation planners to look for efficiencies in action by focusing on larger geographical areas and assemblages of species or natural communities.

Planning at large scales is particularly critical in the Great Plains. There are few geographic barriers of consequence in the Plains; as a result, species tend to have widespread distributions frequently determined by climate and large-scale habitat types. The fertile nature of many prairie soils has resulted in extensive conversion to agricultural uses, especially in the eastern Great Plains (Klopatek et al. 1979). The result is a highly fragmented grassland system. Fragmentation has effectively turned what were nearly continuous populations into metapopulations of semi-independent demes. Excellent examples of this include prairie insects such as the regal fritillary (*Speyeria idalia*), prairie mole cricket (*Gryllotalpa major*) and several prairie skippers—the Dakota (*Hesperia dacotae*), ottoe (*H. ottoe*), Assiniboin (*H. assiniboia*) and poweshiek (*Oarisma poweshiek*). Protecting individual demes may be futile unless it is done within the context of understanding the large-scale functioning of the entire metapopulation (Gilpin 1987).

Another reason to focus at large scales is that disturbances once operated at that level in the prairies. Two major disturbances, fire (Axelrod 1985, Higgins 1986) and drought (Weaver and Albertson 1956, Weaver 1954), occurred at scales of many thousands of square miles. Herbivore pressure also was a frequent large-scale phenomenon. Individual herds of the estimated 60 million-strong presettlement bison population intensively impacted large areas as they moved through the landscape (Hanson 1984). At least one black-tailed prairie dog (*Cynomys ludovicianus*) town was estimated to have covered 2,500 square miles (6,475 km^2) (Bailey 1905).

Conservation Strategy

The Nature Conservancy's (TNC) Great Plains Program was initiated in 1993. The objectives of the program have been threefold: (1) to compile the information necessary for biodiversity analyses and conservation planning; (2) to consider cooperative actions which would promote the protection of biodiversity while maintaining the economic viability of local communities; and (3) to implement the most promising conservation actions in cooperation with local residents. Each of these three objectives need to be addressed at multiple scales to succeed in the ultimate goal of the Program to preserve the plants, animals and natural communities that represent the diversity of life within the Great Plains. The Great Plains Program has chosen to focus on four different scales—bioregion, ecoregion, landscape and individual site.

Bioregion

For the purposes of conservation planning, TNC defines the Great Plains as all of the former central North American grassland biome, excluding the prairie peninsula from central Iowa eastward. This boundary includes all or parts of 13 states and 3 Canadian provinces, covering more than 1 million square miles (2.59 million km^2). Working at the bioregion scale will allow an evaluation of conservation needs for wide ranging species, particularly migratory birds. Also, a number of ecological processes that affect communities and species are best understood from a large-scale perspective (e.g., climate change, some types of disturbance, long-range migration, and material transport via rivers and wind). Understanding these processes should inform our conservation action at smaller scales to ensure long-term protection of the elements of biodiversity (species and natural communities).

Ecoregion

Ecoregions are areas with similar climate, geomorphology and potential natural vegetation composed of clusters of interacting landscapes. We have designated eight ecoregions in the Great Plains using boundaries delineated by Bailey et al. (1994). These units vary in size from 56,370 square miles (146,000 km^2) to 193,436 square miles (501,000 km^2). A biodiversity analysis of Great Plains ecoregions will serve to target areas for conservation work at several levels of scale: landscapes (very coarse filter), communities (coarse filter) and species (fine filter).

Landscapes

Landscapes are defined as kilometers-wide areas where clusters of interacting vegetative stands are repeated in similar form (Forman and Godron 1986). They are the functional conservation planning units of a size large enough to encompass ecological processes and species within a mosaic of natural communities. Some landscapes have more of their native biota remaining than do others. Our focus is on Landscapes of Biological Significance, which we define as large areas of predominantly natural vegetation with concentrations of rare species and/or high-quality examples of natural communities. Because of their size, none of these landscapes are undisturbed natural areas. All have people living within them and consist of areas with varying levels of human impact (and biological significance). Landscapes are the appropriate scale to engage local residents in conservation planning and action. How those residents view and treat the natural system largely will determine the viability of the system.

Site

The finest-scale conservation planning unit is the site. It is defined in terms of the species or natural community occurrences it is designed to protect. It is the area needed to maintain a viable occurrence at least for the short term and, thus, is related to the concept of minimum area requirement (Shafer 1990). Most individual sites are less than 3,200 acres (1,295 ha) (The Nature Conservancy 1987) but can be larger for wide-ranging species or large continuous populations or communities. Sites can be complex to define if an assemblage of species of conservation interest co-occur. Site boundaries then are a composite of multiple species or community needs. Usually, there will be many sites within a Landscape of Biological Significance.

For more than two decades, TNC and the Natural Heritage Programs have employed a "coarse filter/fine filter" paradigm to identify conservation sites (Brown 1991). This approach involves the identification and protection of ecological communities as well as rare species. Identifying and protecting intact representative examples of each ecological community in an area (the course filter) assures conservation of a large proportion of the species, biotic interactions and ecological processes found in the area including members of poorly studied taxa such as lower plants, microbes and soil invertebrates. There are species (especially those which are rare) which are likely to be missed if only a few examples of each community type are protected. Protection of these species need to be addressed individually (the fine filter). The coarse filter/fine filter approach is needed both to evaluate the success of landscape-scale conservation planning activities and to supplement these activities with standard site conservation planning to protect that biodiversity not found within designated landscapes.

Conservation Goals

Resources for conservation action always are limited. Under such constraints, an objective is to use the available resources as efficiently as possible to protect regional Great Plains biodiversity. The Great Plains Program has chosen to adopt an operational goal which is both concrete and measurable.

Operation goal: *In each ecoregion, protect multiple viable examples of each natural community and imperiled species within naturally functioning landscapes.* Accomplishing this goal necessitates planning at the ecoregion, landscape and site scales. We view this operational goal, in a sense, as a hypothesis and will continually test how well it ultimately protects Great Plains biodiversity. This goal does not imply that government entities need necessarily buy or regulate private land. The nature of landownership patterns and public attitudes in the Great Plains are such that public/private partnerships at the local level probably will achieve more rapid and permanent results. It will be important to include local residents in all aspects of the efforts to protect the biodiversity of their local surroundings.

Landscapes of Biological Significance

To identify the landscapes of biological significance in the Plains, TNC developed a set of selection criteria (Table 1). Of these nine criteria, greatest emphasis was placed on three: (1) predominant natural vegetation, (2) concentrations of rare element occurrences (species and natural communities), and (3) ecoregion representation. These three were emphasized as a means of identifying the significant landscapes when other biological data may not have been detailed enough to utilize all nine (particularly in the western Great Plains).

Using these criteria, we asked state government Heritage Programs, TNC Field Offices and local biological experts to collaborate on the identification and mapping

Table 1. Selection and boundary criteria for Landscapes of Biological Significance

For preliminary nomination these criteria are meant to be flexible; it was not a requirement of nomination for landscapes to meet each of the criteria. Due to the nature of some ecoregions in the Plains (having few rare species, or human disturbances which nearly eliminated natural vegetation), and the general low level of biological information available for many areas of the Plains, very few landscapes could meet each and every criteria.

1. Continuous Natural Cover: Core areas in a potential landscape should be covered to a great extent by continuous natural vegetation, even if disturbed.
2. Concentrations of Element Occurrences: Landscapes should possess significant concentrations of rare species and high-quality community occurrences.
3. Ecoregion Representation: Landscapes should contain a significant portion of the variability in an ecoregion including geology, topography, soils and vegetation types.
4. Significant Core Area: A landscape should contain one or more significant core areas, either a very large, high-quality example of a community, or a large cluster of several high-quality community occurrences.
5. Area-linked Element Protection: A landscape should be of sufficient size to protect species and communities whose viability is linked to large acreages. Examples include fish and aquatic mollusks dependent on watershed and water quality, riverine community types, top predators, large migratory bird concentrations and large ungulates.
6. Core Viability Enhancement: Establishment of a landscape should dramatically improve the chances for maintaining the biological integrity of existing managed areas which contain important biodiversity. Landscape protection should help prevent exotic species invasions, increase stewardship options for management and perimeter defense, permit buffer restoration for animals that require interior habitat conditions, enable survival after catastrophic natural disturbances (e.g., tornados, wildfires, landslides), and allow natural disturbance regimes such as existed prior to settlement.
7. Environmental Diversity: A landscape should include the widest range of habitat variety that exists in that part of an ecoregion. For example, it should span the entire moisture gradient that is possible, from river bottoms and marshes up to rocky ridges, mountains and mesas. It also should encompass as large an altitudinal change as possible.
8. Good Design: Design of a landscape should reflect current biological conservation theory. Consideration should be given to the size and proximity of core areas, potential land uses of the matrix surrounding core areas, and the degree of connectivity of core areas within the landscape. In addition, a landscape should be a natural, defensible entity; e.g., an entire watershed, an entire mountain, a system of natural corridors and core areas. Landscape borders should follow physiographic boundaries if possible (e.g., edge of the Flint Hills landform, edge of the Turtle Mountains landform, Spearfish Creek-Little Spearfish Creek watersheds).
9. Appropriate Size: The size of a landscape should be appropriate to the ecoregion it may represent. Encompassing an entire ecoregion as a landscape is not appropriate. Depending on the ecoregion, a landscape may range from thousands to hundreds of thousands of acres.

of landscapes within their respective states. A similar process has been initiated in Canada with the Heritage Program equivalent, Provincial Conservation Data Centres (CDCs). Landscape boundaries were plotted on maps (1:500,000) and digitized into a GIS for use in analyses and planning efforts.

To date, 63 landscapes have been identified within the United States portion of the Great Plains (Table 2). Ranging in size from 13.5 square miles (35 km^2) for San Marcos Springs in Texas to 24,200 square miles (62,680 km^2) for the Sandhills of Nebraska and South Dakota, they are distributed throughout the Plains (Figure 1)

Table 2. Landscapes of the Great Plains (alphabetical and hierarchial listing).

- Alexandria Moraine (MN)
- Arbuckle Uplift (OK)
- Arikaree River Sandsage Prairie (CO, KS, NE)
- Arkansas River Sandsage (KS)
- Big Stone Potholes (MN)
- Black Hills and Grasslands
  - Black Hills (SD, WY)
  - Badlands (SD)
- Central Plains Wetlands
  - Great Salt Plains (OK)
  - Central Kansas Wetlands (KS)
    - Cheyenne Bottoms
    - Jamestown Marsh
    - Lincoln Salt Marsh
    - McPherson Wetlands
    - Ninescah Marsh
    - Quivira Wetlands
    - Slate Creek Marsh
    - Talmo Salt Marsh
    - Tuthill Salt Marsh
  - Rain Water Basin (NE)
- Central Platte River (NE)
- Cimarron River
  - Lower Cimarron (KS, OK)
  - Upper Cimarron Mesas (CO, KS, NM, OK)
- Chalk Breaks (KS)
- Clymer Prairie (TX)
- Coastal Sand Plain (TX)
- Cross Timbers[a] (OK)
- Des Moines River (IA, MN)
- Devil's Lake Basin (ND)
- Devil's River/Dolan Creek (TX)
- Eastern Nebraska Saline Wetlands (NE)
- Flint Hills (KS, OK)
- Fort Hood (TX)
- Fort Worth Prairie (TX)
- Glacial Lake Agassiz
  - Agassiz Beach Ridges (MN)
  - Aspen Parkland (MB, MN)
  - Sheyenne Delta (ND)
- Great Plains Pine Escarpments (NE, SD)
  - Cheyenne Table Escarpment (NE)
  - Pine Ridge (NE, SD)
  - Wildcat Hills (NE)
- High Plains Border[a] (OK, TX, KS)
- Killdeer Mountains/Lower Little Missouri River (ND)
- Little Missouri Badlands (ND)
- Little Sioux River (IA)
- Loess Hills (IA, MO)
- Minnesota River
  - Middle Minnesota River (MN)
  - Upper Minnesota River (MN, SD)
- Missouri Coteau
  - Bijou Hills[a] (SD)
  - Comertown Prairie (MT)
  - Lostwood (ND)
  - Medicine Lake Sandhills (MT)
  - Orient Hills[a] (SD)
  - Ree Heights[a] (SD)
  - Southern Missouri Coteau (ND, SD)
- Missouri River
  - Unchannelized Missouri River (NE, SD)
  - Upper Missouri/Yellowstone (MT, ND)
- Neosho River (KS, OK)
- Northeast Blackland Prairie (TX)
- Osage Cuestas Tallgrass
  - Anderson County Tallgrass (KS)
  - Eldorado Springs Tallgrass (MO)
  - Liberal Tallgrass (MO)
  - Lockwood Tallgrass (MO)
  - Marais des Cygnes River (KS)
  - Marmaton River (KS, MO)
  - Sedalia Tallgrass (MO)
- Pembina Gorge (MB, ND)
- Prairie Coteau
  - Prairie Coteau (MN, SD)
  - Sisseton Escarpment (MN, SD)
- Red Hills (KS, OK)
- Rolling Red Prairies (TX)
- Sandhills (NE, SD)
- Smokey Hills (KS)
- Souris River (MB, ND)
- Southeastern Sandhills (OK)
- Sweetwater Sandhills (OK, TX)
- Texas Hill Country
  - Balcones Canyonlands, Northeast (TX)
  - Balcones Canyonlands, Southwest (TX)
  - Comal Springs (TX)
  - San Marcos Springs (TX)
- Tule Canyon/Palo Duro Canyon (TX)
- Turtle Mountains (MB, ND)
- Verdigris River (KS, OK)
- West Bijou Creek (CO)
- Western High Plains Grasslands[a] (CO, NE, WY)
- White Cloud Blufflands (KS, NE)
- Wichita-Quartz Mountains Archipelago (OK)

[a]Boundaries for these landscapes have yet to be determined and, consequently, have not been mapped.

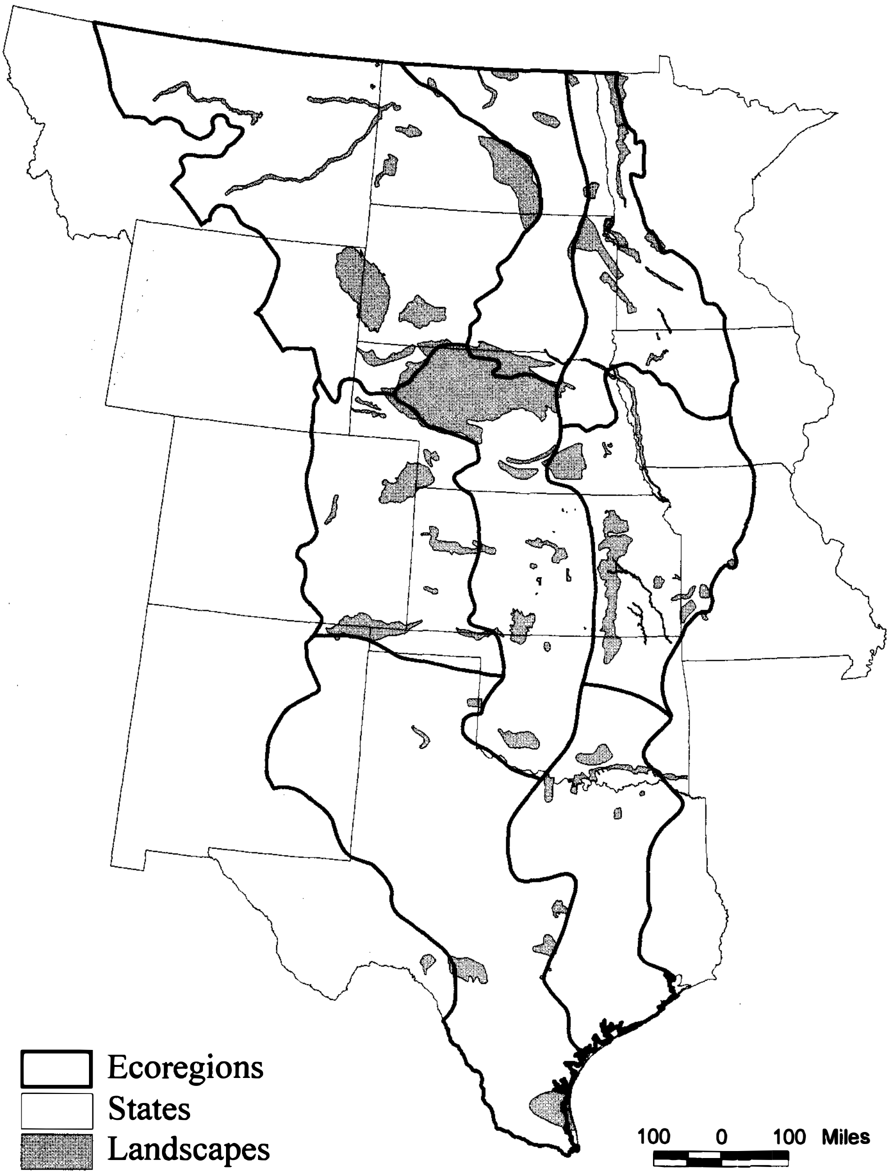


Figure 1. Ecoregions and currently identified Landscapes of Biological Significance in the U.S. portion of the Great Plains. The landscapes depicted do not necessarily reflect the boundaries of any proposed conservation activity.

and encompass a wide variety of natural community types. The landscapes average 1,250 square miles (3,238 km^2) in size and together make up 85,100 square miles (220,400 km^2), or about 10 percent of the total area of the United States portion of the Great Plains.

Within the coarse filter/fine filter paradigm for conservation planning, landscapes are the *very* coarse filter. To serve as very coarse biodiversity filters, landscapes should capture a significant portion of the variability in an ecoregion. However, there are several reasons why the landscapes selected as biologically significant may not represent the full array of landscapes present in presettlement times. The conversion of large portions of the native prairie to agricultural uses has had dramatic effects on the species and natural communities of the Plains. This is particularly true in the tallgrass prairie of the eastern Plains. The vast majority of the fertile mesic prairie has been converted to rowcrop agriculture over the past 150 years. What remains intact are a few areas where the soil was too rocky or shallow to plow. No landscape-scale mesic prairie complexes remain in the eastern Plains to be identified, and any effort designed to recreate them would require an immense restoration effort (Shafer 1995).

Inventory bias also has compounded problems with ecoregion representativeness. This is most pronounced in the western two-thirds of the Plains where the perception is that natural vegetation still is relatively intact and is, consequently, a lower priority for biological inventory. The result is a general lack of data on the most common vegetation types of each ecoregion. Those areas studied to any great degree within the western Plains have been the atypical areas (e.g., sandhills, mesas, riparian areas) which attract inventory due to their concentrations of rare species or unique flora. Enhanced inventory of the western Great Plains and in Canada would further facilitate the identification of Landscapes of Biological Significance.

Ecological Communities

Over the last 20 years, communities have been used to help develop conservation priorities only on a state-by-state basis. Community information was systematically collected by biologists from the state Natural Heritage Programs and others. This information was used to develop and refine state-level community classifications and associated conservation ranks. A major obstacle to using communities as conservation units at the regional and national levels was the lack of a consistent national classification system. To overcome this problem, TNC, in conjunction with Natural Heritage Programs and CDCs, have developed a standardized hierarchical system to facilitate the identification and classification of vegetated terrestrial communities across the United States (The Nature Conservancy 1994).

This national classification system was primarily developed for the purposes of conservation planning and biodiversity protection. The intent of the classification system is to provide a complete, standardized listing of all communities that represent the variation in biological diversity and to identify communities that require protection. The classification will be consistent throughout the United States at appropriate scales for the management and long-term monitoring of ecological communities and ecosystems. It also is intended to have applications as a vegetation data layer in landscape and ecosystem characterization.

This terrestrial community classification is hierarchical and combines physiognomy at the highest levels of the hierarchy and floristics at the lowest levels. The physiognomic portion is a modification of UNESCO (1973) and Driscoll et al. (1984), and utilizes the physical form of the dominant vegetation to organize the units. An important aspect of the classification is that the community elements are related to a set of environmental factors rather than to a particular site. This ensures that the classification has ecological meaning over a broad geographic range. The classification is broadly defined and includes vegetation of uplands, as well as emergent and rooted submergent vegetation of marshes, lakes, ponds, rivers and marine shores.

The Great Plains section of this national classification recently has been completed. Community data from the respective Heritage Programs and CDCs is being merged into a regional spatial database which will make possible for the first time a rangewide analysis of Great Plains communities. The distribution of community types will be evaluated in relation to the currently identified Landscapes of Biological Significance to determine what portion of the diversity those landscapes contain. Additional landscapes may be proposed by locating clusters of rare and/or high-quality common communities.

Rangewide analyses also will facilitate more traditional, smaller-scale conservation efforts. Combined with data on occurrence quality, we can target for protection those sites that best can preserve a community type. The rangewide database also will help determine gaps in existing data and target future inventory work.

Within the Great Plains, 663 community types have been identified (Table 3). A number of the forest types have their primary range of distribution outside the Great Plains boundary, to the east or west. The non-forest types have their range primarily or entirely within the Great Plains, while the vast majority of the rare types are endemic.

The rare communities are imperiled for a variety of reasons. Some, such as the saline marshes of Nebraska, were rare even in presettlement times because they were dependent on an uncommon set of environmental conditions. Human alterations have further reduced these natural rare communities. Many of the others have become imperiled or degraded due to human actions such as conversion to agricultural or other uses, alteration of disturbance regimes, or the introduction of livestock grazing. The high proportion of rare sparse-woodland (savannas) is due to a combination of conversion and fire suppression. Those savannas that were not cleared and plowed have succeeded to woodlands or forests in the absence of fire. The large number of rare tallgrass communities reflects their nearly complete conversion to farmland. The forb-dominated communities are primarily wetland types. The high percentage of

Table 3. Terrestrial communities of the Great Plains. Rare communities are those which have been ranked G1 (critically imperiled globally) or G2 (imperiled globally). The graminoid-dominated herbaceous types include a range of hydrologic conditions from marshes and fens to upland prairies.

Class	Number of types	Number of rare types	Percentage of rare types
Forest	144	16	11
Woodland	109	20	18
Sparse-woodland	14	8	57
Shrubland	143	19	13
Herbaceous			
Tallgrass	76	17	22
Midgrass	96	13	14
Shortgrass	33	7	21
Forb dominated	18	7	39
Total	633	107	17

rare types in this category reflects both their natural rarity in the Great Plains and the results of wetland drainage and filling.

Rare Species

Individual species conservation is the fine filter in biodiversity protection planning. This is the approach often taken under the Endangered Species Act and is intended to focus on species that have not been adequately protected at the landscape (very coarse) or community (coarse) levels.

We compiled a centralized element occurrence database of 18,400 records from the existing Heritage/CDC Programs in the Great Plains (Figure 2). These programs maintain detailed information on the location and condition of rare species and natural communities occurring within their respective states/provinces (Morse 1993) and rank them by their level of global imperilment. These global ranks range from G1 which indicates a particular element is critically imperiled to G5 which indicates that it is demonstrably secure (Master 1991).

Compared with other geographic regions in the United States, the Great Plains is relatively depauperate in rare species. Despite the fact that the Plains encompass approximately 28 percent of the continental U.S. land mass, only 7.5 percent of all G1–G3 species and 6.3 percent of all G1–G3 species occurrences found within the continental United States occur within its borders (Table 4). A high proportion of these rare species are endemic to the Great Plains. One hundred and thirty-four of the 285 G1–G3 species found in the Great Plains are considered to be endemic to the region, and another 57 have the bulk of their range within the Plains (Table 5).

Despite the relatively small numbers of rare or endemic species, persistent trends in habitat loss throughout the region have led to decreases in once-common species. For example, recent analyses of trends have shown that grassland nesting birds have exhibited more consistent, widespread and steeper declines in the last 25 years than any other North American bird group (Knopf 1994). Assessments of Heritage data show that 59 federally listed species occur in the Plains. However, a relatively large number of species (140) occurring in the Plains are candidates for federal listing. Reversing the trends of decline in these candidate species is a significant conservation objective. It is this group of species that will have the greatest impact on landowners in the future if trends of decline continue.

Long-term protection of rare and declining species is most likely to be successful if the species are maintained within functioning landscapes. These species have evolved with and are adapted to large-scale processes. While the selected landscapes encompass only 10 percent of the Great Plains, they contain populations of 41 percent of the G1–G3 species. In addition, 32 percent of all the known occurrences of G1–G3 species in the Plains are found within these landscapes (Table 4). However, the majority of rare species and their known occurrences are found outside of currently identified landscape areas.

To understand better whether the identified landscapes adequately encompass rare species, spatial analyses of individual taxa need to be undertaken. For example, a number of high-quality occurrences of Mead's milkweed (*Asclepias meadii*) do fall within identified landscapes (Figure 3), but other important occurrences are found outside landscape boundaries and will need to be addressed at the site level.

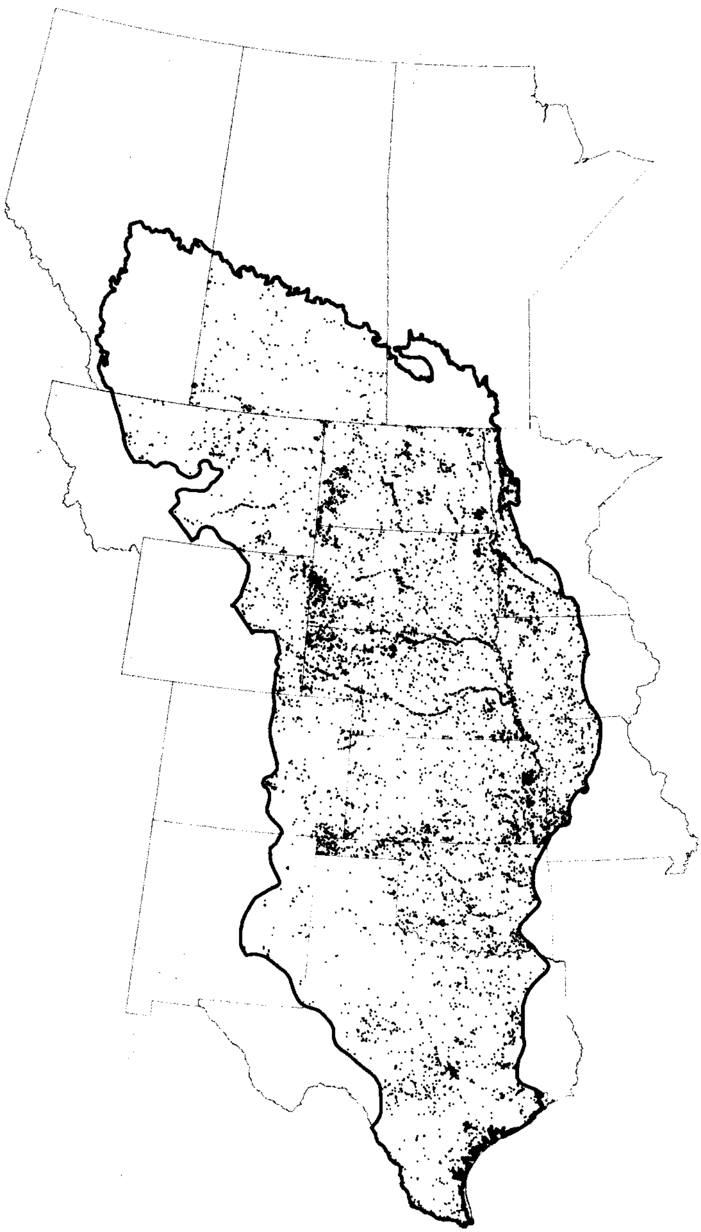


Figure 2. Documented rare species and high-quality community occurrences in the Great Plains. Data were supplied by State Natural Heritage Programs and Provincial Conservation Data Centres. Data are not yet available in this format from Alberta and Manitoba. The data depicted are not based on a comprehensive inventory of each state or province, but rather were compiled from state field surveys, systematics collections, county inventories, publications, expert observation, university research, government agency inventories and other sources.

Table 4. G1–G3 species and species occurrences within the Great Plains and currently identified Landscapes of Biological Significance. Percentages are based on the proportion of G1–G3 species and species occurrences of (1) the continental United States which are found in the Great Plains, and (2) the Great Plains which are found within the currently identified Landscapes of Biological Significance.

	Number and percentage of U.S. species found in the Great Plains				Number and percentage of Great Plains species found in landscapes			
	Species		Species occurrences		Species		Species occurrences	
Taxonomic group	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Vascular plants	167	7.1	1,954	4.5	55	32.9	450	23.0
Invertebrate animals	42	5.6	696	7.9	25	59.5	370	53.2
Vertebrate animals	76	12.2	2,331	8.8	37	48.7	778	33.4
Amphibians	11	14.7	61	2.9	5	45.5	16	26.2
Birds	17	25.0	1,445	11.9	9	52.9	545	37.7
Fish	27	9.4	592	13.2	12	44.4	159	26.9
Mammals	8	6.9	159	4.7	6	75.0	35	22.0
Reptiles	13	16.3	74	1.7	5	38.5	23	31.1
Total	285	7.5	4,981	6.3	117	41.1	1,598	32.1

Table 5. Endemism of G1–G3 species in the Great Plains. A species is considered endemic if all of its global distribution is within the Great Plains, mostly within Great Plains if 50–99 percent of its known occurrences are in the Great Plains, mostly outside Great Plains if 10–49 percent of its known occurrences are in the Great Plains and peripheral if less than 10 percent of its known occurrences are in the Great Plains.

Taxonomic group	Endemic	Mostly within Great Plains	Mostly outside Great Plains	Peripheral	Total
Vascular plants	87	31	29	20	167
Invertebrate animals	13	7	15	7	42
Vertebrate animals	34	19	14	9	76
Amphibians	10	0	0	1	11
Birds	2	8	6	1	17
Fish	11	7	4	5	27
Mammals	4	2	2	0	8
Reptiles	7	2	2	2	13
Total	134	57	58	36	285

A significantly smaller percentage of federally listed species occur on federally owned land in the Great Plains than in the United States as a whole. In the United States, 36 percent of all known listed species occurrences are found on federal land (Natural Heritage Data Center Network 1993), while in the Great Plains, 19 percent occur on federal lands. Only 12 percent of federal candidate species occurrences in the Plains are found on federal lands. Because most non-federal lands in the Great Plains are privately owned, the success of any conservation initiative will depend largely upon strong support from private landowners.

Acknowledgments

We greatly benefitted from discussion with Kerry Herndon, Brenda Groskinski, Rob McKim, Jo Clark, Peter Buesseler, Hal Watson, Shawn Canady and other participants in the Great Plains Partnership. Data and many helpful suggestions were provided by the Colorado Natural Heritage Program, Iowa Natural Areas Inventory, Kansas Natural Heritage Inventory, Minnesota Natural Heritage and Nongame Research Program, Missouri Natural Heritage Database, Montana Natural Heritage Program, Nebraska Natural Heritage Program, New Mexico Natural Heritage Program, North Dakota Natural Heritage Inventory, Oklahoma Natural Heritage Inventory, South Dakota Natural Heritage Data Base, Texas Parks and Wildlife Department, Wyoming Natural Diversity Database, Manitoba Conservation Data Centre, and Saskatchewan Conservation Data Centre.

Although the research described in this paper has been funded in part by the U.S. Environmental Protection Agency under assistance agreement number X007803–01–1 to The Nature Conservancy, it has not be subjected to the Agency's peer and administrative review and, therefore, may not necessarily reflect the views of the Agency and no official endorsement should be inferred. Neither should the interpretations, conclusions and recommendations of this paper necessarily be attributed to the Great Plains Partnership, state Heritage Programs or provincial Conservation Data Centres.

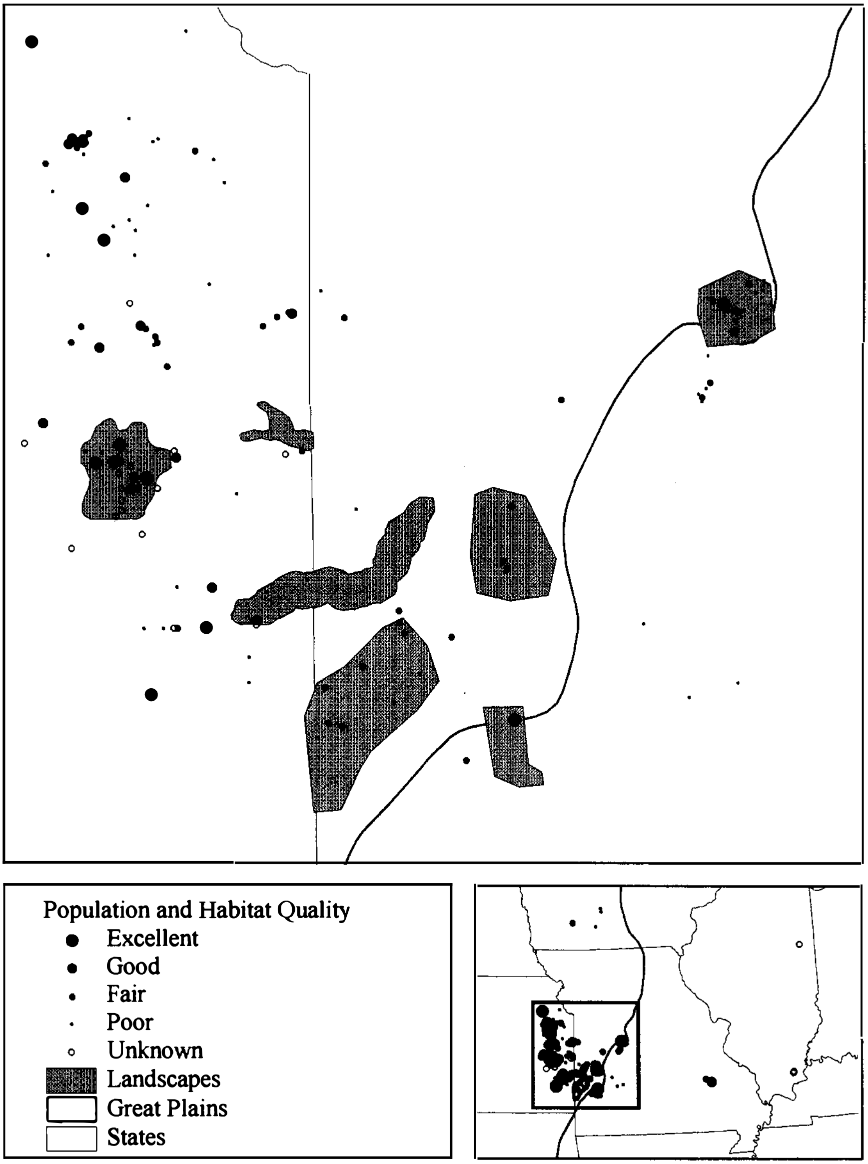


Figure 3. Documented distribution of Mead's milkweed (*Asclepias meadii*) with respect to currently identified Landscapes of Biological Significance.

References

Axelrod, D. I. 1985. Rise of the grassland biome, central North America. The Botanical Rev. 51: 163–201.

Bailey, R. G., P. E. Avers, T. King and W. H. McNab. 1994. Ecoregions and subregions of the United States. USDA For. Serv., Washington, D.C. Map.

Bailey, V. 1905. Biological survey of Texas. U.S. Biological Survey, North American Fauna 25. 222 pp.
Brown, B. A. 1991. Landscape protection and The Nature Conservancy. Pages 66–71 *in* W. E. Hudson, ed., Landscape linkages and biodiversity. Island Press, Washington, D.C. 196 pp.
Driscoll, R. S., D. L. Merkel, R. L. Radloff, D. E. Snyder and J. S. Hagihara. 1984. An ecological land classification framework for the United States. USDA For. Serv. Misc. Publ. No. 1,439. Washington, D.C. 56 pp.
Gilpin, M. E., 1987. Spatial structure and population vulnerability. Pages 125–139 *in* M. E. Soule, ed., Viable populations for conservation. Cambridge Univ. Press, Cambridge. 584 pp.
Forman, R. T. T. and M. Godron. 1986. Landscape Ecology. John Wiley and Sons, New York, NY. 619 pp.
Hanson, J. R. 1984. *Bison* ecology in the northern Great Plains and a reconstruction of *Bison* patterns for the North Dakota region. Plains Anthropologist 29: 93–113.
Higgins, K. F. 1986. Interpretation and compendium of historical fire accounts in the northern Great Plains. Resour. Publ. 161. U.S. Fish and Wildlife Service, Washington, D.C. 39 pp.
Klopatek, J. M., R. J. Olson, C. J. Emerson and J. L. Joness. 1979. Land-use conflicts with natural vegetation in the United States. Environ. Conserv. 6: 191–199.
Knopf, F. L. 1994. Avian assemblages on altered grasslands. Studies in Avian Biol. 15: 247–257.
Master, L. L. 1991. Assessing threats and setting priorities for conservation. Conserv. Biol. 5: 559–563.
Morse, L. E. 1993. Standard and alternative taxonomic data in the multi-institutional Natural Heritage Data Center Network. Pages 69–79 *in* F. A. Bisby, G. F. Russell and R. J. Pankhurst, eds., Designs for a global plant species information system. Systematics Assoc. Special Vol. No. 48, Clarendon Press, Oxford. 350 pp.
Natural Heritage Data Center Network. 1993. Perspectives on species imperilment. The Nature Conserv., Arlington, VA. 40 pp.
Shafer, C. L. 1995. Values and shortcomings of small reserves. Bioscience 45: 80–88.
———. 1990. Nature reserves: Island theory and conservation practice. Smithson. Inst. Press, Washington, D.C. 189 pp.
The Nature Conservancy. 1994. Standardized national vegetation classification system. Arlington, VA 209 pp.
———. 1987. Preserve selection and design operations manual. Arlington, VA. 143 pp.
United Nations Educational, Scientific and Cultural Organization (UNESCO). 1973. International classification and mapping of vegetation, Series 6, Ecology and Conservation. Paris, France: United Nations Educational, Scientific and Cultural Organization. 93 pp.
Weaver, J. E. 1954. North American prairie. Johnsen Publ. Co., Lincoln NE. 348 pp.
Weaver, J. E. and F. W. Albertson. 1956. Grasslands of the Great Plains: Their nature and use. Johnsen Publ. Co., Lincoln, NE. 395 pp.

Working Partnerships for Conserving the Nation's Prairie Pothole Ecosystem—The U.S. Prairie Pothole Joint Venture

Steven J. Kresl
U.S. Fish and Wildlife Service
Woodworth, North Dakota

James T. Leach
U.S. Fish and Wildlife Service
Fort Snelling, Minnesota

Carol A. Lively
U.S. Fish and Wildlife Service
Denver, Colorado

Ronald E. Reynolds
U.S. Fish and Wildlife Service
Bismarck, North Dakota

Introduction

In a wet spring such as this, there is almost as much sky on the ground as in the air. The county is dotted with sloughs, every depression is full of water, the roadside ditches are canals. In deep sloughs tules have rooted, and every such pond is dignified with mating mallards. . . .

Stegner (1962)

If Wallace Stegner had been travelling through parts of the Prairie Pothole Region (PPR) in the spring of 1994, he might have recalled these words. In 1994, wetland numbers in the northcentral U.S. (which includes much of PPR) were the highest since comparable surveys began in 1974. Breeding duck numbers in the same area were 8.75 million, an increase of 104 percent over the previous years (Caithamer et al. 1994).

In July 1994, U.S. Fish and Wildlife Service (USFWS) Director, Mollie Beattie said, "While this is just one year's results, we finally have some good news to cheer about. The dramatic improvement in duck breeding populations should be a rallying point to redouble our efforts to conserve and restore the wetland habitat on which waterfowl and other wildlife depend."

The PPR is renowned for its production of ducks and other wetland-dependent wildlife. Since settlement, agriculture has had a tremendous impact on the prairie grassland ecosystem. The destruction and degradation of grassland and wetland habitats have most certainly had a negative impact on migratory birds in the PPR. According to the Breeding Bird Survey, grassland birds have declined dramatically in some areas of the U.S. Less than 18 percent of grassland birds show positive continental population trends from 1966–1991 (Peterjohn and Sauer 1993). Although continental populations of breeding ducks increased moderately in 1994, populations of species such as northern pintail (*Anas acuta*), blue-winged teal (*A. discors*) and mallard (*A. platyrhynchos*) generally have declined during the last three decades (Caithamer et al. 1994).

For prairie-nesting duck species, population declines can be attributed mostly to low recruitment, partially as a result of low nest success. Klett et al. (1988) concluded that nest success in much of the U.S. PPR was inadequate to maintain populations of five of the most common upland-nesting duck species studied: predators caused most nest failures.

The increased breeding populations of ducks that occurred in the northcentral U.S. in 1994 primarily was the result of the increased numbers of wetlands available. Abundant precipitation during the summer of 1993, near record snowfall during the winter of 1993–1994 and abundant rainfall during the spring and summer of 1994 recharged prairie wetlands, many of which had been dry for more than five years because of drought.

However, the picture is a little bigger than just increased precipitation. Waiting in the wings to capitalize on the return of water were a combination of factors. These include: (1) the North American Waterfowl Management Plan (NAWMP); (2) the U.S. Department of Agriculture's (USDA) Conservation Reserve Program (CRP), with more than 12 million acres (4,858,300 ha) of undisturbed grass habitat in the northcentral plains states (USDA unpublished reports); (3) the protection, restoration and enhancement of wetlands and grasslands on public and private land; and (4) a holistic approach to resource conservation by numerous agencies, organizations and individuals. These factors greatly contributed to increased waterfowl production in the U.S. PPR in 1994. For, in the spring of 1994, Wallace Stegner's words could be modified to say that "every such pond is dignified with young mallards. . . ."

This paper will review the working arm of the NAWMP in the U.S. portion of the PPR; the Prairie Pothole Joint Venture (PPJV), its contributions to the continental waterfowl population and its role in the conservation of the prairie wetland landscape.

A Commitment to Waterfowl Conservation

Over the last century, committee sportsmen and women, wildlife managers, and others, have worked to reverse the continuing decline of duck numbers and habitat in North America. Despite these efforts, in 1985, continental duck numbers reached their lowest point in 40 years (Caithamer et al. 1994). As a result, biologists, managers and other conservationists in the U.S. and Canada sounded a rallying cry for the need for increased efforts to conserve North America's waterfowl resources. It was recognized that to be successful, large amounts of critical habitat would have to be affected in the primary breeding and wintering areas of waterfowl. Because most land in the primary range of ducks is held in private ownership, any efforts to increase productivity would require cooperation from these landowners.

Several years of planning and coordination came together in 1986 when the NAWMP was signed by the U.S. and Canada (USFWS 1986). This historic agreement revealed a vision for continental waterfowl and wetland conservation and produced a course of action for both countries to take by the year 2000. In 1989, Mexico, with its many critical wintering areas, became a signatory to the NAWMP and, in 1994, became a full partner. This made the continental approach to waterfowl management complete, facilitating an integrated approach to the planning, coordination and implementation of wetland conservation activities on the North American continent.

The NAWMP: (1) recognized "loss and degradation of habitat" as the major waterfowl management problem in North America; (2) identified the need for long-term protection, restoration and enhancement of habitat on an ecosystem basis, including long-term land-use changes; and (3) set goals and objectives for the protection and improvement of habitat. One goal of the NAWMP was to reach a breeding duck population of about 62 million birds that would produce an average autumn flight of about 100 million ducks (levels last seen in the 1970s). To accomplish this by the year 2000, the NAWMP called for the protection, restoration and enhancement of 6 million acres (2,428,200 ha) at a projected cost of $1.5 billion (U.S. dollars). It was acknowledged that achieving these waterfowl objectives would "require an unprecedented partnership of public and private organizations from a wide spectrum of society."

Thirty-four important habitats, including breeding, migrating and wintering areas were identified. Six key geographical areas also were selected as areas where the work would be initiated. These areas included the Prairie Potholes and Parklands, the Lower Mississippi Valley, the Gulf Coast, the Central Valley of California, the Great Lakes/St. Lawrence Basin and the Atlantic Coast.

The NAWMP acknowledged that the job of protecting and enhancing such vast areas would require more than one agency or organization. The NAWMP recommended the development of coalitions, known as joint ventures, to carry out this seemingly enormous task. In the U.S., the following Joint Ventures were established: U.S. Prairie Pothole; Atlantic Coast; Lower Mississippi Valley; Gulf Coast; Central Valley; and Lower Great Lakes/St. Lawrence Basin.

Joint Ventures were composed of federal, state and local government agencies, conservation organizations, sportsmen's groups, and private landowners. The concept was to blend resources from a geographic area to maximize financial, organizational and other support toward common objectives. A management board was established to define priorities and direction for each Joint Venture. Steering committees that brought together participating partners were established to carry out projects at the local levels. By 1988, the six original Joint Ventures were in operation.

Since the signing of the NAWMP in 1986, partners have invested more than $500 million for waterfowl and wetland conservation and more than 2 million acres (809,400 ha) of habitat have been protected, restored or enhanced (USFWS 1994a). Four new Joint Ventures have begun, and many new partners jointed the effort, bringing diversity in outlook and added strength to the conservation effort. In 1994, the NAWMP was updated, further expanding the commitment and vision. The 1994 update states: "The plan's purpose is to achieve waterfowl conservation while maintaining or enhancing associated ecological values in harmony with other human needs."

A Cooperative Effort for Wildlife and Wetlands—The U.S. Prairie Pothole Joint Venture

The PPJV (Figure 1) is located in what was, historically, a large grassland ecosystem. It is dotted with millions of wetlands that were formed when glaciers advanced

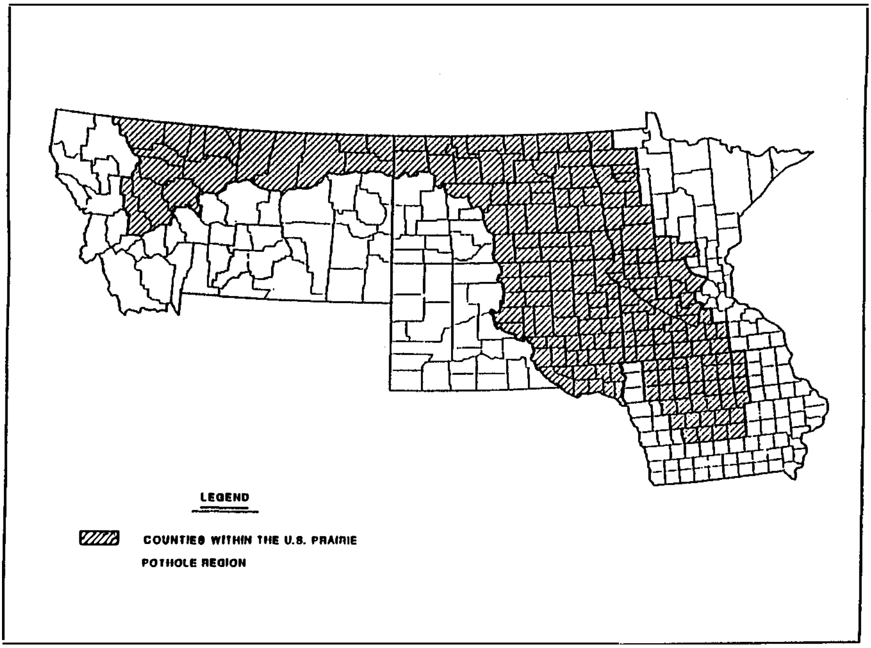


Figure 1. Counties within the U.S. Prairie Pothole Region (U.S. Fish and Wildlife Service).

and retreated across the prairies about 11,000 years ago. Once a myriad of wetlands in a sea of native prairie, the area now is the intensively farmed "bread basket" of the country. In the U.S., North and South Dakota and eastern Montana (these three states contain most of PPR in the U.S.) cover approximately 60 million acres (24,282,000 ha). Wetland drainage in the three states, largely for agricultural purposes, has reduced the original 7.2 million acres (2,913,840 ha) of wetlands by more than 40 percent to 3.9 million acres (1,578,330 ha), and native prairie, mostly mid-grass, has been reduced by 75 percent to 14.9 million acres (6,030,030 ha) (USFWS 1994b). Most of the remaining grassland is heavily grazed by livestock. Changes in land use and wetland drainage have accelerated downstream flooding, negatively impacted water quality and degraded fish and wildlife habitat.

Despite these changes in the landscape, the area remains rich in wildlife. Prairie wetlands are the life blood for waterfowl and other migratory water birds. As an example of the importance of the PPR, mallards produced there are harvested in all four waterfowl flyways and several provinces in Canada (Munro and Kimball 1982). In addition, the PPR also provides breeding habitat for more than 200 species of nongame migratory birds, many of which migrate to the tropics. Several species currently listed as endangered, threatened or candidates for listing under the Endangered Species Act use the PPR during breeding or migration periods. These include piping plover (*Charadrius melodus*), ferruginous hawk (*Buteo regalis*), black tern (*Chlidonias niger*), Baird's sparrow (*Ammodramus bairdii*), bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), whooping crane (*Grus americana*) and interior least tern (*Sterna antillarum*).

Based on the 1993 PPJV Accomplishment Report (US PPJV 1994a), since organization in 1987, the PPJV has protected, restored and enhanced a total of nearly 1,900,000 acres (768,930 ha) of wetland and grassland habitat. Partners have generated about $140 million in support of PPJV habitat activities. In addition, the USDA's CRP has converted nearly 6.8 million acres (2,751,960 ha) of cropland to undisturbed grass/legume cover in the PPR for a ten-year period. The USDA Water Bank Program (WBP) has been another major contributor, enrolling 380,000 acres (153,786 ha) in Montana, North and South Dakota, and Minnesota. North American Wetlands Conservation Act Funds totaling $30 million and matching money from non-federal partners has restored, protected or enhanced a total of more than 195,000 acres (79,137 ha) of habitat in the PPJV.

Specific PPJV habitat projects are carried out by federal and state agencies, landowners, communities, businesses, conservation organizations, colleges and universities, schools and youth groups, and other concerned citizens/conservationists who live and work in the five-state area of the PPR.

In 1994, the PPJV reflected on its accomplishments and updated its original implementation plan (US PPJV 1994b). The goal was to "increase waterfowl populations through habitat conservation projects that improve natural diversity across the U.S. Prairie Pothole landscape." Based on improved waterfowl information and population models, new waterfowl population objectives were established. The PPJV will strive to provide breeding habitat capable of supporting 6.8 million breeding ducks that produce an autumn flight of 9.5 million ducks under average environmental conditions. Habitat acreage targets are being established to meet population objectives.

While ducks continue to be a major focus of the PPJV, other wildlife, in particular wetland/grassland migratory birds and threatened and endangered species, will be addressed through new partners such as Wetlands for the Americas and Partners in Flight. A PPJV objective was added to "stabilize or increase populations of declining wetland/grass wildlife species in the PPR, with special emphasis on non-waterfowl migratory birds." Integrated conservation planning and management actions that benefit waterfowl and other migratory birds of the PPR will be developed. it is hoped that additional financial resources and partnerships can be generated to address these additional objectives.

Implementing the PPJV

The fundamental problems impeding attainment of the objectives for the PPJV are habitat loss and degradation. Primarily as a result of agricultural activities, loss of wetlands through drainage and agricultural conversion of native grasslands to cropland has negatively impacted migratory bird populations that depend on the prairie grassland and wetland ecosystem. Habitat fragmentation has caused the amount of secure nesting cover to be drastically reduced. This has resulted in increased negative impacts of nest predators on ground-nesting birds to the point where populations often cannot be maintained.

The primary means by which PPJV partners will improve waterfowl and other grassland wildlife populations is through the protection and restoration of grasslands in association with wetland complexes. Implementation strategies utilized by the partners address PPJV objectives which, in turn, support the goal of the PPJV. All implementation strategies continue to emphasize waterfowl production and recruitment while providing additional benefits to other grassland/wetland associated wildlife. For example, where large grassland areas are secure, wetlands are being restored, enhanced or created to increase wildlife production. In areas where intensive cultivation is the dominant land use, more intensive conservation strategies are implemented. These may include a combination of practices such as grassland or wetland easement/leases, nesting structures and predator management.

The PPJV partners recognize that the majority of wetlands, grasslands, waterfowl and other wildlife occur on private lands. In fact, more than 95 percent of the PPR is privately owned (USFWS 1994b). Provision of habitat and production of waterfowl and other wildlife must include adequate compensation or benefits for private landowners, who, in most cases, must maintain profitable agricultural enterprises. This approach remains the key to the success of the PPJV.

Because agriculture is the predominant land use within the PPJV, USDA conservation programs are vital to achieving PPJV objectives. Traditional natural resource management agencies and organizations have limited impact on agricultural land practices. Conservation provisions in U.S. farm bills and individual landowner practices provide the greatest opportunities for habitat improvements on private lands in the PPJV. Though not targeted specifically toward wildlife, CRP lands are providing important habitat for many species of grassland birds, including some whose populations have declined over the last several decades (Johnson and Schwartz 1993). Nest success for ducks nesting in CRP cover is well above that needed for population growth, and populations of several non-waterfowl bird species nesting in North Dakota are increasing (Reynolds et al. 1994). The Wetland Reserve program (WRP) and WBP also have played a key role in the attainment of PPJV habitat objectives.

Working Partnerships for Conservation

Because success in meeting the goals of the NAWMP requires local partnerships, several flagship projects were developed in each PPJV state. The intent was to achieve certain habitat objectives, with maximized partner participation, support and awareness.

Following is a synopsis of flagship projects in each state in the PPJV. The Chase Lake Prairie Project (a national flagship project of the NAWMP and PPJV) has been highlighted to illustrate in greater detail how the NAWMP and PPJV goals and objectives are stepped down.

North Dakota—The Chase Lake Prairie Project (CLPP). The CLPP is centered in the Missouri Coteau physiographic region (Bluemle 1977), an area of prime importance to the waterfowl within the PPR. The Missouri Coteau (Coteau) is a 10- to 50-mile wide band of sharply rolling hills dotted with thousands of various-sized wetlands whose densities sometimes exceed 100 per square mile (38.6 km^2) (H. A. Kantrud personal communication: 1994). The Coteau runs northwest to southeast from Saskatchewan through Montana and North and South Dakota (Kantrud et al. 1989).

The Coteau is considered by many to be most productive waterfowl habitat in the PPR and is important migration habitat for many species of birds. The Coteau has retained a substantial amount of its original grassland and wetland habitat base, and continues to support an impressive array of wildlife, especially birds, including several which are listed as endangered, threatened or are under consideration for listing. Still, wetland drainage and grassland conversion to cropland have taken their toll on wildlife productivity in this area. The CLPP area covers 5.5 million acres (2,225,850 ha) of Coteau in southcentral North Dakota.

In 1989, the CLPP Plan of Action was prepared (USFWS 1989). The plan contains 38 Action Items aimed at enhancing wildlife on public and private lands by providing landowner incentives, increased public awareness and recreation opportunities. The CLPP also is designed to deliver systematic application of the latest waterfowl management techniques over the area. These practices will benefit ducks and many other species of resident wildlife and migratory birds.

Like the PPJV, the philosophy of the CLPP is that "agriculture and wildlife can not only coexist but flourish." The CLPP demonstrates that certain land-use practices can benefit natural resources while sustaining people and a cherished way of life. Land ownership in the project area is approximately 97-percent private, so, from the beginning, the CLPP recognized that if it were to be successful, wildlife and agricultural interests would need to find common ground. For decades, many people in the area saw agriculture and wildlife at cross purposes, even adversaries. To dispel this, the CLPP launched a large public relations, outreach and marketing initiative. Public forums and meetings were held and action plans were sent to all parties with an interest. Word spread of the CLPP like a prairie wildfire.

Initially, the CLPP had many skeptics and received a lot of resistance. Over the first five years, sincerity and honesty, combined with the willingness, commitment and flexibility to work with individual landowners and partners, has proven successful. These building blocks fostered the trust necessary to establish hundreds of beneficial wildlife projects. By forming partnerships at every level and adhering to a few basic principles, the CLPP has enjoyed tremendous success. A sample of this success is reflected in the milestones listed below.

Since 1989, more than 700 agreements beneficial to wildlife were secured from landowners. Nearly 1,200 wetland basins totaling 2,200 acres (890 ha) were restored within privately owned CRP acres. In addition, more than 100 wetland basins were restored or created on other private lands totaling about 350 acres (142 ha). Approximately 30,000 acres (12,141 ha) of previously overgrazed, privately owned native prairie were placed under rotational grazing systems to the benefit of both livestock and ground-nesting birds. More than 40 nesting islands and 6 peninsula cutoffs have been constructed to provide secure nesting habitat for migratory birds. In excess of 6,000 acres (2,428 ha) of land have been purchased by the USFWS in fee title, and another 2,700 acres (1,093 ha) by other partners. The more than $5 million expended in the CLPP has brought welcome economic gain to the rural, sparsely populated area (USFWS 1994).

The CLPP is an example of how the NAWMP and PPJV can benefit wildlife managers, hunters, bird watchers, private landowners and distant city dwellers. It is about restoring lost wetlands and grasslands like they were lost, one at a time. It is as much about fostering an improved land ethic and an appreciation for the beauty and uniqueness of the PPR as it is about acres of habitat restored. And it is working in the Missouri Coteau of North Dakota!

Montana—Northeast Montana PPJV Project. This project encompasses Sheridan, Daniels and Roosevelt counties in the northeast corner of the state. The core area of the project lies within the northeast corner of Sheridan County, a part of the Coteau with high wetland densities. Projects within the most intensively farmed core area focus on nesting cover enhancement, predator management and wetland restoration. Outside the core area, where there is more grassland cover, wetland development is the focus. The land is primarily in private ownership. Thus, partnerships with Montana's farmers and ranchers are essential to making this project a success.

Montana PPJV partners recognized early on that it was important to focus their limited resources toward helping to keep the private landowner on the land.

South Dakota—Lake Thompson Project. The Lake Thompson project is located in the heart of a 506-square mile (1,310 km^2) watershed that encompasses parts of Kingsbury, Lake, Miner, Clark and Hamlin counties in eastern South Dakota. Prior to 1985, Lake Thompson was a shallow 9,000-acre (3,642 ha) marsh. Heavy rains in the heavily drained watershed turned the marsh into South Dakota's largest natural lake. A task force commissioned by the late Governor, George Mickelson, called for an extensive wetland restoration effort in the upstream watershed to prevent future flooding. The PPJV activities in the Lake Thompson area have generated new partnerships. In 1993, more than 1,000 people attended the Lake Thompson Waterfowl and Wetlands Festival, an integral part of the project's education and outreach effort.

The partnerships forged at Lake Thompson have spawned additional projects, including the South Dakota Ponds Program. This program is a unique partnership of 50 farmer- and rancher-directed conservation districts; four Native American tribes; three federal agencies; South Dakota Department of Agriculture; South Dakota Department of Game, Fish and Parks; Ducks Unlimited, Inc.; and other private conservation organizations. The goal of the pond coalition is to create 600 new wetlands with approximately 200 acres (81 ha) of adjacent, protected upland cover. Through improved grazing management, an additional 120,000 acres (48,546 ha) of enhanced wildlife habitat is expected.

Minnesota—Heron Lake Project. Located in southwestern Minnesota, Heron Lake is internationally recognized as a canvasback breeding and staging area. The lake also is important for many colonial nesting waterbirds, including Franklin's gull (*Larus pipixcan*), black tern (*Chlidonias nigra*) and black-crowned night heron (*Nycticorax nycticorax*). The long-term goal of the project is to restore Heron Lake to its historical status as an internationally significant migratory waterbird production and staging area. Implementation strategies include wetland and grassland acquisition, restoration and enhancement. Since 1989, more than 3,600 acres (1,457 ha) have been acquired, restored and enhanced by project partners.

Iowa—Iowa Great Lakes Project. For decades, the Iowa Great Lakes, located in northwestern Iowa, have fascinated outdoor enthusiasts. Runoff from surrounding residential and agricultural lands significantly degraded lake water quality. The economic, environmental and recreational viability of this region revolves around the water quality of these lakes. Partners involved with this project have focused on the protection of existing wetlands, restoration of drained wetlands and converted grasslands, and the seeding of grassed filter strips along streams and watercourses. These practices, combined with other soil and water conservation techniques, have reduced the quantity of pollutants entering the lake system, while also providing essential wildlife habitat.

U.S. Prairie Pothole Joint Venture—Looking to the Future

The strength of the PPJV is in its grassroots organization and the dedication of the organizations, agencies and individuals that are willing to work at bringing about long-term protection for wetland and upland habitat in the prairies. The PPJV also is a forward-looking coalition, incorporating the latest technology and stimulating new coordinated efforts in order better to integrate waterfowl and non-waterfowl migratory bird needs.

The Canadian Prairie Habitat Joint Venture (PHJV) and the PPJV have shared information and loosely cooperated in the organizational stages. However, there never has been a formal mechanism for encouraging specific areas of cooperation. With approval of the 1994 PPJV Update, new windows of opportunity began to open. Broad outlines of an integrated PHJV/PPJV approach were laid out in September 1994, at a joint management board meeting held to discuss cooperation at an international level. There was unanimous consent to develop a small working group to facilitate increased communication and coordination. Further, it was agreed that one joint meeting would be held each year to explore possible joint projects. Informal steps also have begun to combine certain evaluation and assessment projects. The future will bring increased cooperation and coordination with the PHJV provinces of Manitoba, Saskatchewan and Albert and an international outlook for shared ecosystem concerns. Cooperative approaches toward conservation planning and the development of information on certain non-waterfowl birds is being considered for the future. The proposed outcome will be an ecosystem-level plan that identifies habitat priorities and strategies to benefit priority wetland- and grassland-associated species.

The use of new technologies, such as Geographic Information Systems and Gap Analysis, along with tools such as migratory bird population models and multi-agency planning and evaluation will help guide the PPJV into the future.

A priority for the PPJV will be increasing the focus on and support for conservation legislation. Agriculture programs such as CRP, if supported and funded, will provide major benefits to wildlife.

Working with private landowners will continue to be the backbone of the PPJV. Continuation of essential private lands programs like the USFWS Partners for Wildlife program will ensure that the needs of private landowners are considered along with the needs of waterfowl and other migratory birds.

One of the greatest challenges for the PPJV will be maintaining and increasing funding for projects on the prairies. Strategies in the 1994 PPJV Update will be expensive to implement. The cost of these large investments must continue to be shared by a multitude of agencies, organizations and individuals dedicated to the goals of the PPJV and the NAWMP. New sources of funding must be secured and new partners must be recruited if the PPJV is to meet its goals.

The PPJV has reached middle age in an organizational sense. Its early years saw the implementation of many projects and a tremendous amount of enthusiasm and support generated by those projects. Enthusiasm and support remain high as 1995 begins. The vision of the PPJV includes integration, innovation and continuing its status as highest-priority joint venture of the NAWMP in the U.S. This includes maintaining and expanding leadership in conserving one of North America's most valuable ecosystems.

Conclusion

The strength of the PPJV is found in its diverse partnerships and common goals. What keeps this broad-based partnership alive is success. Success in the form of acres of grassland and wetland habitat protected, restored or enhanced and the generation of added awareness and appreciation for the PPR. All partners including landowners, conservation organizations, corporations and public agencies must continue their commitment to the PPJV and NAWMP. Without the continued success of on-the-ground accomplishments, and the commitment and appreciation for the resource, interest and participation will fade. All PPJV partners can be proud of their accomplishments to date, but need to realize that there is much more to be done.

The PPJV will continue to provide the opportunity for all partners to participate in planning, implementation and evaluation. Most importantly, PPJV partners will continue working closely with private landowners to integrate wildlife conservation practices that support a profitable agricultural operation. This cornerstone philosophy has been practiced throughout the PPJV. It is the foundation of our past accomplishments and will be the key to our future successes.

References

Bluemle, J. P. 1977. The face of North Dakota geological story. North Dakota Geological Surv. Education Ser. II. 73 pp.

Caithamer, D. F., J. A. Dubovksy, F. A. Johnson, J. R. Klley, Jr., and G. W. Smith. 1994. Waterfowl population status, 1994. U.S. Fish and Wildl. Serv., Ann. Rept. 37 pp.

Johnson, D. H. and M. D. Schwartz. 1993. The Conservation Reserve Program and grassland birds. Conserv. Biol. 7: 934–937.

Kantrud, H. A., G. L. Krapu and G. A. Swanson. 1989. Prairie basin wetlands of Dakotas: A community profile. U.S. Fish and Wildl. Serv., Biol. Rept. 85 (7.28). 111 pp.

Klett, A. T., T. L. Schaffer and D. H. Johnson. 1988. Duck nest success in the prairie pothole region. J. Wildl. Manage. 52: 431–440.

Munro, R. E., and C. F. Kimball. 1982. Population ecology of the Mallard VII. Distribution and derivation of the harvest. U.S. Fish and Wildl. Serv., Resour. Publ. 147. 127 pp.

Peterjohn, B. G. and J. R. Sauer. 1993. North American breeding bird survey annual summary 1990-1991. Bird Populations. 1: 1–15.

Reynolds, R. E., T. L. Shaffer, J. R. Sauer and B. G. Peterjohn. 1994. Conservation Reserve Program: Benefit for grassland birds in the northern plains. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 59: 328–336.

Stegner, W. 1962. Wolf willow. The Viking Press, New York, NY. 320 pp.

U.S. Fish and Wildlife Service. 1994. 1994 update to the North American Waterfowl Management Plan: Expanding the commitment. Washington, D.C. 43 pp.

———. 1986. North American Waterfowl Management Plan. Washington, D.C. 19 pp.

———. 1994. Draft ecosystem planning for the prairie, wetlands, and Missouri River main stem. Bismarck, ND.

———. 1989. Plan of action, the Chase Lake Prairie Project. Woodworth, ND. 63 pp.

———. 1993. Chase Lake Prairie Project accomplishment report. Woodworth, ND.

U.S. Prairie Pothole Joint Venture. 1994. Partnerships in progress. U.S. Prairie Pothole Joint Venture accomplishments. Washington, D.C. 21 pp.

———. In press. PPJV 1994 Implementation Plan update. Denver, CO.

Vickery, H. 1994. Breeding duck populations rebound in response to wet weather, improved habitat conditions. U.S. Fish and Wildl. Serv., News Release, Washington, D.C.

Improving Ecosystem Management in the Glacial Lake Agassiz Interbeach Area—A Great Plains Partnership Project

Peter Buesseler
Minnesota Department of Natural Resources
Fergus Falls

Introduction

What can be done with expiring Conservation Reserve Program lands in the Glacial Lake Agassiz Interbeach Area? How do we protect and manage the region's native prairie lands and species before they're gone forever? How do we balance an expanding gravel mining industry with environmental protection.

In the past, agencies and organizations took on these challenges as ''lists of problems'' to be solved. Conventional wisdom guided us to (1) identify the problem, (2) assign responsibility to an appropriate institution, (3) figure out the right answer, and (4) build public support for the solution. Many of these efforts have had preliminary success addressing first-order problems. However, there is an emerging awareness that we need additional tools and strategies to address a whole new set of second-order problems that have emerged.

These new types of approaches include sustainable development, holistic resource management, adaptive management and ecosystem-based management. Rather than isolate one concern from another, these approaches make connections between them. Situations are not fragmented into independent problems to solve, but addressed as webs of multiple views, dilemmas and interdependencies (Figure 1). While considerable work is being done in agriculture to adapt specific land-management practices to these ideals, there are few cases where these practices are being integrated into region-wide, collaborative changes.

Organizations and agencies participating in the Great Plains Partnership (GPP) have recognized the Glacial Lake Agassiz Interbeach Area as one of the most important areas in the Great Plains for strengthening coordinated, ecosystem-based management. A number of activities are underway or planned here to improve ecosystem management. This reflects a long history of collaboration in the Red River Basin around land and water stewardship issues. The Glacial Lake Agassiz Interbeach Area offers an opportunity to explore how landowners and communities can put ecosystem-based management into operation—and how our institutions best can assist them in that effort.

Current project cooperators include the Minnesota Forage and Grassland Council, The International Coalition, University of Minnesota Extension, Minnesota Department of Agriculture, Minnesota Department of Natural Resources, Great Plains Partnership (GPP), The Nature Conservancy, USDA Natural Resources Conservation Service of North Dakota and Minnesota, local communities, and landowners.[1]

---

[1]GPP is a voluntary alliance for conserving biodiversity while enhancing the economic health of the Great Plains. GPP spans 13 states, Canada, Mexico, and includes federal, state, tribal and local governments, and private organizations.

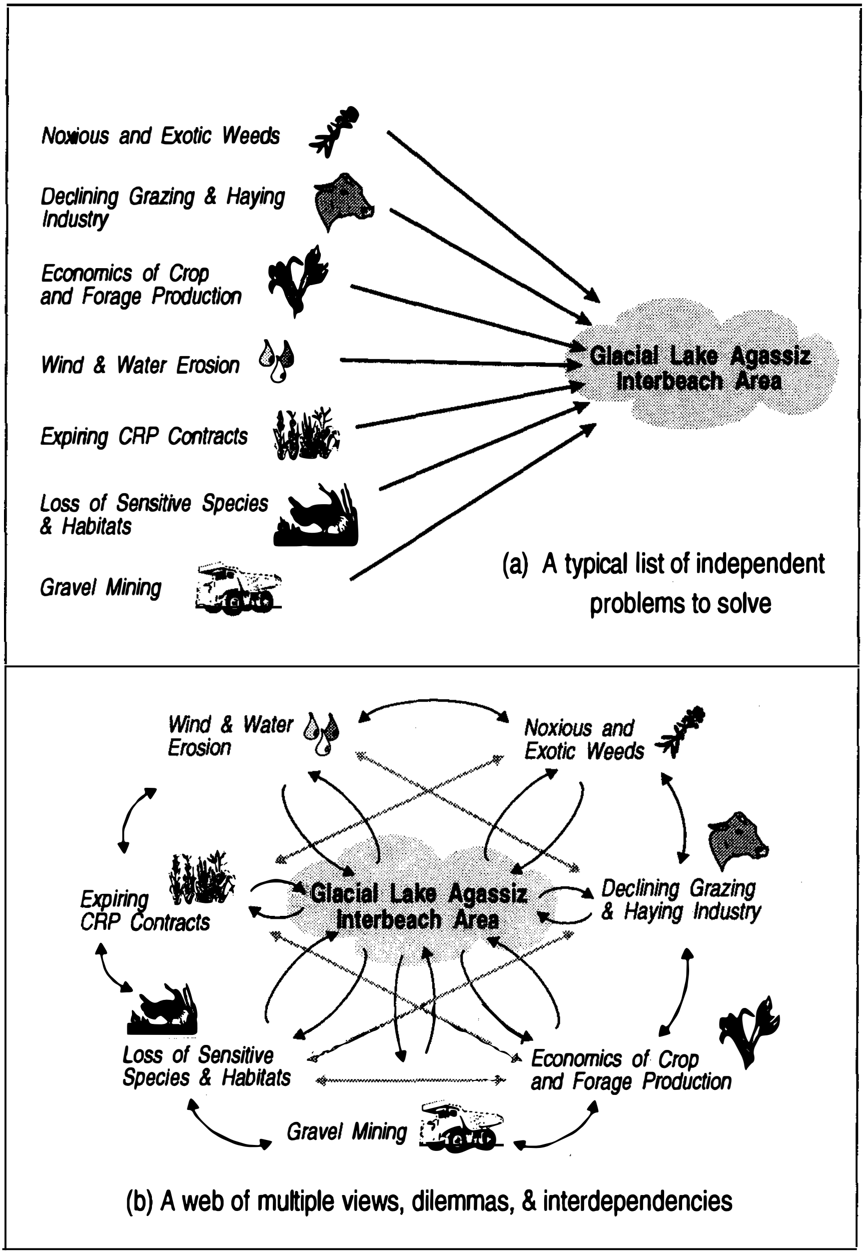


Figure 1. From (a) linear problem solving to (b) systems thinking; a web of multiple views, dilemmas and interdependencies.

Background

Glacial Lake Agassiz Interbeach Area

The Glacial Lake Agassiz Interbeach Area is located in the northern portion of one of North America's most productive and intensively utilized ecosystems—the tallgrass prairie (Figure 2). The Interbeach Area itself is characterized by relatively less-fertile soils which formed on the beach ridges and deltas of the former glacial lake. There are three major grassland landscape areas in the Interbeach area: the Lake Agassiz Beach Ridges in northwestern Minnesota, Aspen Parkland in southeast Manitoba and northwest Minnesota and the Sheyenne Delta in southeastern North Dakota. Together, these harbor the largest acreages of grassland and wetland habitat left in the northern tallgrass prairie ecosystem.

In Minnesota alone, these grassland landscape areas include 190,000 acres of pasture land, almost 40 percent of the state's CRP lands (approximately 750,000 acres) and an estimated 75,000 acres of native prairie. Statewide, forage and grasslands contribute 15–20 percent of cash farm income, provide the primary habitat for many wildlife species, are important in reducing soil erosion and are home to more than 40 percent of Minnesota's rare and endangered species. The continuing decline of grass- and forage-based agriculture in the region, upcoming expiration of CRP contracts and other major changes have brought us to a crossroads in the future of this ecosystem.

Trends

The majority of land in Glacial Lake Agassiz Interbeach Area is privately owned. Approximately three-quarters of the area is in row crop agriculture, with wheat and other small grains being the predominant crops. Except for CRP, the long-term trend for grassland acres continues to go down. In USDA Major Land Resource Area (MLRA) 56, more than 40 percent of noncrop pasture acres have been converted to other uses in the past 10 years. Most of the grassland acres in MLRA 56 occur in the Interbeach area. Livestock production and the total number of beef/dairy farms have declined significantly over the past few decades as well.

Increased use of center pivot irrigation and continued expansion of aggregate mineral (gravel) mining have put additional pressure on the Lake Agassiz Interbeach grassland landscape areas. In addition to directly reducing grassland acres, both of these activities are having an impact on the hydrology of the many seeps, springs and fens, as well as groundwater quality issues. Encroachment of exotic plant species (leafy spurge, smooth brome, Canada thistle, etc.) is another significant problem. Herbicide spraying to control spurge and other noxious weeds adds to farm operation costs and further reduces grassland diversity. The USDA Forest Service estimates that 30,000 acres of the Sheyenne National Grasslands currently is affected by leafy spurge.

One result of these trends has been an accelerating loss of the region's biological diversity. Grasslands in the Interbeach Area provide habitat for two federally protected species and two federal candidate species. In Minnesota, these grassland landscapes harbor 34 state-listed rare plant species and 23 rare animal species (Figure 3). The Glacial Lake Agassiz Interbeach Area is an area where proactive, integrated action now could prevent future "environmental trainwrecks." However, integrated action

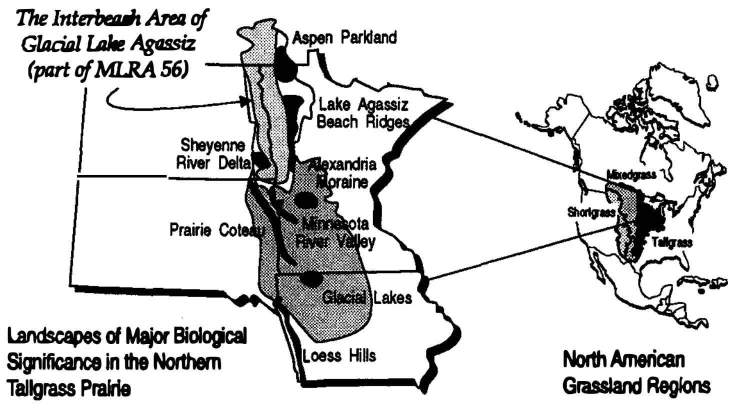


Figure 2. Glacial Lake Agassiz Interbeach Area.

is hampered by two state, one international and several federal agency boundaries, not to mention the large number of county and local jurisdictions.

Public Concern

In most cases, people come together when the issues they face already have combined to create a threat or crisis—rather than to prevent one. Unfortunately, by this time, opportunities to deal with the situation frequently are limited. Stakeholders already may be polarized. Examples like that which occurred between the spotted owl and logging industry in the Pacific Northwest are the norm rather than the exception.

A public opinion survey of residents in the Glacial Lake Agassiz Beach Ridges shows strong concern for interrelated water issues in the Glacial Lake Agassiz Interbeach Area (The Nature Conservancy [TNC] 1993). There has been considerable effort over the past 10–15 years to address these issues. There does not, however, appear to be a shared understanding and concern about the grassland issues described above.

To learn more about how people think about ecosystems and ecosystem management, the Great Plains Partnership is conducting a series of focus groups with citizens from communities in potential ''hotspots'' like Glacial Lake Agassiz Interbeach area. The purpose of these discussions is to understand better people's starting points, the values that drive their thinking and the barriers that prevent them from engaging on this issue.

The focus group work is being done by The Harwood Group. Based on their first four discussions (including one in the Sheyenne Grasslands and one in the Lake

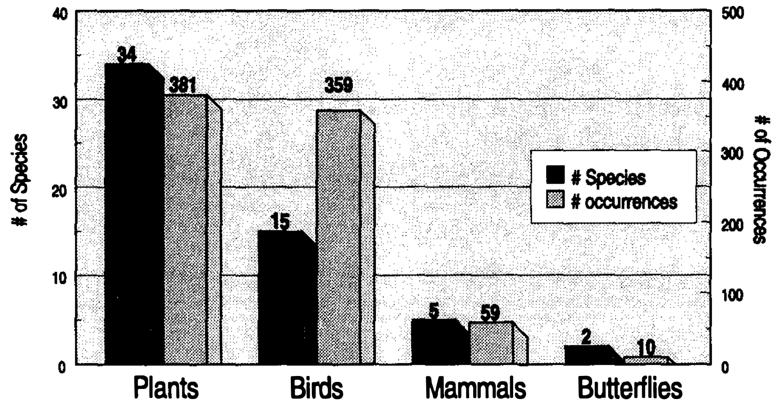


Figure 3. Number of State Listed Species Occurrences in the Glacial Lake Agassiz Interbeach Area of Minnesota.

Agassiz Beach Ridges), a few overarching messages seem to be emerging (Harwood 1995).

- People are anxious about what the future holds for themselves and their communities; they feel they are losing control of their lives. These concerns drive many people's views on ecosystems and ecosystem management.
- People see ecosystems as directly related to their quality of life—in particular, their personal health and economic security.
- People approach ecosystem management from a perspective of maintaining their way of life. They seek a balance between doing what is important for ecosystems and, for instance, maintaining economic security.
- The ethic that people want to drive ecosystem management is one of rights and responsibility—not laws and mandates. People believe that everyone has a responsibility to protect ecosystems, but that this must be pursued within the context of individual freedom.
- People want an active role in addressing ecosystem issues. They do not want "outsiders" to dictate what they should do—something they often feel is occurring now.

It is important to note that these are just some initial hypotheses from The Harwood Group project. They will continue to flesh out the research findings as they complete the remaining focus groups.

In their preliminary report to GPP, The Harwood Group also observes that "people of the Great Plains are wrestling with deeply felt—yet competing—values when it comes to ecosystems and ecosystem management. People recognize that their views are at times contradictory, but they clearly have not had that opportunity to work through these conflicts. Creating sustainable change, however, requires that people come together to set priorities and work through the tough trade-offs involved in the policy issues. Our experience suggests that when people come together as citizens to set priorities and make trade-offs, they often shift away from being claimants to become problem solvers and new possibilities for action begin to emerge.''

A Conceptual Framework for Ecosystem Management

Clarifying Terms

The terms sustainability, ecosystem-based management and ecological integrity are closely related and often used interchangeably. To understand their relationship, it is useful to view them as follows (Minnesota Department of Natural Resources [MNDNR] 1995):

- *Sustainability—A desired outcome.* Sustainability is the achievement of economic and social well being without damaging the planet's resource base; its soils, vegetation, wildlife, etc. Sustainability is as much a political concept as it is scientific, in that it represents what people value in ecosystems. It is about what ecosystem goods and services people want, how much of each and over what time period.
- *Ecosystem-based Management—A methodology.* Ecosystem-based management is a geographically targeted, whole-systems approach to achieve sustainability for both natural and human communities. Interrelated problems are considered on multiple scales—for instance, on the immediate site, within the larger ecosystem and across larger regional systems. It is a partnership approach; working together through cooperative action and mutual agreement to face problems, identify opportunities and find solutions. This is different from the model of ''multiple use'' where stakeholders and agencies work in isolation or competition with each other to improve individual resources.
- *Ecological Integrity—A measurement.* Integrity implies a state of being whole, complete or sound. Ecological integrity is an ecosystem state that maintains a capacity to produce desired goods and services on a sustainable basis. Environmental indicators are analogous to the vital signs used in human health; where a few standardized measures—blood pressure, body temperature and pulse—can give us a quick and reliable assessment of an individual's health.

Framing Problems from a Public Point of View

The conventional approach to inquiry into problematic situations is to start by identifying the problem. In a systems approach, it is exactly what you do not do. First, the overwhelming majority of situations we face do not have one problem, rather, they are characterized by a complex mass of problems that interrelate with one another. Moreover, these problems are not easily understood at the beginning of the inquiry. Various people involved in a situation will view it differently. These differences of perception may be a determining feature of the situation. To look for the problem implies that all parties see the situation in the same way, which most often will not be the case.

The inquiry process starts by looking at problematic situations rather than at a problem. In a problematic situation, people believe that if things were done differently, the situation would improve. We advance in this stage by accumulating information. What do people think is relevant? The tangible results may consist of new clippings, interview tapes, reports, agency/organization documents, plans and maps. What we are trying to accomplish at this stage is not closure on a problem or other neat final characterization, but rather the richness and variety of alternative ways of looking at things.

In order to have a productive discussion of problems confronting the Interbeach Area, we have to frame them from a public point of view. Because people have different experiences, needs, interests and so forth, framing a problem from a public perspective requires that we incorporate the full diversity of perspectives into the framing. We need to present the problem in a way that includes these different perspectives. Each offers a distinctive view of what causes the problem, what should be done about it and who should do what. Taken together, these perspectives constitute a public framing of the problem. A public framing does not make it easier for us to make the choice that confronts us—just the opposite. It does, however, make the discussions more productive and, hence, progress more likely.

The information gained from all sources is synthesized in a provisional "framing document" for discussion. Such a synthesis will cover a range of features of the situation. It includes: a description of the individuals and groups involved, their themes of concern, the historical context that bears on an adequate understanding of the present, key human activities involved in and relating to the groups' themes of concern, decision-making structures and processes, and other qualitative and quantitative data on physical, biological, economic and demographic features of the situation that bear on various groups' themes of concern.

A Network Structure

People often begin a large-scale ecosystem management project by creating some type of new organization, board or association. An overall plan is developed and then the new organization seeks to acquire resources and direct the implementation of the plan. Frequently, these organizations become formalized with bylaws, joint powers agreements or other compacts. Through this kind of structure, the new organization can make decisions and carry out the work on behalf of all the parties involved.

Though still in its early stages, the Glacial Lake Agassiz Interbeach project is being formed and managed around a different structural design—a *network.* Instead of creating a new, centralized organization to address the web of ecosystem issues and problems, our approach is to strengthen the *connections* between people and programs in *existing* organizations.

Networks, like more traditional organizations, are formed to carry out work. In this case, the work is "continuous improvement in ecosystem management" in the Glacial Lake Agassiz Interbeach Area. This approach looks at problems as a guide in the search for better performance. All related parts of the system are looked at and multiple stakeholders are involved in improving the situation. The measure of success is whether improvement is accomplished. The traditional organizational structure often is more reductionist, defining which parts of the problem it will address and which it will not. Participants are seen as experts rather than stakeholders in the system. The board or committee makes recommendations for others to follow, rather thank take accountability for success themselves.

In *The Age of Network*, Jessica Lipnack and Jeffrey Stamps (1994) describe five organizing principles of networks.

- *Unifying Purpose*. Purpose is the glue and driver. Common views, values and goals hold a network together. A shared focus on desired results keeps a network in sync and on track.
- *Independent Members*. Independence is a prerequisite of interdependence. Each member of the network, whether a person, company or country, can stand on its own while benefiting from being part of the whole.
- *Voluntary Links*. Just add links. The distinguishing feature of networks is their links, far more profuse and omnidirectional than in other forms of organization. As communication pathways increase, people and groups interact more often. As more relationships develop, trust strengthens, which reduces the cost of doing business and generates greater opportunities.
- *Multiple Leaders*. Fewer bosses, more leaders. Networks are leaderful, not leaderless. Each person or group in a network has something unique to contribute at some point in the process. With more than one leader, the network as a whole has great resilience.
- *Integrated Levels*. Networks are multilevel, not flat. Lumpy with small groups and clustered with coalitions, networks involve both the hierarchy and the "lower-archy," which leads them to action rather than simply to making recommendations to others.

Accommodating the Diversity of Needs

A strategic framework for action in the Interbeach Area needs to accommodate an array of action levels, with triggering mechanisms that reward local initiative and local capacity for effective implementation. Various groups and regions have very different capacities for change and adaptation. Policymakers can be ambitious about ecosystem management initiatives, but communities will capitalize on assistance only if their local leadership and infrastructure capacity have reached a critical mass. Expensive, sophisticated projects often are not as realistic as local institution and leadership building assistance. The key principles that will guide action are: (1) actions should help people help themselves, (2) actions should encourage, support and reward local initiative, and (3) actions should accommodate an array of readiness levels.

Basic Readiness actions. Where there is a need for substantial assistance to understand interrelated problems, prospects and options, and to organize to respond, the network's focus will be to help build a basic level of readiness. Examples include: synthesis and integration of existing data, identification of critical landscapes and ecosystems, convening of cross disciplinary and jurisdictional meetings, promotion of BMPs, species recovery projects and outreach. *These actions help people understand their current situation and meet the most basic needs before moving ahead.*

Adaptation actions. Where there is a good understanding of problems, prospects and options, and people are sufficiently organized to take strong actions, the network's focus will be to facilitate adaptation. Examples include: cross jurisdictional/institutional cooperation agreements, expansion or redesign of existing programs, integrated collaborative landscape projects and multidisciplinary planning. *These actions enable stakeholders to expand their current activities, organize more effectively and try new approaches.*

Redesign actions. Where there are special comparative advantages, a proven capacity for innovation and leadership, and a consensus for action, the network's focus will be to create opportunities for expanding beyond traditional approaches. Examples include policy or market incentives for "environmental services" of land, planning and budgeting systems for service sharing, and common project funding based on ecological and economic boundaries of problems (the "problemshed"). *These actions create new directions for integrating economic and environmental issues.*

Improving Ecosystem-based Management in the Interbeach Area

Current Activities

As stated earlier, the Glacial Lake Agassiz Interbeach Area has been identified as one of the most important areas in the Great Plains for strengthening coordinated, ecosystem-based management by the Great Plains Partnership. This reflects increasing concern about the Interbeach Area, as well as the level of activity already underway in the region. These activities provide a strong foundation for taking an improved, ecosystem-based approach to the issues facing the Glacial Lake Agassiz Interbeach Area. For example:

- A relatively extensive, biological survey of the Interbeach counties in Minnesota have been completed by the Minnesota Department of Natural Resources, and a Conservation Data Centre recently has been established in Manitoba. Analysis and presentation of much of this biodiversity data now are available through GIS systems.
- The U.S. Fish and Wildlife Service has included this part of the tallgrass prairie as one of its top priorities in its Upper Mississippi/Tallgrass Prairie Ecosystem Management Plan. The Service also has received approval to begin the planning the NEPA compliance phase of a Northern Tallgrass Prairie Habitat Preservation Area refuge. This project would seek to protect and manage the remaining tallgrass prairie through a concerted effort by a variety of agencies, organizations and individuals.
- The Army Corps of Engineers is involved in a major EIS looking at water retention basins in the Red River Basin.
- In northwestern Minnesota, a number of joint landowner/agency workgroups are exploring and developing alternatives for CRP lands as part of the Minnesota CRP Investment Initiative led by the Minnesota Department of Agriculture.
- Through funding from the Critical Wildlife Habitat Program, Manitoba is creating a network of protected tallgrass prairie lands in the Tolstoi/Gardenton area of southeastern Manitoba. This will include variously owned, leased and voluntarily protected lands. In a message delivered to the GPP Executive Council on January 19, 1995, Premier Filmon committed his government to developing a partnership with Minnesota and North Dakota to demonstrate sustainable development in the region.
- In July 1995, the State of Minnesota will initiate two 2-year projects: Sustainable Grassland Conservation and Utilization, targeting the Agassiz Beach Ridges; and

Glacial Lake Agassiz Beach Ridges: Mining and Protection, a long-term plan to balance protection of native prairies with a sustainable aggregate industry in Clay County, Minnesota.

- The USDA Natural Resources Conservation Service and President's Interagency Ecosystem Management Task Force has accepted the entire Glacial Lake Agassiz Interbeach Area as a New Initiative Laboratory project. Funding will be used to expand ecosystem planning and coordination efforts to the whole region. This will bring in many more stakeholders and substantially broaden interagency and cross-regional support, and promises to provide the foundation for a more ecosystem-wide improvement effort.

Upcoming Improvement Activities

When communities and groups are found to act effectively, their actions seem to have two characteristics. First, the actions are open. Everyone who wants to participate can find a role. Second, their actions are mutually reinforcing. People are not looking to one authority or following one directive. They are doing different things, yet the activities are not chaotic. They are centered on a common purpose and complement one another (McAffee 1992).

This describes ecosystem management activities in the Glacial Lake Agassiz Interbeach Area as well. The following list represents a preliminary ''map'' of upcoming improvement activities (Figure 4). This locates some of the currently known features of the terrain. New landmarks will be discovered and new roads will be built as we learn more about navigating through this relatively unfamiliar territory.

A. Buildup regional and local capacity for addressing integrated issues. The goal is to improve ways for engaging people in the area to work together in addressing ecosystem challenges. It will take finding appropriate mechanisms for involvement, framing issues in ways that make sense and are meaningful to people, and creating an environment in which obstacles to change can be dealt with.

Planned activities.

1. Organize resource information from Minnesota, North Dakota and Manitoba for the Interbeach Area.
2. Do more extensive public research work to gain greater clarity for how people think about the area and its ecosystems, the values they hold when it comes to these issues, and how people in the area respond to strategies for ecosystems.
3. Accelerate and broaden participation in a regional, internet-based communication/information network—the Red River Basin Information network (rrbin.cfa.org).

Rationale: This will provide participants with sufficient knowledge about the area and interrelated issues to be able to discuss them effectively. Materials will be prepared in such a way as to stimulate discussion. They will help clarify what the issues or points of concern are that lead people to view the problems from different perspectives.

B. Develop integrated strategies for the Glacial Lake Agassiz Interbeach Area. Locally, based, interdisciplinary teams (including landowners, government agencies, Extension, farm consultants, agribusiness, credit lenders, conservation and agricultural

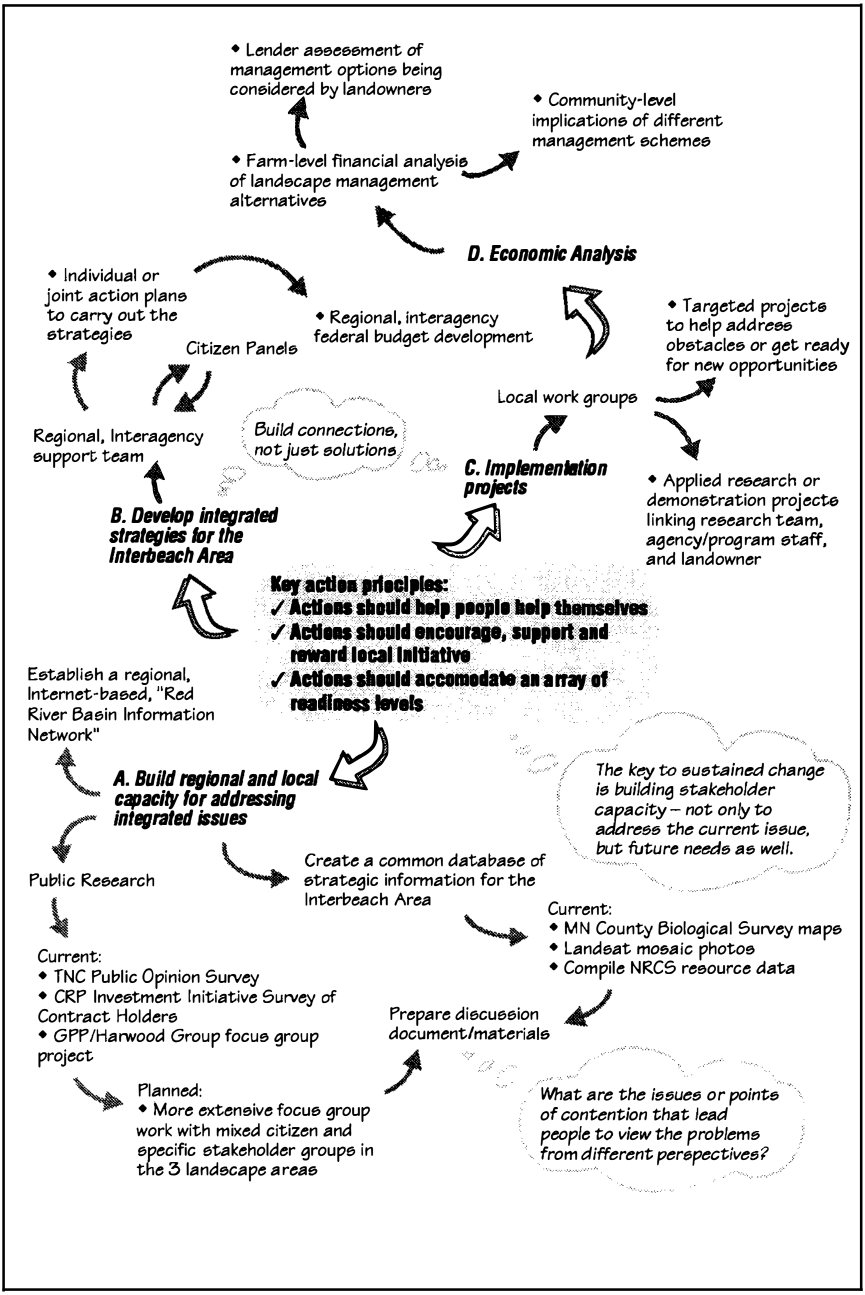


Figure 4. Preliminary map of improvement activities.

organizations) will be offered the assistance of regional/statewide experts and agency representatives to develop a strategy for grasslands and forages within the Interbeach Area. Their task will be to create both collaborative and individual strategies for positioning landowners, businesses, financial and government institutions, and other affected interests to better address grassland opportunities and needs. The workgroups will explore and develop integrated strategies for addressing key issues such as "the future of CRP lands" and "protection of biodiversity." Participating agencies and organizations then will develop individual or joint action plans to carry out the strategies.

Planned activities:

1. Build and support a strong, broad-based Ecosystem Management Improvement Team.
2. Prepare landscape strategies.
3. Prepare individual and joint agency/organization action plans.

Rationale: Use of landscape workgroups gives ownership and responsibility of the project to those closest to the real needs. These are the landowners, but also the many public and private programs and services these landowners turn to for help. If successful, the project will create a climate of dynamic collaboration and enthusiasm among these diverse stakeholders, and develop the local leadership to address needs into the future.

C. Initiate integrated grassland projects. This part of the project gives landscape teams the opportunity and responsibility to tailor projects to address the specific needs and opportunities of the area. These activities could include: trying out new management practices, establishing grazing associations, conducting workshops or doing whatever else they feel best will position the pilot landscape area to take full advantage of its grassland and forage resources in the future.

Planned activities:

1. Applied research/demonstration projects will be on-site, participatory projects linking the research team, agency/program staff and landowner. They will address critical questions relating to grassland use and conservation (e.g., livestock/forage systems, integrated pest management, BMPs for critical species—prairie chicken, white fringed prairie orchid, etc.).
2. Targeted projects will help individuals and local institutions address obstacles or get ready for new opportunities. These might include organizing grazing associations, new market development, coordinating weed control strategies and piloting new or accelerated services (e.g., grazing plan development, extension programs).
3. Interagency, cross-regional federal budget proposal for the Interbeach Area.

Rationale: The primary purpose is to provide stakeholders within the local area with an opportunity to cooperatively design and implement innovative projects to enhance grass and forage lands. The work groups will have the flexibility and accountability of looking at all aspects of the economic, social and environmental system, and targeting what they feel are the best opportunities for improving the situation. Projects will help prepare both individuals and local institutions for future sustainable grassland utilization and conservation within the landscape.

D. Farm- and community-level economic analysis. Evaluate both individual and community-level implications of post-CRP decisions.

Planned activities:

1. Farm and Community Assessment. Twenty to twenty-five landowners (40–50 with New Initiative Laboratory funding) will be assisted with working their whole farm (not just CRP acres) through FINPAK, a University of Minnesota farm-management and financing decision aid. Several landscape-management alternatives will be tried with each farm. The participant will select a desired management option, along with a pre-CRP baseline, for subsequent analysis. Aggregate results of the farm-level studies will be used to assess community-level economic implications of different management schemes through changes in farm input demand and farm outputs.
2. Lender Assessment. Cooperating agricultural lenders will use in-place credit scoring and environmental liability checklists to rate each farmer's post-CRP land-management option with respect to its creditworthiness. Each farm plan will be examined by credit officers from three different financial institutions. Their credit opinions should provide a better idea about how environmentally sound management options are viewed by the financial community.

Rationale: Through this analysis, changes at farm level will be scaled up to examine community-level implications and effects on financial institutions. Collectively, these results will give a better understanding of the financial implications of "post-CRP" management decisions throughout a community and, hence, their likelihood of adoption. Together with existing state and county land resource information and GIS capabilities, participants will learn how better to integrate environmental and economic goals and strategies for the area.

References

Lipnack, J. and J. Stamps. 1994. The Age of the network. Oliver Wight Publ., Inc., Essex Junction. VT.

McAfee N., R. McKenzie and D. Mathews. 1992. Hard choices. The Kettering Found., Dayton, OH. 41 pp.

Minnesota Department of Natural Resources. 1994. Directions for natural resources—An ecosystem based framework for natural resource management. Draft internal doc.

The Harwood Group. 1995. January 18, 1995 memo to the Great Plains Partnership regarding GPP Ecosystem Focus Groups.

The Nature Conservancy. 1993. Unpublished findings of a telephone survey conducted for TNC by Decisions Resources, Ltd.

Management Challenges for Canadian Prairie Grasslands in the 21st Century

Richard K. Baydack
Natural Resources Institute
University of Manitoba
Winnipeg

James H. Patterson
Ducks Unlimited Canada
Ottawa, Ontario

Clayton Rubec
Canadian Wildlife Service
Ottawa, Ontario

Allen Tyrchniewicz
International Institute for Sustainable Development
Winnipeg, Manitoba

Ted W. Weins
Agriculture Canada
Regina, Saskatchewan

Introduction

The southern regions of prairie Canada historically comprised the grassland ecosystems of the country. Challenges to the sustainability of Canadian prairie ecosystems include a combination of ecological, economic and societal issues. Landscapes in the prairies have been simplified by agricultural trends towards monoculture, with subsequent negative effects on biodiversity. Although it is tempting to portray agriculture as the villain in the game of grassland conservation, working with agriculture and the rural community is vital to the success of conservation efforts.

Traditionally, the ''problems'' of grassland conservation and the decline of agriculture each have been dealt with separately. Conservation experts have developed strategies for conservation of grasslands, while agriculture policies were modified to improve agriculture. In addition, rural development strategies were developed to attempt to arrest the decline of communities. The problem with these sectoral approaches is that they fail to recognize that declines of landscapes, economies and social structures are interrelated, as are policy solutions.

This paper will explore the changes, largely driven by agriculture, that have occurred on the Canadian prairies as a result of human intervention. These changes affecting the prairies include current patterns of land, water and biological resource use, changes in international trade policies, and the approach of both public and private sector investments.

Existing Canadian prairie agriculture has been molded by current and past policies of government and non-government organizations. While many of these policies have been under intensive scrutiny, it has not been in a holistic fashion. These programs and policies will be reviewed with special attention paid to their resulting impact on the prairie landscape and their effect on grassland conservation. Policy and program instruments from other jurisdictions will be assessed to determine their applicability to the Canadian situation.

There is evident need for agriculture in the Canadian prairies to become more sustainable through a redesign of policies which affect agriculture. Many of these already are being scrutinized by various organizations. Policies and programs should encourage development of practices which are sustainable or lead to sustainability in agriculture.

Recommendations will be offered which are designed to ensure the future sustainability of the grasslands of the Canadian prairies in an agriculturally dominated environment. The strategies will link ecology, economics and social factors to achieve sustainable development principles.

The Changing Canadian Prairie Landscape

Agriculture was practiced by native peoples in Canada, but agriculture development and grassland modification was accelerated by European settlers (Sopuck 1993). Early farming by Europeans primarily was a subsistence activity, as commercial agriculture grew slowly in response to market opportunities (Environment Canada 1991). In 1885, with the completion of the Canadian Pacific Railway, settlers moved west to the prairies. Municipal governments were established soon after. Their revenue base was the land, evaluated, for revenue purposes, according to its perceived potential for cultivation (Sawatsky 1993). Land which failed to meet the criteria for cultivation was designated as wasteland, to be taxed at a lower rate, but still taxed. Sawatsky (1993) contends that this was the first mistake in Canadian prairie conservation, as this land likely should not have been taxed at all, but rather maintained as an ecological reservoir to be used for society-at-large.

By 1931, 60 percent of Canadian grasslands were under cultivation, and large-scale agriculture was beginning to develop (Environment Canada 1991). As Canada urbanized, markets for food products expanded. Average farm size increased from 40 hectares in 1900, to 96 hectares in 1941 and to 242 hectares in 1991 (Statistics Canada 1992). The number of farms decreased from almost 730,000 in 1941 to about 280,000 by 1991 (Statistics Canada 1992). Similarly, by 1931, rural residents had become a minority in Canada (Bollman 1992). Within rural Canada, farmers also became a minority in 1956, and now comprise only 13 percent of the total rural population (Statistics Canada 1992). The rural economy differs from the urban economy in a number of important ways, and the loss of rural residents reflected a changing landscape pattern and economy.

Disappearing Canadian Grasslands

The grassland areas of Canada, primarily in the southern agricultural working landscape, have been disappearing at an alarming rate. More than 80 percent of the Canadian prairie landscape has been transformed by agriculture. Most of the tallgrass prairie is gone and 90 percent of the fescue grassland has been plowed (World Wildlife

Fund Canada 1989). Approximately 24 percent of the mixed prairie and 25 percent of the aspen parkland remains in the native state (World Wildlife Fund Canada 1989). Environment Canada (1991) indicates that only 13 percent of the aspen parkland remains. It has been noted that a disproportionate number of threatened and endangered wildlife species inhabit the prairie ecozone (Environment Canada 1991). The above stresses have had equally significant impacts on both the economic and social viability of rural communities in the region.

The presence of farming *per se* has not caused this environmental and economic dislocation. Rather, the problems have been brought about by the substantial expansion of cultivated acreage beyond the sustainable land base onto marginal agricultural lands and wetlands. By and large, this expansion was not fuelled by market forces. In the 1980s and early 1990s, cropping practices responded to agricultural policy and support programs that were based on the area of land under commodity production. The negative impacts of these policies and programs have been unintended results of responses to market-distorting and price-depressing international agricultural trade disputes.

Historical Policy Aspects

Policy development on the Canadian prairies has occurred with little regard for anything but the primary production objective. The settlement processes in Canada and the United States were very similar, relying on the free homestead system, preemptions, and school and railway land grants. In Canada, some policies used to develop the Canadian prairies still are in existence today in some form.

The Crow's Nest Pass Agreement of 1897 ensured rail rates on grain shipments out and agricultural inputs onto the prairies. This program, effective in 1897 and even into the beginning of the 20th century, was just rescinded. However, it sent the wrong messages to producers. The newest form of this Agreement was the Western Grain Transportation Act, which was modified slightly in 1983. The message received by many farmers on the Canadian prairies was to expand production into marginal cropping land and export raw material out of Canada. While this is just one example of policy developed to meet a short-term need, it represents how policies must change with economic, social and ecological conditions on the prairies.

Current Policy Situation

Perhaps one of the greatest effects on grassland conservation in Canada is government policy, since producers react to agriculture policies to ensure good returns from production. It is on the prairies that influences of policy best can be examined.

Canadian Influences

Canadians are the custodians of a substantial proportion of the earth's northern latitude ecosystems. Since settlement, the diversity and richness of these ecosystems collectively have been tied to the prosperity and well-being of its peoples. However, as elsewhere on the continent, many of Canada's natural landscapes have been altered, resulting in the emergence of a growing number of modified ecosystems ranging from urban and agricultural types to managed forests. In contrast, natural ecosystems often are perceived to be isolated and uncommon. Currently, major debate in Canada is focused on establishment of national, systematic plans for protection of representative examples and the biological diversity of these landscapes. Biodiversity conservation has become the operative delivery mechanism, and this emphasis is clear in prairie Canada.

Expansion of cultivated acreage on the Canadian prairies in the 1970s and 1980s was in response to strong commodity prices and increasing export markets. This also was fueled by agriculture policy and support programs based on acreage and commodity production. The prolonged drought of the 1980s revealed the present system of agriculture production was not sustainable on much of the marginal land. Government support programs did not provide adequate risk protection so new safety net programs were designed. Unfortunately, these new programs again were based on acreage, yield and commodity prices. International trade disputes have resulted in depressed market prices and production is being driven more by government programs than by market demands. The negative impacts of these actions is a continuation of production in an unsustainable manner along with its environmental consequences.

Generally speaking, agriculture policies in Canada tend to reward expansion of cropland irrespective of whether it would otherwise be in crop production, and make land-use changes difficult because farmer income will decline faster than returns from crop production (Girt 1990). Canadian Wheat Board policies, for example, based incentive payments on area cultivated. This increase often is at the expense of grasslands, considered to be marginal for agriculture production. Similarly, present grain quota systems in Canada base the amount of grain that a farmer can sell on the number of acres cultivated.

In Canada, just more than $8 billion was spent to support agriculture in 1991–92, of which about $5.4 billion was from the federal government and the remainder was from the provinces (Statistics Canada 1992). Although it is difficult to separate the types of support, about $3–5 billion of these expenditures could be considered direct export and production subsidies. Examples include direct commodity payments, the Western Grain Transportation Act "Crow Benefit," crop insurance and financial assistance programs. These subsidies have kept agriculture alive, and any producer surplus in the past few years has come from public programs (Lerohl 1990).

Canadian grain and oilseed products receive annual subsidies in the order of $45 per acre. In spite of this, farmers have demonstrated a willingness to set aside marginal lands for permanent cover for $15–20 per acre. Projects such as the Permanent Cover Program of Agriculture Canada and Prairie Care by Ducks Unlimited Canada under the North American Waterfowl Management Plan (NAWMP) are success stores in this context. Using the Canadian prairies as an example, a set-aside program targeted at the estimated 8 to 10 million acres of marginal and fragile land in grain production could reduce costs to the public treasury in the order of $240 million per year. Rural development income options for alternative use of set-aside lands could add to the performance of the rural economy. Payments to landowners that are consistent with international trade arrangements could help sustain farm families during the period of adjustment to alternative land-use options that build new economic activity to the rural community.

Socio-economic research in Manitoba has demonstrated that the adoption of conservation farming practices through the Prairie Care program resulted in an average net increase in profits of more than $13 (Canadian) per acre per year (Josephson

1992). This does not include any incentive or government support payments. Effective prairie conservation programs in Canada's agricultural working landscape, as exemplified by the NAWMP, can only come about through revitalized rural communities supported by more diverse and stable income opportunities that are economically and environmentally sustainable. Clearly, the creation of a ''sustainable development market force'' is the only option that would ensure environmental, economic and social sustainability. Positive action toward this end can be a cost-effective and affordable imperative for Canada. Inaction would contribute to economic, social and environmental liabilities of ever-growing dimensions.

U.S. Influences

The United States is in the process of drafting the 1995 Farm Bill which will have a major effect on agriculture in the United States. As in Canada, many external factors, such as budget, trade agreements and the environmental movement, now are having a pronounced effect on the development of agriculture policy. There is potential for the 1995 Farm Bill to address issues such as conservation of wetlands, protection of environmentally sensitive areas, watershed management and animal waste management. Current programs, such as the Conservation Reserve Program (CRP) and the Export Enhancement Program (EEP), could feel the modification of the 1995 Farm Bill.

The CRP, a program designed to take crop land out of production, is due for review in 1995. The program has a cost of $1.8 billion (U.S.) set up as a special line in the budget, and not included as part of the agriculture budget. ''There is strong environmental interest group support for including the budget line for the conservation reserve in the appropriation for agriculture, if the special line is not continued. This will result in a cost of about $1.8 billion that will have to be absorbed within at best a flat agricultural budget'' (Johnson 1995). As well as the budget issue, a significant number of CRP contracts will expire in 1995. This program will have significant effects on agriculture in the United States, as well as Canada.

The CRP has been identified as one reason that Canada will increase its exports of grain to the United States. With the United States reducing production by removing land from crop production, domestic prices increase, making a market for Canadian grain. The development of this nearby market increases the demand for Canadian grain. The CRP was not the only reason, however, for the increase in demand from the United States for Canadian grain. The EEP also has been identified as an important influence.

The EEP is designed to facilitate the marketing of grain to U.S. export markets. The program provides a subsidy to importing countries. This effectively provides grain farmers with higher domestic prices than that of the world markets. Most of the program funds are used to ensure competition with major grain exporters. Recent research results on the EEP have indicated considerable ''leakage,'' which would result in a sharp reduction and reorientation toward more targeted market development (Johnson 1995). With an inefficient transfer of funds to farmers and little market development, changes in this program likely will have an important impact on U.S. agriculture.

The effect of the EEP was an increase in the domestic price in the United States market because most farmers were exporting their grain using EEP. Like the CRP, EEP contributed to increased demand for Canadian grain because of the short supply available domestically.

North American Free Trade Agreement

The North American Free Trade Agreement (NAFTA) charts a new course for economic cooperation throughout North America. It also establishes rules and procedures for resolving trade disputes between countries. The North American Commission on Environmental Cooperation (NACEC) offers the challenge and opportunity for continental environmental cooperation on an equal scale.

By taking a cooperative and facilitative approach, the NACEC could play a significant role in the conservation and protection of North American ecosystems, habitats and species. The NAWMP is a tangible example and model of how continental ecosystem conservation can succeed. In the same sense that NAFTA has become a template of continental economic cooperation, the NAWMP has become a template for continental environmental cooperation. The creation of the NACEC under the North American Agreement on Environmental Cooperation (NAAEC), in turn, is an opportunity to link these two parallel areas for cooperation. This Commission could help to promote continental environment and the economy linkages under the aegis of sustainable development and address the imperative for biodiversity conservation on a continental basis (Rubec et al. 1995).

Within an individual country, regulation and protection are important tools for environmental security. However, between countries, regulation and protection are much more restricted in terms of application and more difficult to codify. Transboundary pollution issues in North America, such as acid rain impacts or water quality degradation, usually have required protracted negotiations often resulting in litigation. On the other hand, transboundary conservation issues traditionally have involved cooperative agreements and non-litigative solutions.

A reality in North America is that governments are hard pressed to provide significant funding for major new programs. It is widely recognized that NAFTA is not designed as a mechanism for governments to spend money, but rather to facilitate wealth generation in the private sector for the benefit of all North Americans. Similarly, an objective of the NACEC should be for governments to facilitate conservation on a continental scale, particularly through environment/economy linkages.

World Influences

Canada is a world leader in the development of a policy framework for the transformation to environmentally sustainable agriculture. The agriculture and conservation sectors have worked together for a number of years and are in general agreement as to what needs to be done to restore the environmental sustainability of the agricultural landscape. However, the overriding negative impact of international trade disputes has created an economic and political environment where changing agricultural policies and programs are perceived as a threat to the industry.

There is a ray of hope on the horizon. Ratification of the Uruguay Round of the General Agreement on Tariffs and Trade (GATT) and NAFTA would lead to a phased liberalization in agricultural trade. In addition, the UNCED '92 Global Convention on Biodiversity has raised awareness of biodiversity conservation efforts in Canada and around the world.

Using trade liberalization to fuel sustainable agriculture and prairie conservation makes good environmental and economic sense. OECD countries currently are expending more than $350 billion (U.S.) annually on agricultural subsidies. The negative environmental and economic impacts of these subsidies are not just felt domestically but are devastating to developing countries. The World Bank recently has estimated that a 50-percent reduction in trade barriers by Europe and the United States would raise the value of exports from developing countries by $50 billion (U.S.) per year, providing critical resources to address environmental and other problems.

A number of things regarding international trade now have an empirical basis in fact that can be demonstrated to farmers, and many farmers have become evangelists themselves. While we are not revolutionizing the world, we are trying to run it in a far more efficient and effective way, to conform with international trade regulations to the benefit of everyone who lives on this landscape. Another important factor is that farmers, because of the changing world, recognize that if they don't become part of the solution, they are going to be identified as the problem and the solutions are going to be dictated to them. So, there is a tremendous vested interest in the farm community, public and private, to get involved at the beginning, to start rationalizing these various factors and taking into account the environment and sustainability, as well as their ability to make a living.

Let's get back to trade liberalization for a moment. In the last few years, OECD countries have spent in the order of $350 billion (U.S.) per year in agricultural support programs. The European Union and the United States have been the major forces through large export and domestic subsidies. That is not to say that these two powers are the only influences. Everyone else in the game of exporting agricultural produce has felt they had to play the same game. The point is that the level of subsides grossly distorts production of commodities. That means it is profitable in many cases to cultivate lands marginal for agriculture, whereas, if you were in a free market system, you probably would last a year or two before experiencing financial hardships. Hence, farmers are making decisions to farm programs, not the land, and it is the land, water and wildlife that suffers.

The GATT negotiations probably have set a world record for length, going on for years and years. The greatest stumbling block was agriculture, how to somehow wean the world from this gross distortion of commodity production markets, prices and land-use decision making. The end result was that the more money that was thrown at the problem, the greater the problem became. There has been a successful conclusion to the Uruguay Round of GATT and the World Trade Organization is to come into being in 1995.

GATT calls for reductions of 36 percent in export subsidies from all participating members, with about 20-percent reduction in export volumes. There are some short-term wrinkles but, in the long-term, this will establish criteria and timetables for phasing down export subsidies—a major cause of unsustainable land use. Similarly, there is a 21-percent reduction called for in domestic subsidies. As it turns out, when negotiations began, Canada was at a level of about $4 billion per year in agricultural subsidies. This meant, according to these criteria, that $1 billion per year would not be eligible. Now, that could either go back to the treasury or a portion of it could be used for green, conservation-friendly programs.

Sustainable Agriculture

Some government policies and programs do not promote agriculture that is sustainable. These policies are inconsistent with the goal of protecting the productive capacity of the land for future generations. Farmers are facing many challenges when modifying current production practices. This modification becomes more feasible, however, when there are tangible economic, social and ecological benefits. An understanding of the factors that affect economic viability, agricultural production practices, resource use and ecological resilience is an essential prerequisite to the design of policies, budgets and agreements for sustainable agriculture and rural development.

Sustainability challenges to the prairie ecosystem represent a combination of ecological, social and economic problems, which all must be considered in policy design. This range of issues is not accounted for in any decision-making process, at any level.

Sustainable agriculture is a subset of sustainable development. Therefore, it is appropriate to revisit the definition of sustainable development to help define the scope of our concern. Sustainable development has been defined as: "a process of change in which the exploitation of resources, the direction of investments, the orientation of technological development, and institutional change are all in harmony and endorse both the current and future potential to meet human needs and operations" (Brundtland 1987).

This definition provides an idea of the scope of sustainable development, but does little to explain how sustainable development can be operationalized. The various contributors to development, such as agriculture, manufacturing, service industries and even lifestyles, have different viewpoints on sustainable development. To narrow the broad definition of sustainable development to confine this project to a manageable task, a definition of sustainable agriculture is required. Several definitions of sustainable agriculture are available, but the one best suited for the needs of this paper is as follows: "one that, over the long term, enhances environmental quality and the resource base on which agriculture depends, provides for basic human food and fibre needs, is economically viable, and enhances the quality of life for farmers and society as a whole" (Nasavada 1991).

While this definition focuses on agriculture, it should be recognized that environmental quality and the resource base are being shared by other activities as well. A definition of sustainable agriculture does not provide an effective method to evaluate a program or a policy. What is required is some form of measurement that would provide an accurate estimator of the sustainability of policies or programs. A technique is required for policy makers that can outline where policies could be improved to reach the goal of sustainable development. Work at the International Institute for Sustainable Development lead to the creation of Principles for Sustainable Agriculture (Tyrchniewicz and Wilson 1994). The Principles are as follows:

1. *Stewardship.* There exists both an individual and collective responsibility to sustain the environment for both our own and future generations. Economic and social activities should be undertaken in such a fashion as to maintain and preferably enhance the capacity of the resources used for the benefit of future generations as well as our own.
2. *Conservation.* There is need to maintain biological diversity while strengthening essential ecological processes.Non-renewable resources must be used wisely, this involving their recovery after use to the extent economically feasible. The major

renewable resources in agriculture, soil and water, must be protected so that productivity is maintained.

3. *Rehabilitation.* Where renewable resources such as the soil have been damaged, effort must be expended in their rehabilitation so that, to the extent feasible, their original productivity is restored or preferably increased. It is recognized that lack of adequate care has contributed to soil and water degradation on the Canadian prairies.
4. *Internalization of Costs.* In our society, certain production inputs and outputs are not priced in terms of their real value. Examples include the air we breathe and the carbon dioxide absorbed by plants. Furthermore, the by-products of production in terms of their environmental damage are not necessarily subject to a monetary penalty. What is required is that the real costs of both presently considered "free goods" or "undervalued goods" be incorporated into the total costs when determining the net returns from production. Such costing, for example, will include the value of any net loss or gain in soil nutrients as a result of crop production.
5. *Scientific and Technological Innovation.* Research to enhance the development of technologies which contribute to the maintenance of environmental quality and economic growth must be supported. Such support should extend to provision of educational services which will further the research program while, at the same time, maintaining social and cultural values.
6. *Economic Viability.* Production cannot be sustained over the long run unless it is economically viable. Such viability requires that the net returns from marketing are positive. Unless such returns are adequate within a region, the prairies for example, producers cannot be expected to continue to utilize their available resources for this purpose. The net returns from production should enable adequate standards of living to be maintained while, at the same time, being sufficient to continue to attract replacement operators.
7. *Trade Policy.* Barriers to trade can create impediments to the achievement of sustainability. Consequently, trade liberalization is an important component of progress toward sustainable development. In addition such liberalization leads to greater international efficiency in production. As a result, true comparative advantage should be an objective of trade policy. This implies recognition of the real costs of production and, therefore, the maintenance of environmental integrity.
8. *Societal Consideration.* Economic activity should minimize social costs while maximizing social benefits. At the same time, it should not detract from human health and cultural resources, or the quality of land and water. Cultural and social diversity should be respected. In agriculture, a balance must be struck between the size of production units consistent with technology and a social structure acceptable to all stakeholders, including those providing the infrastructure.
9. *Global Responsibility.* Ecological interdependence exists among nations as there is no boundary to our environment. Stakeholders in the maintenance of the environment, therefore, are not necessarily local. How the local environment is treated ultimately impacts other parts of the world and can be expected to haunt those guilty of its mistreatment. There is a responsibility on the part of all nations to "think globally when acting locally."

Future Policy Directions

Effective grassland conservation in the prairie landscape of Canada only can come about through revitalized rural communities supported by more diverse and stable income opportunities that are economically and environmentally sustainable. Implementation of both GATT and NAFTA may provide a unique opportunity for Canada to work toward rural renewal.

Potential elements of trade-driven adjustment to sustainable agriculture are as follows:

1. *Market Forces.* As international agricultural production subsidies are reduced, it is anticipated that commodity prices will increase. This should encourage land-use decisions that are more responsive to market forces and to the sustainable capability of the land base.
2. *Non-distorting Commercial Income Support.* Agricultural safety net policies and programs can be modified to remove trade and land-use distortions and comply with international trade agreements. Decoupling support from commodity production to broader farm income should encourage a shift from gross production to sustainable productivity.
3. *Conservation Incentives.* A portion of the $1 billion trade war peace dividend could be used as financial incentives, specifically for conservation measures, to help rural Canada and the agricultural industry adjust to environmentally sustainable and economically sound practices.

We also believe that special efforts must be taken in coming years to ensure that perceptions of landowners in prairie Canada are appropriate with respect to grassland conservation. In many cases, more grasslands will mean more wildlife. In many cases again, this will be viewed as a problem that can only be solved by eliminating the cause—i.e., the grassland itself. We urge agencies of government to respect these views by ensuring that adequate compensation, and possibly education, are provided in unique forms. Additional consideration should be given to novel approaches such as ecotourism, rural bed and breakfast operations, or nature viewing.

We further believe that the potential for future conservation of Canadian prairie grasslands has been enhanced by the creation of the NACEC. We endorse the following recommendations to this agency as developed by Rubec et al. (1995):

1. The NACEC should sponsor continental policy fora to identify and promote adoption of aspects of trade liberalization that have positive impacts on continental conservation.
2. The NACEC should recognize the NAWMP as a priority continental program contributing to prairie conservation. The NACEC also should facilitate support for other programs that reinforce and augment the achievements of the NAWMP.
3. The NACEC should support the establishment of innovative funding initiatives that harness market forces and new partnerships in the business sector resulting from NAFTA to foster support for continental biodiversity conservation programs.
4. The NACEC should serve as or foster the implementation of a Continental Round Table on Biodiversity Conservation and Sustainable Development, which would lead to spinoff benefits for grassland conservation.
5. The NACEC should provide leadership for the establishment and enhancement of a continental approach to prairie conservation and models for biodiversity

risk assessment, protected areas and ecosystem science, and biodiversity information integration.

References

Bollman, R. D. Ed. 1992. Rural small town Canada. Statistics Canada, Ottawa, Ontario.

Brundtland, G. H. 1987. Our common future. World Commis. on Environ. and Develop., Oxford Univ. Press, New York, NY.

Environment Canada. 1991. The state of Canada's environment. Environ. Canada, Ottawa, Ontario.

Girt, J. 1990. Common ground: Recommendations for policy reform to integrate wildlife habitat, environmental and agricultural objectives on the farm. Wildl. Habitat Canada, Ottawa, Ontario.

Johnson, S. R. 1995. The future direction of U.S. farm policy. Grain World '95 Conf., Can. Wheat Board, Winnipeg, Manitoba.

Josephson, R. A. 1992. An economic evaluation of land use changes in southwest Manitoba. Manitoba Habitat Heritage Corp., Winnipeg.

Lerohl, M. L. 1990. The western Canadian farm policy dilemma. Can. J. Agric. Econ. 38: 557.

Nasavada, U. 1991. Trade policy implications of sustainable agriculture. Can. J. Agric. Econ. 39: 595.

Rubec, C. D. A., K. W. Cox and J. H. Patterson, 1995. NAFTA opportunities for conserving continental diversity. Invited pap., No. Amer. Commis. on Environ. Coop., Montreal. January 26–27.

Sawatsky, H. L. 1993. Endangerment of species: Some thoughts on causes. Proc. Third Prairie and Endangered Species Work., Brandon, Manitoba.

Sopuck, R. D. 1993. Canada's agriculture and trade policies: Implications for rural renewal and biodiversity. Nat. Round Table on Environ. and Econ., Ottawa, Ontario.

Statistics Canada. 1992. 1991 census of agriculture. Statistics Canada. Ottawa, Ontario.

Tyrchniewicz, A. and A. Wilson. 1994. Sustainable development for the great plains: Policy analysis. Int. Inst. for Sustain. Develop., Winnipeg, Manitoba.

World Wildlife Fund Canada. 1989. Prairie conservation action plan. World Wildl. Fund Canada, Ottawa, Ontario.

Sandhill Management Plan: A Partnership Initiative

Gene D. Mack
U.S. Fish and Wildlife Service
Kearney, Nebraska

Introduction

The Sandhill Management Plan is a resource management approach authored by the Sandhills' people and the U.S. Fish and Wildlife Service (FWS) to benefit both them and wildlife. The plan reflects the belief that an ecosystem approach, including the people, is necessary to sustain a healthy environment.

For years, resource management aligned a specific sandhill resource with its respective agency. Wildlife agencies managed for wildlife (primarily game species), Soil Conservation Service controlled erosion, water resource agencies focused on irrigation and agricultural groups worked to improve production. Each group concentrated on its mission from its perspective, with little outside interaction. As agencies enacted land-use regulations, landowners perceived them as a loss of property rights. Opposition to such regulations reinforced the belief that the regulations were necessary. Continual contention between conservation and agricultural groups have caused opportunities and solutions to be missed, or to be judged on a win or lose basis.

Past actions by the FWS in the Sandhills illustrate this relationship. In the early 1980s, the FWS drafted a wetland acquisition plan to protect the region's wetlands from land development. Local residents strongly opposed any type of government acquisition or involvement with sandhill wetlands. They claimed the program addressed wildlife needs but ignored the needs of the people. The acquisition plan was abandoned and no alternatives were considered.

Ten years later, the FWS began an ecosystem approach that recognized local people as part of their environment. In the Sandhills, landowners control more than 90 percent of the land (Bose 1977). Local involvement is needed to provide guidance on what management can be done with the support of the people. The FWS aimed toward reducing contention between environmental and agricultural groups, and combining local and professional knowledge of the resources to develop a workable plan.

Landscape Description

The Sandhills is 19,300 square miles (49,970 km^2) of grass-covered sand dunes stretching across northcentral Nebraska and southwestern South Dakota. The region is a continuous expanse of grassland, wetlands and privately owned ranches. Approximately 1.3 million acres (526,000 ha) of wetlands (Rundquist et al. 1981) are scattered throughout. Ecological connection between dunes, hydrology, plants and people have created diverse habitats. Dunes vary from high, steep hills in the western region to small mounds in the east. Wetlands exist in the interdunal valleys, and include hyperalkaline lakes, freshwater lakes and marshes, wet meadows, and fens. Plant communities range from extensive short- and tallgrass prairies to isolated deciduous and coniferous forests. Plants associated with arid conditions inhabit the tops of dunes, while lush stands of aquatic plants are found in the valleys a few hundred yards away. The species of plants present are dependent on the ranching style of individual ranchers.

Ranching dominates the economy. Population is sparse, with fewer than 1.5 people per square mile (0.6/km^2) (Bureau of the Census 1993). Large ranches, 4,000–6,000 acres (1,620 to 2,430 ha), are needed to sustain a ranch family. The grasses on the dunes are used for summer grazing while the meadows are mowed for winter hay. The amount of winter forage can be the limiting factor in the success of a ranch. Thus, ownership of meadows becomes critical to the value of a ranch. Overall, ranching has benefited the grasslands. In the semi-arid climate, proper grazing has aided decomposition of organic matter, improved compaction in the soft sands and stimulated plant growth and reproduction.

The hydrology associated with sand dunes affects the landscape and economy of this region. Porous sand quickly captures the 17 to 23 inches (43.2 to 58.4 cm) of annual precipitation, allowing little runoff. High infiltration rates, as much as 10 feet (3 m) per day (Bleed 1990), limit plant use of precipitation before it reaches the water table. Twenty-five to 50 percent of the water (Lawton 1984) becomes part of the Ogallala Aquifer. The thickest portion of the Ogallala Aquifer exists under the Sandhills and contains nearly 1 billion acre-feet of water (Dreeszen 1984). During seasonal wet periods, groundwater mounds form under the dunes. The hydraulic head of the mounds slowly releases excess water to the neighboring wetlands and streams (Winter 1986). Lakes and wetlands, in turn, restrict the release of groundwater. The local water table is maintained at a higher level. Lands with the water table about 2 feet below the surface produce lush stands of native grasses. As the vertical distance to the water table increases or decreases, vegetation shifts toward more arid or aquatic plants, respectively. Groundwater released to streams provides 90 percent of the water flowing from the Sandhills (Bentall 1990). Average annual flow is 2.4 million acre-feet (2.96 billion m^3) (Dreeszen 1984).

Throughout the Sandhills' existence, vegetation on the dunes has increased and decreased depending on such factors as climate, overgrazing and wildfires. Since settlement, control of wildfires and managed grazing has increased vegetation on the dunes. About 720 plant species (Kaul 1990) exist, including 2 endangered species. Hayden's penstemon (*Penstemon haydenii*) occurs in bare sand on the dunes and prairie fringed orchid (*Platanthera praeclara*) inhabits the wet meadows. Resident and migratory wildlife are abundant in the grassland/wetland ecosystem. Thousands of birds, migrating along the Central Flyway, use the area for breeding and resting. About 224 species of birds (Labedz 1990) can be found.

Human settlement has altered the ecology of the Sandhills. In the late 1800s, open range grazing abused the federally owned land. Investors overstocked cattle until two harsh winters caused huge livestock losses and forced the investors out of business. By the early 1900s, much of the land was in private ownership and grazing was controlled. Landowners, eager to develop the land, drained large lakes and wetlands to increase forage production. The alignment of valleys between the linear dunes made it possible to extend miles of ditches from one wetland to the next. The total number of lakes and wetlands lost or altered is unknown. By the 1950s, much of the drainage was completed, but their impact on the landscape and hydrology continues today. The drainage lowered the hydraulic head of the basin and increased groundwater discharge (Winter 1988). Increased streamflows eroded the sand bottom of channels, further lowering the water table and drying adjacent lands. Downstream, aggradation and groundwater recharge created new wetlands. These often were dredged to reclaim flooded meadows.

Center-pivot irrigation began booming in the eastern region in the 1970s. Tax laws, irrigation technology, low land values and high grain prices encouraged investors to convert grassland to cropland. Irrigated cropland increased from 70,550 acres (28,552 ha) to 215,000 acres (87,010 ha) in 10 years. Nebraska Natural Resource Commission (1993) documented the effect of the additional irrigation of the sandhill ecology. In some areas, pumping caused local water tables to drop. Neighboring wet meadows became drier and forage production declined. In other areas, irrigation water raised local water tables, creating marshes and lakes. Often, the newly formed wetlands were drained, only to create problems downstream. Fertilizer and pesticides leached into the groundwater and contaminated nearby domestic wells. The Commission's report concluded that nitrate leaching could not be prevented, even with the use of the best fertilizer management practices. Wind erosion was 10 times greater on cropland than on grassland. The blowing sand damaged young corn and deposited dunes on neighboring pastures. By 1990, more than 50,000 acres (20,200 ha) were no longer profitable to farm. Cost of reseeding often exceeded the productive value of the land. The Conservation Reserve Program replanted the areas but plant communities remain in an early successional stage and provide little forage value.

Management Approach

In 1991, the FWS began an ecosystem approach in the Sandhills. It focused on (1) obtaining a better understanding of the ecosystem, and (2) developing a program that would benefit people and wildlife. Understanding the people and their need for the resources was very important. FWS personnel made individual visits to ranchers and organizations to share perspectives and concerns. The interaction helped ranchers and FWS build trust and discover their common ground. Both groups indicated a need to maintain a grassland/wetland ecosystem and improve wildlife numbers, both recognized the role ranching has played in maintaining the diversity and abundance of flora and fauna, and both were concerned about the level and quality of the groundwater.

The Nebraska Cattlemen (NC), a private organization, joined the FWS to design an interacting group of ranchers and government personnel. To ensure broad support, organizations active in the Sandhills were asked to recommend leaders from their membership. The group, named the Sandhills Task Force, consisted of 13 members—8 involved in ranching and 5 associated with government and private organizations. Members were recommended by NC, Natural Resource Districts (NRD), Nebraska Association of County Officials, North Central Resource Conservation and Development, Nebraska Game and Parks Commission (NGPC), FWS, and Preserve Our Water Resources. Membership was weighted toward sandhill ranchers to ensure their voice was heard.

One year after the Task Force was formed, the group had drafted the Sandhill Management Plan. Its stated goal is "to enhance the sandhill wetland/grassland ecosystem in a way that sustains private ranching, wildlife and vegetative diversity, and associated water supplies." This is to be accomplished by (1) identifying workable management strategies, and (2) building partnerships between landowners, government and public interests.

The Task Force recognized that a successful program needs to provide flexibility so a solution can be molded to fit specific problems. Five broad management strategies were identified: (1) education and technical assistance, (2) acquisition, (3) lease agreement, (4) legislation, and (5) financial support. The strategies are not all equal in value or need, but provide a full complement of management approaches.

Education has been identified as the most positive and effective way to improve human and land resources. Educational strategies seek to:

- provide information about the interrelationship between grassland, hydrology, livestock and wildlife in a healthy ecosystem;
- identify and work toward research studies that will help guide future management;
- provide up-to-date information on regulations, programs and technology;
- promote seminars, workshops and training courses that improve management of natural resources;
- organize programs that give schools and the public an interaction with ranching and wildlife;
- encourage and develop educational films, literature and public service announcements about aspects of the sandhill ecology;
- build and promote small community management or support groups;
- identify and encourage outside support; and
- assist landowners and the public in identifying wetlands and wetland benefits to ranching and wildlife.

The Task Force concluded that the best approaches are one-on-one and small group meetings because information flows in both directions. For example, while a rancher learns about wetland values to groundwater and wildlife, the conservation personnel learns the importance of meadows to a ranching operation.

Technical assistance is an extension of education. Its focus is on specific land-management problems. The aim of activities is to:

- identify limiting factors for wildlife (such as lack of permanent water, overgrazing, poor survival and lowered water table) and management options that benefit ranching and wildlife;
- assist in the development of grazing and water management programs;
- provide guidance on what appropriate steps (legal and planning) must be taken to complete a project;
- provide guidance on the cost-versus-benefit associated with specific management practices;
- develop a resource directory of agencies and expertise;
- provide guidance to community and outside interests on how they can improve wildlife in the Sandills;
- assist landowners with financially or technically difficult projects by finding the needed funds and expertise; and
- build a team attitude in all parties to promote sound grassland and wetland management.

Two types of acquisition were identified: conservation easement and fee title. The role of acquisition would be to purchase minimum interest in lands necessary to preserve a specific resource. All acquisition would be voluntary and based on sound biological and ecological criteria. Criteria identified include ecological significance of the site, its value to wildlife and the threat of change in land use. Easements would monetarily compensate the landowner for specific rights. One application would be to compensate landowners for abandoning maintained drainage ditches and allowing wetlands to revert to their natural state. Fee acquisition would be a last alternative to ensure that unique ecosystems remain. Acquisition could be the practical solution to restore a drained fen because the spongy ground and aquatic habitat provide little value to ranching operations.

Lease agreement was noted as a short-term compensation to landowners for land-use changes. One example may include leasing meadows to shift plant composition toward warm-season grasses to improve nesting habitat. Such a project would mean a loss of hay production for several years. A lease agreement would provide monetary compensation for the loss. After a period of years, the money and effort would be directed to another site.

Legislation was recognized as one strategy that departs from the partnership approach, but it may be needed to protect broad resources. Increasing demands for water in agricultural and populated areas may require legislation to ensure the ecological integrity of the Sandhills. Beneficial legislation would:

- not undermine property rights;
- consider the impact of the local people;
- support the goal of the Sandhill Management plan; and
- be flexible enough to fit unique situations.

Financial support is a strategy to build a coalition of people and agencies to enable the other listed strategies to work effectively. It would help match conservation needs with the available people and financial resources. An example would be combining private conservation funds, agency expertise and landowner property to restore riparian habitat.

The Plan recognized a need for a full-time coordinator. The individual would (1) oversee all aspects of an established program, (2) serve as a liaison between landowners and conservation groups, (3) serve as an information source, (4) form partnerships in education and technical assistance, and (5) obtain multiple sources of funding. Staff and equipment would match the success of the program. A complete staff would include a coordinator, two extension biologists and one clerk. Funding for staff and projects would depend on partnerships, cost-share programs and challenge grants.

After the plan was written, draft copies were distributed to hundreds of individuals, mostly ranchers and organizations, for their review. Public meetings were organized and sponsored by local Task Force members. A FWS representative was invited as their guest. Most of those present were ranchers concerned with government intervention in their lives. During the meetings, the atmosphere shifted from apprehension to vocal support. Questionnaires distributed during the meetings showed nearly 90 percent of the people supported the Plan. Other support has included the governor, U.S. Senators, members of Congress, NC and Natural Resource Districts.

On September 21, 1993, a formal signing ceremony was held on a sandhill ranch. Those present included area ranchers, Task Force members, regional office personnel of the FWS, congressional and gubernatorial staff, local news media, and reporters for National Public Television and Minneapolis Star Tribune. The group also toured several wildlife projects accomplished through partnerships between ranchers and FWS. The day ended with a steak barbecue. The ceremony reinforced the idea that "win-win" solutions can be found.

Implementation

Since the signing ceremony, a coordinator has been hired by the FWS and 24 partnership projects have been completed. Partners sponsored land-management courses for landowners, distribution of resource management information and enhancement of riparian and wetland habitats. Each project, with its unique problem, combined expertise and funds from various sources. Partners have included landowners, Nebraska Board of Educational Lands and Trusts, Leafy Spurge Task Force, Nebraska Branch of Holistic Resource Management, NC, NRD, NGPC, NRCS, FWS and county government.

Habitat projects have focused on finding solutions that benefit the landowner and the resources. One project, for example, brought together the landowner, NGPC and FWS to solve a stream degradation problem. The landowner had lost vehicle access to one side of the stream. He no longer could hay the area and was forced to use the land for pasture. Stream erosion also had drained critical riparian wetlands used by threatened fish species. The partnership arrangement provided the resources to fence out the stream, reestablish willows, construct small control structures and restore riparian wetlands. The landowner was pleased with his new crossing and the improvement of one-half mile of stream.

Some projects have created non-traditional partnerships. One example is a two-day cattlemen environmental workshop co-sponsored by NC and FWS. The workshop focused on (1) viewing traditional management practices in new ways, and (2) bringing together cattlemen and conservation personnel to discuss issues and concerns related to property rights and regulations. NC used its communication network to reach the public and the FWS provided funding and assistance in developing the workshop. The cooperative effort brought together both groups in a non-threatening constructive environment.

The Sandhill Management Plan is young but growing. Its progress proves that a "grassroots" approach can break down barriers and provide solutions. Local involvement has given the people assurance that they have some control in affecting their land and well being. The two dozen completed projects serve as demonstration areas and proof that "win-win" solutions can be accomplished between landowners and resource agencies.

References

Bleed, A. 1990. Groundwater. Pages 67–92 *in* A. Bleed and C. Flowerday, eds., An atlas of the Sand Hills. Conserv. and Survey Div., Univ. Nebraska, Lincoln. 265 pp.

Bose, D. R. 1977. Rangeland resources of Nebraska. Soc. Range Manage., Denver, CO. 121 pp.

Bureau of the Census. 1993. Population and housing unit counts: Nebraska. U.S. Govt. Print. Off., Washington, D.C. 89 pp.

Dreeszen, V. 1984. Overview of Nebraska and the Sandhills. Pages 1–15 *in* The Sandhills of Nebraska: Yesterday, today and tomorrow. Proc. 1984 Water Resour. Seminar Series, Univ. Nebraska, Lincoln. 140 pp.

Kaul, R. 1990. Plants. Pages 127–142 *in* A. Bleed and C. Flowerday, eds., An atlas of the Sand Hills. Conserv. and Survey Div., Univ. Nebraska, Lincoln. 265 pp.

Labedz, T. E. 1990. Birds. Pages 161–180 *in* A. Bleed and C. Flowerday, eds., An atlas of the Sand Hills. Conserv. and Surv. Div., Univ. Nebraska, Lincoln 265 pp.

Lawton, D. 1984. Physical characteristics of the Sandhills: Groundwater hydrogeology and stream hydrology. Pages 44–53 *in* The Sandhills of Nebraska: Yesterday, today and tomorrow. Proc. 1984 Water Resour. Seminar Series, Univ. Nebraska, Lincoln. 140 pp.

Nebraska Natural Resources Commission. 1993. Report on the Sandhills area study. Nebraska Natur. Resour. Commis. 56 pp.

Rundquist, D. C., S. A. Samson and D. E. Bussom. 1981. Wetland atlas of the Omaha District. Contract Number DACW–80–C–0220. U.S. Army Corps of Eng., Omaha, NE. 77 pp.

Winter, T. C. 1986. Effect of ground-water recharge on configuration of the water table beneath sand dunes and on seepage in lakes in the Sandhills of Nebraska. J. Hydrol. 86: 221–237.

———. 1988. A conceptual framework for assessing cumulative impacts on the hydrology of nontidal wetlands. Environ. Manage. 12(5): 605–620.

Northern Grassland Conservation and the Prairie Joint Ventures

Michael G. Anderson
Institute for Wetland and Waterfowl Research
Ducks Unlimited Canada
Oak Hammock Marsh, Manitoba

Rod B. Fowler
Ducks Unlimited Canada
Oak Hammock Marsh, Manitoba

Jeffrey W. Nelson
Ducks Unlimited, Inc.
Memphis, Tennessee

Introduction

The purposes of our paper are to: (1) review briefly contributions to the conservation of northern grassland ecosystems made by the prairie joint ventures of the North American Waterfowl Management Plan (NAWMP); and (2) suggest ways to enhance the effectiveness of joint ventures as vehicles for prairie conservation.

The grasslands of central North America have been altered by humans as extensively as any ecosystem on the continent (Bird 1961, Kiel et al. 1972, World Wildlife Fund 1989, Trottier 1992, Knopf 1994). In North Dakota, for example, more than 72 percent of the original prairie now in private ownership has been converted to cropland or tame pasture (from data in Knopf 1994). In Canada, nearly 76 percent of the mixed grass prairie and more than 95 percent of the tallgrass and fescue prairies have been cultivated (Trottier 1992), and most all of the remaining grasslands are subject to haying or grazing by domestic animals. At the same time, a large proportion of the original prairie wetlands have been drained, filled or cultivated (Tiner 1984, Kiel et al. 1972, Ducks Unlimited 1994).

Because of these impacts, a broad consensus has emerged regarding the need for grassland conservation, however, there are differing views about what specific actions are needed. Protection and enhancement of remnant native prairie are vital, of course, because restoration of complete grassland ecosystems is not possible and remnant prairie supports many threatened or endangered species (World Wildlife Fund 1989). Because natural processes have been altered and large herbivores such as bison (*Bison bison bison*) and prairie dogs (*Cynomys* spp.) have been eliminated from most remnant prairies, some sort of active management (e.g., fire) is needed to maintain such grasslands and prevent encroachment by woody plants or undesirable introduced grasses. Moreover, because of the scale of grassland loss and the wide-ranging nature of most animal species adapted to the dynamic prairie environment, we believe that the recovery of many plant and most animal species associated with native grasslands will require management of large landscapes in ways other than full restoration to pre-agricultural conditions; specifically, in ways compatible with sustainable agriculture.

Prairie farmers and ranchers produce crops that help sustain North America's human population and provide products for export around the world. They own most of the land we are concerned about and, thus, must be involved centrally in any large-scale conservation successes. Conservation interests will be able to "re-claim" certain of these private lands, especially more marginal lands that, from the viewpoint of agronomic sustainability, should not have been developed in the first place. It is not reasonable, however, to assume that many large tracts of productive privately owned agricultural lands can be retired from agricultural use. It is necessary, therefore, to focus attention on combinations of activities, including protection and enhancement of native parcels, managed grazing systems, sound soil and water conservation practices, forage production on marginal land and the like, which should, collectively, provide for a more diverse, wildlife-friendly prairie landscape than exists over much of central North America today. This hopeful philosophy was an important component of the consensus that began to emerge among wildlife interests across the northern prairies during the early 1980s, and helped give rise to the prairie joint ventures of the North American Waterfowl Management Plan (NAWMP) (Anonymous 1986).

NAWMP and the Prairie Joint Ventures

Despite long-standing concerns among biologists about agricultural impacts on prairie ecosystems, little progress was made in reversing the trend of habitat loss on the northern prairies until the late 1980s. An important catalyst for change took shape with the signing of the NAWMP agreement between the governments of Canada and the United States in 1986 (Mexico joined the partnership in 1994). In brief, the NAWMP established population goals and provided an overall framework for the management of waterfowl in North America. Strong emphasis was placed on massive new habitat conservation efforts in degraded ecosystems important to waterfowl. NAWMP recognized that conservation and restoration of wetlands and associated grassland habitats in the prairie pothole region of central North America were critical to achieving its continental population goals. NAWMP considered the prairie pothole region to be a 300,000-square mile (778,000 km^2) arc of mainly mixed-grass prairie and aspen parkland extending from northern Iowa to the Alberta foothills (Batt et al. 1989). Within this region, NAWMP partners established two parallel joint ventures—the Prairie Pothole Joint Venture (PPJV) in the United States and the Prairie Habitat Joint Venture (PHJV) in Canada.

Launching these efforts presented formidable challenges, the greatest of which was the development of significant new sources of funds for conservation. Now, nearly nine years since the signing of the NAWMP and six to seven years since the inception of the prairie joint ventures, the actions of federal, state, provincial and non-profit partners have resulted in the conversion of 200,155 acres (88,958 ha) of cropland to grassland; conversion of 397,398 acres (176,621 ha) of continuously grazed native pastures to more sustainable deferred or rest-rotation grazing systems; protection of 257,333 acres (114,370 ha) of idle native parkland and other grasslands; and the protection, restoration or enhancement of 279,572 acres (124,254 ha) of prairie wetlands (Table 1).

Table 1. Grassland conservation accomplishments of the NAWMP Prairie Joint Ventures from 1986 through January, 1995.

NAWMP Program	PPJV[a]	PHJV[b]	Total
Grassland protection			
Perpetual	155,400	21,265 (54% Native)	176,665
Shorter-term[c]	32,100	48,568 (43% Native)	80,668
Total	187,500	69,833 (46% Native)	257,333
Grassland restoration			
Native grasses	40,200	34,026 (89% Perpetual)	74,226
Tame grasses	61,100	64,829 (23% Perpetual)	125,929
Total	101,300	98,855 (34% Perpetual)	200,155
Enhanced agricultural management			
Hayland	23,100	35,491	58,591
Pasture	143,700	253,698	397,398
Other uplands	27,900		27,900
Total	194,700	289,189	483,889
Wetland protection/restoration	206,400	73,172	279,572

[a]PPJV (Prairie Pothole Joint Venture) includes portions of Montana, North Dakota, South Dakota, Minnesota and Iowa.
[b]PHJV (Prairie Habitat Joint Venture) includes most of the agricultural zones of Alberta, Saskatchewan and Manitoba.
[c]Typically 10-25 years.

Conservation Strategies

In Canada, where losses of grassland and aspen parkland have been extreme, most recent waterfowl conservation work has focused on reestablishing permanent grass in parkland landscapes with numerous and relatively permanent existing wetlands. Less work has been done in the more drought prone mixed-grass prairies and, there, upland projects have been designed to moderate the use of existing native grasslands by cattle. These initiatives, mainly in cooperation with irrigation districts in southern Alberta and ranchers in the western United States, usually involve provision of reliable water to natural wetland basins, coupled with the establishment of deferred grazing systems that typically feature large paddocks where grazing is deferred for most or all of a growing season. Such deferral can benefit certain cool-season native grass species by reducing grazing pressure in spring and early summer, while providing undisturbed habitat for nesting birds.

In the United States, where public lands dedicated to wildlife are more extensive and the USDA Conservation Reserve Program (CRP) has converted 36.5 million acres (16.2 million ha) of cropland to mostly idle grass, the PPJV has invested relatively more in wetland restoration (Table 1). In addition, establishment of Waterfowl Production Areas and other wetland easements by the U.S. Fish and Wildlife Service (USFWS) has protected more than 1.8 million acres (809,000 ha) of wetlands and grasslands in the PPJV region (Nelson and Connolly in press). Restoration of prairie wetlands usually is accomplished by simple installation of small earthen ditch plugs or removal of existing drainage tiles (Galatowitsch and van der Valk 1994). This wetland work is increasingly targeted at areas where CRP or publicly managed grasslands provide extensive upland nesting cover. Significant tracts of grasslands also have been restored or protected by the PPJV, much of it native prairie (Table 1), and nearly 150,000 acres (66,667 ha) of pasture have been converted to grazing systems designed to reduce the impact of cattle on grassland-nesting birds.

In both joint ventures, program planners have attempted to maximize waterfowl benefits while secondarily assisting the conservation of many other indigenous species. Programs are targeted at landscapes, typically 40–200 square miles (104–518 km^2) in size, with high densities of remaining wetlands that should attract large numbers of breeding pairs and adequately support waterfowl broods. Plans for each landscape are developed based on computer models that optimize productive cover mixes, tempered by local experience concerning the acceptability of programs to landowners. Typically, such plans involve some combination of land purchase or lease with establishment of dense nesting cover on formerly cropped land, protection of existing native pasture or idle land, deferred grazing systems, delayed hay cutting and the like. Where grass has been reestablished, wetland restoration usually is conducted on small temporary and seasonal basins (Stewart and Kantrud 1971) which have been lost from the prairie landscape at disproportionately high rates.

Increasingly, native grass varieties are being seeded in cover plantings in mixtures designed to establish appropriate species on wet soils, dry soils, eroded knolls and other specific sites. This is done to maximize cover establishment across whole fields, improve plant species diversity and minimize long-term management costs.

Wildlife Responses

Responses by many species of migratory birds and resident wildlife to these landscape interventions have been encouraging. For example, use of newly established grass stands by bobolinks (*Dolichonyx oryzivorus*), sedge wrens (*Cistothorus platensis*), LeConte's sparrows (*Ammodramus leconteii*), grasshopper sparrows (*A. savannarum*), clay-colored sparrows (*Spizella pallida*) and other grassland birds has been extensive (Higgins et al. 1984, Dale 1994, C. de Sobrino and T. Arnold personal communication: 1994). Several studies now are underway to assess the productivity of waterfowl and songbirds that have responded to this cover in order to learn how managers might maximize wildlife benefits.

While the accomplishments of the prairie joint ventures have been substantial, important questions remain about the biological effectiveness of joint venture programs, including concerns about the effects of grassland fragmentation on breeding success of migratory birds, the attractiveness and safety for breeding birds of various types of planted cover, and the effects of joint venture projects on less-common species. Impacts of joint venture programs on the biology of prairie carnivores also are poorly understood and potentially of great significance to breeding birds. Another important question for managers is the degree to which some agricultural use, e.g., periodic haying or grazing, might be permitted without jeopardizing wildlife habitat values. There is pressure to accommodate such use both to increase the acceptance of programs within rural communities and to generate revenues to help offset long-term management costs for lands dedicated to wildlife.

Reflections on Joint Venture Partnerships

The significant accomplishments of the PHJV and PPJV have been achieved through partnerships of federal agencies, provincial and state governments, and multiple non-government wildlife organizations. For there to be value in a partnership, it must be facilitating rather than restrictive so that more might be accomplished collectively, not less. The fact that both joint ventures remain active today attests to the positive nature of these partnerships. Ducks Unlimited has been an active participant in both joint ventures since their inception. We would like to offer some reflections on what has made these partnerships work, while noting a few of their limitations. Our intent is not to be critical of any joint venture or agency, rather to provide helpful thoughts for improving future partnerships.

Undoubtedly, the greatest benefit of the partnerships has been the merging of numerous agencies with diverse capabilities to pursue common goals. Full knowledge of land-use issues, problems with waterfowl recruitment, reasons for declines of grassland-nesting birds, potential solutions and program ideas were not resident in any single agency. Therefore, development of the original joint venture plans benefitted greatly from the various perspectives that were available from the staff of many agencies.

It also quickly became clear that there was no single solution to restoring northern grasslands and wetlands. Due to funding limitations, mission focus or limitations of operational policy, no single agency was in a position to deliver the full range of proposed solutions. However, because agencies forming these partnerships possessed different skills and interests, most program needs were filled.

Partnerships also have been essential in maintaining financial support for the NAWMP. In these times of financial restraint, government agencies are hard-pressed to maintain funding for wildlife programs. The NAWMP has fared much better than most wildlife programs because of the financial leverage achieved by each agency's contribution. Private sector partners have been influential in demonstrating to politicians the benefits and efficiency of NAWMP funding.

In hindsight, it seems that such partnerships typically are infused with energy during the planning phase, when the commitment and excitement of forging a common vision is a driving force. Once joint ventures face the hard realities of program funding and delivery, however, partnerships can undergo fundamental change. An early challenge was for partners to understand and accommodate the different cultures and requirements of others on the team, particularly the fundamental differences between the public and private sectors. Non-profit organizations are strongly mission focused. Their missions sometimes are rather narrow, but usually long-term. Most government partners have much broader missions and the imperative of responding to short-term political pressure. These differences can lead to predictable conflicts over program emphasis, geographic location and the time frame in which results must be achieved and demonstrated. For some partners, the joint venture is only one of many, perhaps transient, programs; for others, the joint venture's goals are congruent with their organization's mission. Understandably, this can result in varying agency commitments to the joint ventures and varying satisfaction with program results.

Another complication is the nature of management and decision making in joint ventures. Most agencies, public or private, are hierarchial, with a single point of authority. Joint ventures, on the other hand, are horizontal and decisions are made by consensus without a central point of authority. Such partnerships are inherently inefficient at decision making, with progress tending to be controlled by the pace of the most reluctant partner. Furthermore, because of the informal nature of the joint ventures, decisions of the group are not binding on individual members. This necessary independence can be frustrating for other partners who are anxious to influence joint venture programs and policies.

Everyone, it seems, wants to be involved in the delivery of conservation programs. This can result in either turf wars or duplication of efforts, neither of which is constructive. Unfortunately, activities of lower profile, such as evaluations, have been slow to get underway and sometimes are regarded as unwelcome requirements, rather than activities central to successful program implementation.

The marketing of joint ventures also can create challenges, especially when some organizations depend on public exposure in order to raise funds critical to their continued involvement in partnership programs. Multi-agency marketing efforts are difficult to construct, in our view, and may not deliver programs to the public in a clear and understandable way. In Canada at least, public communication programs also need to be broadened. Because of the drought-related decline of ducks in the last decade and the generally high public profile of waterfowl, the PHJV has benefited to some degree from the understanding and support of the general public. There have been insufficient efforts, however, to communicate the massive loss of prairie grasslands and the significant declines of many other species that depend on this habitat.

One of the biggest challenges for the joint ventures is sustaining agency interest and funding over the long term. Some agencies with broad mandates can spend little on any single program. Other agencies that are not active on a daily basis lose touch and, consequently, lose interest with what is taking place. They tend to be involved only when there are major issues, and because these usually are major problems, they can develop a negative image of the program. For the joint ventures to maintain successful, long-term evolving programs, the enthusiasm of partners must be sustained. They all must learn what is happening on a regular basis. They must hear about the success stories. They must get out on the land and see projects firsthand. They must hear the results of program evaluations and understand what is working and what is not. In short, all partners must feel a strong sense of ownership in what is being accomplished. In an innovative effort to enhance its partnerships, the PHJV recently retained an independent consultant to undertake a broad program evaluation. This exercise is providing an independent assessment of various components of the joint venture and may become an effective catalyst for rekindling the commitment of all partners.

The Need for Expanded Partnerships

With the major exception of funds from the North American Wetlands Conservation Act and, to a lesser degree, Canadian federal funds, the majority of recent support for habitat conservation on the Canadian prairies has come from traditional waterfowl interests such as Ducks Unlimited and state wildlife agencies. In the United States, several federal, state and private conservation organizations have targeted significant resources to restore and protect components of the prairie system. In most cases, however, only small remnant tracts have been conserved. It seems unlikely, therefore, that the current partnerships and programs, which are primarily wildlife driven, will result in the restoration of a significant proportion of the original northern grasslands. More innovative initiatives with broader-based political and financial support than the joint ventures of today will be needed to ensure success in conserving these grasslands and their associated wildlife. Most importantly, in our view, conservation organizations must find new ways of working cooperatively with prairie agriculture. Land use and, thus, grassland conservation are affected far more by government agricultural programs than all other forces combined. Prairie wildlife needs a conservation-friendly U.S. farm bill and revamped agricultural policies in Canada more than anything wildlife organizations can deliver on their own. The prairie joint venture leaders understand this, however, policy and legislative initiatives are just beginning to get the attention they deserve.

The Canadian Wheat Board estimates that some 88 million acres (39.1 million ha) of land were cultivated in prairie Canada in 1994. Of these cultivated lands, the federal Prairie Farm Rehabilitation Administration estimates that 12.2 million acres (5.4 million ha) are classified as marginal or fragile (L. Moats personal communication: 1995) and, arguably, never should have been broken. Many of the individual decisions to break this land were not made in response to market forces, but were fostered by subsidies provided by provincial and federal governments based on acres under cultivation for specific commodities. Prairie grain and oilseed producers received annual subsidies of about $45 per acre when cropping marginal lands (Patterson 1993). The only solution that is likely to cause major landscape change is for governments to realign agricultural subsidies to discourage inappropriate land use and provide incentives for adjustments to sustainable agriculture, such as conversion of marginal cropland to grassland. In the U.S., demand to enroll marginal farmland in idled grass exceeds available funds, while the CRP provides an estimated $13 billion worth of environmental benefits at no net cost over what government would have paid to subsidize cropping on the same lands.

Fortunately, more changes are coming. A combination of deficit reduction pressures on governments and required compliance with the GATT and NAFTA treaties seem likely to gradually reduce subsidies for annual cropping. Farmers then will make land-use decisions based more on market forces and land capability. Although we believe that this will lead to an increase in grassland, there is great uncertainty about how much conversion actually will take place and how those new grasslands might be managed. Therefore, a conservation incentive program still may be required.

Fifteen years ago, when planning was initiated for the NAWMP, interaction between the agricultural and conservation communities was difficult. Planners of the prairie joint ventures hoped that if conservation programs were implemented in cooperation with farmers and ranchers, trust and cooperation would develop between the two sectors and lead to mutually beneficial changes in agricultural policies and practices. Today, that relationship is greatly improved. Acceptance of conservation incentives by landowners has exceeded the capabilities of joint venture partners. In some programs, farmers have realized increased net profits above and beyond incentive payments and this has proven to be an important factor in program acceptance. In addition, good working relationships have been established between wildlife interests and several state, provincial, regional and national agricultural organizations. At a time when global trade and public support for agriculture are in a state of flux, the fact that our two sectors are working together toward more sustainable land use gives us reason for cautious optimism about the future conservation of North American grasslands and their wildlife.

Recommendations

We offer the folllowing recommendations for enhancing the effectiveness of prairie conservation through joint ventures:

1. Enlist the participation and support of additional agricultural interests in the prairie joint ventures.
2. Promote changes in public policy that will discourage further conversion of marginal agricultural lands for commodity production and encourage grassland conservation and restoration.
3. Encourage the financial participation of other grassland conservation interest groups in the shaping, delivery and evaluation of NAWMP prairie programs.
4. Continue to improve operational aspects of the prairie joint ventures in order to enhance efficiency, minimize conflicts and enable individual partners to work as productively as possible under the joint-venture umbrella.
5. Strengthen communications between PPJV and PHJV, especially in the area of biological evaluations.
6. Enlist broad support from the general public for prairie conservation by communicating the loss of North American grasslands, the impact on many species of wildlife and potential long-term solutions including conversion to more sustainable agricultural production systems.
7. Preservation and restoration of large ecosystems such as the northern grasslands are long-term challenges. Even the most pragmatic goals may require decades to attain. It is essential that the prairie joint venture partners recognize that they have begun a long journey, commit to making the trip and ensure that there are systems in place to provide constructive feedback on the progress being made. Long-term vision and strong leadership will be essential for guiding the journey.

Acknowledgments

We thank Mark Koneff, U.S. Fish and Wildlife Service, and Bob Clay, Ducks Unlimited Canada, for providing summary data on joint venture habitat accomplishments. C. Lively, A. J. Macaulay, G. McKeating, J. Patterson and R. Wettlaufer offered helpful comments on the manuscript, but we are responsible for the opinions expressed here. Of course, without our joint-venture partners, we would have far fewer accomplishments to highlight or constructive thoughts to offer on the conservation process.

References

Anonymous. 1986. North American Waterfowl Management Plan. U.S. Dept. Int. and Can. Dept. of Environ. 19 pp.

Batt, B. D. J., M. G. Anderson, C. D. Anderson and F. D. Caswell. 1989. The use of prairie potholes by North American ducks. Pages 204–227 *in* A. G. van der Valk, ed., Northern Prairie Wetlands. Iowa St. Univ. Press. Ames. 400 pp.

Bird, R. D. 1961. Ecology of the aspen parkland of western Canada in relation to land use. Can. Dept. Ag. Res. Branch Publ. 1066. Ottawa, Ontario. 155 pp.

Ducks Unlimited. 1994. Ducks Unlimited Continental Conservation Plan (Parts I–III). Ducks Unlimited, Inc., Memphis, TN. 379 pp.

Galatowitsch, S. M. and A. G. van der Valk. 1994. Restoring Prairie Wetlands: An ecological approach. Iowa St. Univ. Press, Ames. 246 pp.

Kiel, W. H., A. S. Hawkins and N. G. Perret. 1972. Waterfowl habitat trends in the aspen parkland of Manitoba. Can. Wildl. Serv. Rept. Serv. 18. 63 pp.

Knopf, F. L. 1994. Avian assemblages on altered grasslands. Pages 247–257 *in* J. R. Jehl, Jr. and N. K. Johnson, eds., A century of avifaunal change in western North America. Studies in Avian Biol. 15. 349 pp.

Nelson, J. W. and M. B. Connolly. In press. Techniques for increasing the quality of the breeding areas for Anatidae in North America. In P. Havet and M. Birkan, eds., Proc. IWRB Symp., Strasbourg, France, IWRB Spec. Publ., Slimbridge, U.K.

Patterson, J. H. 1993, Trade liberalization, agricultural policy, and wildlife: Reforming the landscape. Pages 61–68 *in* T. L. Anderson, ed., NAFTA and the environment. Pacific Res. Inst. for Public Policy, San Francisco, CA.

Tiner, R. W., Jr. 1984. Wetlands of the United States: Current status and recent trends. U.S. Fish and Wildl. Serv., Washington, D.C. 59 pp.

Trottier, G. C. 1992. Conservation of Canadian prairie grasslands: A landowner's guide. Environ. Canada, Edmonton, Alberta. 92 pp.

World Wildlife Fund. 1989. Prairie conservation action plan: 1989–1994. World Wildl. Fund, Toronto, Ontario.

Special Session 7. *The Need for Partnerships in Ecosystem Management*

Chair
BILL WALL
Potlatch Corporation
Lewiston, Idaho

Cochair
JONATHAN B. HAUFLER
Boise Cascade Corporation
Boise, Idaho

The Need for Partnerships in Ecosystem Management: Opening Remarks

Bill Wall
Potlatch Corporation
Lewiston, Idaho

During this century, natural resource management in the U.S. has passed through three stages and hopefully is entering a fourth. No clear boundaries exist between these stages but movement from one stage to another is revealed by changes in approaches or philosophies for management.

The first stage can be characterized as "freewheeling," or a pioneer approach of resource extraction. Dramatic ecosystem alterations occurred through agricultural conversion and irrigation projects, logging, urbanization, grazing, exclusion of fire, introduction of exotic species, flood control projects, etc.

The recognition that unmitigated utilization could not be sustained led to early conservation efforts by the fathers of the conservation movement (stage two). These efforts were successful in the development of natural resource management sciences. These early efforts were highly successful in laying the foundations for more effective scientific resource management, restoration of many forests and delineation of reserves, refuges and wildlife management areas. However, they were only partially successful at slowing the significant changes occurring within ecosystems.

Stage three grew from the early conservation efforts into the environmental movement. Strong regulatory environmental laws were the outcome. This regulatory environment has accomplished several significant results, both positive and negative, including: (1) an awareness of the significant issues society faces for the management of natural resources and maintenance of biodiversity; (2) pressure for real change in approaches by resource agencies and private/industrial landowners in the face of ever-increasing demands for resource utilization; (3) moving the debates on natural resource management out of the hands of resource professionals and local stakeholders and into the courts; (4) an alienation of private landowners; and (5) inefficient and costly bureaucratic planning processes within land-management agencies.

The purpose of this panel is to explore and give examples of the emerging fourth stage. An approach which blends ecological, societal and economic concerns into collaborative partnerships. There is nothing new about this type of approach other than increased understanding and technology, but it appears that its time in history has come.

If collaborative partnerships are to become the new natural resource management paradigm, several major issues must be resolved. These include: (1) removal of regulation which creates barriers or disincentives; (2) the need for a basic level of regulation but with incentives that keep regulation as far in the background as possible; (3) development of collaborative planning frameworks which empower affected stakeholders in the planning and decision process, as well as responsibility in the outcomes; (4) accountability on the part of agency personnel; (5) development of technological and biological frameworks and data bases which support planning across ownerships, but recognize basic property rights and intellectual ownership of specific types of data; and (6) development of collaborative partnerships based on new levels of trust from all factions.

Partnerships for Ecosystem Management on Mixed Ownership Landscapes

V. Alaric Sample
Pinchot Institute for Conservation
Washington, D.C.

Ecosystem management at the landscape scale increasingly is being recognized as a key to avoiding unintended cumulative impacts on ecological values that must be considered at large spatial scales, especially biodiversity and water quality. But political and property boundaries rarely correspond with ecological boundaries, and there are few places in which the delineation of forest ecosystems at an ecologically significant scale does not include intermingled public and private lands. This suggests a need for far greater collaboration and coordination among adjacent landowners in the planning and management of forest lands. There is an array of non-regulatory approaches to facilitating voluntary partnerships among adjacent landowners in mixed ownership landscapes. Before most of these approaches can be successfully applied, however, it will be necessary to address a number of substantial barriers and disincentives, first to the protection of ecological values on individual private ownerships and, second, to cross-boundary cooperation in both private/public and private/private relationships.

Background

Any effective ecosystem management strategy must recognize the important role that private lands can play in complementing and supplementing ecosystem management on adjacent public lands, but it also must recognize and accommodate the appropriate economic and other goals and objectives on private lands. Public forest lands constitute a relatively small proportion of the total forest land base and are not sufficient in themselves to adequately protect biodiversity in forest ecosystems. Nationally, federal and state lands constitute about 20 percent of the total forest land base. It is estimated that the habitat for more than 50 percent of the species federally listed as threatened or endangered occurs *exclusively* on private lands (Natural Heritage Data Network 1993). Even in the western United States, where ownerships tend to be larger and more contiguous than in many regions of the country, the delineation of ecosystems along watershed or other ecological boundaries nearly always will encompass an intermingled mixture of public and private lands. Private lands, thus, will play a critical role in any ecosystem-based strategy to protect biological diversity, water quality and many other natural values, in every region of the United States and for the nation as a whole.

How can an ecosystem-based approach to natural resource management be implemented on mixed ownership landscapes with diverse public and private land-use goals? The response in the past has been the creation of reserves on public lands and the regulation of forest practices on private lands. As the public concern grows over forest conservation, and especially endangered species habitat conservation, there will be increasing political pressure for protection of ecological values on private as well as public forest lands. In the absence of alternative means of protecting these values on private lands, there will be continuing public pressure for further government regulation of private forest practices.

But existing regulatory approaches aimed primarily at controlling timber harvesting practices are expensive to comply with and enforce, and are of limited usefulness in conserving landscape-level features such as wetlands or habitat for sensitive species. In some instances, regulatory approaches have precipitated a backlash among landowners who feel they are being asked to shoulder an unfair share of the cost of protecting public values on private lands. When environmental protection regulations have reduced income or the economic value of private lands, owners have challenged the constitutionality of what they regard as an illegal government taking of private property without compensation (Cubbage and Siegel 1985, see also Hickman and Hickman 1990, Beuter 1987, Cheng and Ellefson 1993). A recent federal court decision suggests that government may be exceeding its authority in requiring the protection of endangered species habitat on private lands (Washington, D.C. Circuit Court of Appeals 1994). Clearly, there is a need to explore more fully alternative non-regulatory mechanisms for achieving ecosystem management objectives and to improve the effectiveness of those institutional arrangements already in place, before resorting to additional federal or state regulation.

Mechanisms for Facilitating Cross-Boundary Cooperation and the Protection of Ecological Values on Private Lands

In October 1993, a national workshop was convened at Yale University to explore non-regulatory approaches to improving cross-boundary coordination to protect ecological values on mixed ownership landscapes and to identify any institutional, legal or policy barriers to their implementation (Sample 1993). A range of incentive- and information-based approaches were developed and evaluated.

Incentive-based Approaches: Turning Habitat Protection into a Financial Asset

Protecting ecological values on private lands, especially where it limits economic activities, results in what essentially is the reverse of the environmental externality problem associated with most environmental pollution: it provides diffuse public benefits by concentrating private costs (Davis and Kamien 1977). Many innovative ideas have been offered for mitigating this inequity through publicly funded financial incentives to non-industrial private landowners, such as the Stewardship Incentive Program administered by the USDA Forest Service and state forestry agencies (16 U.S.C. 2103a). While not considered compensation—which implies direct payment for assessed fair market value of the loss of economic values—these mechanisms can significantly offset the conservation costs on private lands.

Recently, additional financial incentives have been suggested, targeted specifically at encouraging the protection of endangered species habitat on private lands (Fischer and Hudson 1993). Rather than relying on traditional cost-share approaches that increase federal budget outlays, incentives are created through reducing what a private landowner must pay in federal income taxes. Income tax credits for ecosystem protection would offset in whole or in part expenses incurred in ecosystem protection, improvement or restoration, especially for watershed protection or the restoration of habitat for threatened or endangered species.

Another type of federal income tax deduction could be used to offset in whole or in part the local property taxes paid on lands providing protection for important watershed values or habitat. Conservation easements long have been used to encourage land conservation through reduced property tax assessments, but this approach is being limited by the ability of public or non-profit organizations to purchase easements and by the impact of reduced property tax revenues on local government (Northern Forest Lands Council 1994). The additional benefit of such a federal income tax deduction could result in lower initial purchase prices for easements, significantly improving the effectiveness of the perennially underfunded conservation easement programs of state governments, non-governmental organizations and federal programs such as Forest Legacy.

Additional incentives may be useful in facilitating cooperation across ownership boundaries to protect ecological values that can only be managed for large spatial scales that encompass more than one ownership. An additional portion of local property taxes might be made deductible for participation in a state-approved, multi-owner "Ecosystem Management Agreement" initiated by the landowners themselves and intended to protect distinctive ecological values over a landscape-scale area. Similarly, the Stewardship Incentive Program could offer a higher cost share (currently a maximum of 75 percent) for establishment of or participation in Stewardship Councils at the local level to facilitate multi-owner coordination and cooperation. The Stewardship Incentive Program currently focuses almost entirely on the management of individual private ownerships.

Information-based Approaches: Facilitating Landowners' Achieving Their Own Stewardship Objectives

Presenting a landowner with a plaque noting public appreciation for his or her efforts at habitat conservation is likely to get a government official a far different reception than presenting that same landowner with a notice that an endangered species has been found on his or her back forty, the use of which will hereafter be restricted in order to protect that habitat. Many private landowners are deeply committed to being good stewards of their land and resources, and want only to know that their contributions "beyond the call of duty" are recognized and appreciated. Positive public recognition for such efforts costs very little and requires no change in current law. Many agencies and non-profit organizations have recognized the value of highlighting and rewarding individual conservation efforts, not only for encouraging those individuals but for recruiting others in the community to look for contributions that they too can make. The value of such programs to building understanding and good will for habitat conservation and environmental protection on private lands cannot be overestimated.

There are important opportunities for achieving ecosystem management objectives at low cost by providing education and technical assistance to private landowners for whom protecting distinctive ecological values already is an important ownership objective. In numerous surveys of non-industrial private forest landowners in many regions of the United States, a majority identify commodity production as subordinate to other ecological or aesthetic values (Bliss 1993). Many landowners report that, although there are many sources of technical assistance on timber management or game management, direct assistance for activities like biodiversity inventory and management planning either is unavailable or severely limited by insufficient funding or personnel. This also is a significant economic opportunity for private consultants with the foresight to expand their portfolio of services to private landowners to include biodiversity inventory and management planning. The availability of additional financial incentives, such as those discussed above, to at least partially offset consultant's fees will further expand these opportunities.

Regional Evaluations

Preliminary results from the "field testing" of these potential policy mechanisms suggest that the single greatest set of opportunities for improving ecosystem management on mixed ownership landscapes is through education and technical assistance. Following the national workshop, several regional workshops were held to explore the applicability of these mechanisms to different landownership patterns, and in social, economic and cultural contexts that vary from region to region across the United States. Although financial incentive programs would be welcomed by many landowners, many others convey a disregard or growing mistrust for such programs due to (1) the lack of federal commitment in funding existing financial incentive programs such as the Stewardship Incentives Program and Forest Legacy, and (2) the perception that there are "strings attached" to federal cost-share and incentive payments that increase the risk of future government restrictions on a private owner's economic use of his or her land.

Ironically, many private landowners regard the implementation of the Endangered Species Act (ESA) itself as the greatest single barrier to habitat protection on private lands. Landowners who successfully attract or sustain a threatened or endangered species by protecting its habitat run the risk of having their other management activities curtailed in order to avoid illegal habitat modification or degradation (50 C.F.R. 17.3). In a strange twist of policy, landowners who actively eliminate suitable habitat before it can be occupied are able to continue their management activities unencumbered by ESA requirements. The Ninth Circuit and Washington, D.C. Circuit Courts of Appeal currently disagree on whether this policy indeed is consistent with law, so the matter may have to be decided by the Supreme Court (Washington, D.C. Circuit Court of Appeals 1994). However, ESA §7 clearly prohibits habitat modification through actions "authorized, *funded*, or carried out" [emphasis added] by a federal agency (16 U.S.C. 1536). Accepting federal funding through cost sharing or other direct payments for management on private lands, thus, could increase a landowner's legal liability where habitat for threatened or endangered species is involved.

Landowners who determine that the value of federal incentive payments is less than the economic return they would have to forego, therefore, are unlikely to participate in federal cost-share programs. However, other landowners for whom commodity production is not the primary ownership objective still are likely to take advantage of these programs.

Improved technical assistance elicited the highest level of interest among private forest owners seeking to manage their land in ways compatible with protecting ecological values and coordinate with their neighbors where a landscape-scale ecosystem management strategy is required. Technical assistance programs perhaps are the most useful and cost-effective contribution that federal and state governments can make to ecosystem management on private lands and cross-boundary coordination on mixed ownership landscapes. At the same time, government agencies must keep in mind that they can, at best, be catalyzing forces and resist the temptation to dominate local-level efforts whose continued success is largely dependent on local, private initiative and leadership.

The "catalyzing organization" approach to technical assistance focuses on fostering the development and emergence of local leadership from the landowners themselves. The catalyst organization functions to:

- identify and articulate the landscape-scale conservation goals in the region;
- identify key landowners in terms of the importance of their lands to the larger-scale objectives, but also in terms of their potential to influence and educate fellow landowners;
- convene and facilitate periodic meetings of landowners to promote the exchange of information and build a sense of shared purpose and objectives; and
- Provide or facilitate technical assistance to landowners to help them see their property in terms of the watershed or other ecologically defined landscape-scale area, plan for compatibility between protection activities and prior existing ownership objectives, and assist in tax/estate planning.

Extending technical assistance via peer-to-peer networks among private landowners is important in terms of both the reach and credibility of government programs. In the eastern U.S., the sheer number of forestland owners and the rate of ownership turnover renders it impractical even for catalyst organizations to reach every individual landowner. Peer-to-peer networking programs, such as the Coverts program begun in Vermont, provide habitat conservation training to landowners who, in turn, voluntarily assist other landowners and bring them into an active communications and technical assistance network (Snyder and Broderick 1992). Focusing technical assistance on opinion leaders among local, private landowners also helps overcome a deep-seated mistrust of government programs that persists in many regions. Landowners interested in conservation but opposed to government officials visiting their property often are responsive to information conveyed by a neighbor and become important elements in the overall landscape-scale conservation effort.

Overcoming Legal and Policy Barriers to Cross-boundary Coordination

By and far, the single largest barrier to cross-boundary coordination is the perception—by public land managers, as well as private landowners—that entering into a cooperative planning effort will limit their flexibility for future decision making. However, coordination and cooperation to achieve ecosystem management goals at the landscape level may be the best hope for protecting ecological values sufficiently. This could obviate the need for further direct regulation of forest practices and land use, which would almost certainly result in limitations on the flexibility of future decision making on private forest lands.

The impact of inheritance taxes on the disposition of lands or their resources makes it difficult to commit to any long-term management plan in coordination with adjacent owners. Inheritance taxes are a major cause of parcelization of forest landholdings and the forced liquidation of timber assets. Such actions are forced by inheritance tax law without regard to ecological or environmental values that may be lost, or to the effect on multi-owner coordinated resource management plans. More effective use of existing tools like conservation easements in estate planning through improved technical assistance to landowners can significantly mitigate this problem. However, many newly land-rich and cash-poor heirs are unable to pay the required inheritance taxes within the allotted time, even with assessments reduced through conservation easements. Such situations could be alleviated through case-by-case waivers or reductions in federal inheritance taxes (and/or federal income tax credits to offset state inheritance taxes) on lands judged to be of significant ecological value and threatened with parcelization or resource liquidation.

Federal anti-trust laws continue to be regarded by corporate forest landowners as a major barrier to cross-boundary coordination with adjacent private or public landowners. No matter what the intent, any agreement between major regional timber suppliers that has the effect of reducing local supply and boosting log prices is apt to be regarded by the courts as collusion, resulting in substantial penalties and fines. Waivers from federal anti-trust laws to permit cooperation and coordination by corporate forest landowners, with specific case-by-case approval from a designated federal or state agency, would clear the way for participation by a class of landowner with the capacity to contribute very significantly to the achievement of landscape-scale ecosystem management goals.

Conclusion

Private forest lands, both corporate and non-industrial, will play a role in any successful strategy to protect biodiversity, water quality and other ecological values that must be managed at the landscape level. Financial and economic incentives will be important in encouraging voluntary conservation of ecological values on private lands. However, many private forest landowners simply are seeking improved technical assistance to identify important ecological values and develop management plans that help them better understand and protect those values, consistent with their prior existing ownership objectives. From a policy standpoint, this presents opportunities to substantially increase conservation on private forest lands without additional regulation, and at cost significantly lower than that associated with new or expanded financial incentive programs.

References

16 U.S.C. 2103a. 1990. The "Forest Stewardship Act of 1990" was included as Title XII of the "Food, Agriculture, Conservation, and Trade Act of 1990 (the 1990 Farm Bill).

Beuter, J. H. 1987. When does the regulation of private forest land become taking? Renew. Resour. J. 5(2): 15–22.

Bliss, J. C. 1993. Alabama's nonindustrial forest landowners. Alabama Coop. Ext. Serv., Auburn. 19 pp. See also: Ticknor, W. D. 1993. A survey of selected forestland owners in southcentral Indiana. USDA For. Serv. and Purdue Univ. 13 pp.

Cheng, A. S. and P. V. Ellefson. 1993. State forest practice laws and regulations: A review of constitutional and legal environments. Dept. For. Resour., Univ. Minnesota, St. Paul.

Cubbage, F. W. and W. C. Siegel. 1985. The law regulating forest practices. J. Forest. 83(9): 538–545.

Davis, O. A. and M. I. Kamien. 1977. Externalities, information, and alternative collective action. *In* Dorfman, R. and N. S. Dorfman, eds., Economics of the environment. Norton, New York, NY.

Fischer, H. and W. Hudson. 1993. Building incentives into the Endangered Species Act. Defend. of Wildl., Washington, D.C. 123 pp.

Hickman, C. A. and M. R. Hickman. 1990. Legal limitations on governmental regulation of private forestry in the U.S. *In* Forestry legislation. Rep. of IUFRO Working Party, Zurich, Switzerland.

Natural Heritage Data Network. 1993. Perspectives on species imperilment. The Nature Conserv.

Northern Forest Lands Council. 1994. Finding common ground: The draft recommendations of the northern forest lands council. Portsmouth, NH. 74 pp.

President's Commission on Environmental Quality. 1993. Report of the Task Force on Biodiversity on Private Lands. Counc. on Environ. Quality, Washington, D.C.

Sample, V. A. 1990. Land stewardship in the next era of conservation. Grey Towers Press, Milford, PA.

———. 1993. Building partnerships for ecosystem management on forest and range lands in mixed ownership. J. Forestry 92(8): 41–44.

Snyder, L. B. and S. H. Broderick. 1992. Communicating with woodland owners. J. Forest. 90(3): 33–37.

Washington, D.C. Circuit Court of Appeals. 1994. *Sweet Home Chapter of Communities for a Great Oregon v. Babbitt.*

Forest Industry Partnerships for Ecosystem Management

Jonathan B. Haufler
Boise Cascade Corporation
Boise, Idaho

Introduction

Ecosystem management has been accepted as the preferred approach for future land planning by most federal agencies, many state agencies and a number of private landowners. Definitions of ecosystem management vary, but virtually all focus on an approach to management that strives to balance ecological, economic and social objectives (Kaufmann et al. 1994). Grumbine (1994) reviewed literature pertaining to ecosystem management and found that the overall goal of sustaining ecosystem integrity was a common theme, and that maintaining biodiversity for native species, and for ecosystems and their processes were commonly identified. It is these ecological objectives of ecosystem management that are challenging land managers to develop new methodologies and plan at increasingly complex spatial and temporal scales.

Agencies, especially the USDA Forest Service, have begun attempts at implementing ecosystem management. Many agency efforts to date (e.g., FEMAT 1993, USDA Forest Service 1994) have focused on meeting ecosystem management objectives through government actions alone. However, numerous examples can be identified such as the controversy over the spotted owl (*Strix occidentalis caurina*) or the challenges of meeting red-cockaded woodpecker (*Picoides borealis*) population goals, that point to the desirability of including private land contributions toward ecosystem management objectives. While some people might promote a regulatory approach to obtain these contributions, such a strategy will only result in increased polarization of issues, additional legal battles and challenges to existing or future legislation. A cooperative strategy based on building partnerships for ecosystem management offers a far more effective approach where funds can be spent for the good of the resource rather than in courtrooms or for lobbying efforts. West (1994: 21) stated, "Both public and private lands hold and benefit from biodiversity. Management with sensitivity to biodiversity will require partnerships, cooperation and integration beyond any past experience."

Forestland occupies 33 percent of the U.S. land base, with approximately 66 percent of this classified as commercial forestland, deemed capable of growing sustainable timber products (Davis and Johnson 1987). Of the commercial forestlands, private industrial forestlands comprise approximately 69 million acres (28 million ha) or 14 percent, the USDA Forest Service lands approximately 18 percent, other publicly owned forestlands about 10 percent and the remainder in private, non-industrial ownership (Davis and Johnson 1987). Thus, private industrial forestlands represent a sizable land base throughout the forested areas of the United States, and private industrial landowners can be significant partners in meeting ecosystem management objectives.

Partnerships for Ecosystem Management

If partnerships for ecosystem management involving private industrial forest landowners are to be accepted and successful, a number of features must be present. These include: (1) involvement needs to be voluntary; (2) all players in the partnership should have the opportunity to be involved from the start of any planning activity; (3) mutually agreed upon goals and objectives need to be set, with flexibility maintained in the way contributions toward these can be provided; (4) the different objectives of the various landowners must be recognized and respected; (5) private property rights must be recognized and respected; and (6) partnerships should strive to provide economic incentives and avoid creating economic disincentives for private landowners.

Voluntary Involvement

Many examples can be provided of forest industry seeking out opportunities to cooperate with other landowners and agencies to improve resource management. A concern regarding cooperative efforts is the fear of invoking additional regulatory restrictions stemming from the initial cooperative effort. If voluntary involvement can be assured, many industrial forest landowners might be encouraged to enter into ecosystem management partnerships.

Involvement From the Onset

For successful partnerships, all participants should be identified and invited to participate from the start. Ownership in the decision-making process from the onset is essential. Agencies, or other partners, cannot enter into a partnership with a preconceived agenda and methodology in mind as to what will be the contribution or actions from the private landowners. A partnership will not be successful if a plan already is prepared and an agency then is asking for "partners" to sign on to the plan.

Mutual Goals and Objectives

Mutually agreed upon goals and objectives, and acceptable strategies for meeting these, must be group decisions. It is critical that all cooperators in the partnership have a clear understanding and shared vision of what they would like to accomplish. While agencies may have legislative restrictions in how they can operate, they must recognize that private landowners may be able to provide contributions toward ecosystem management objectives using very different approaches or methods. It is only by keeping a focus on the agreed upon objectives that workable solutions, satisfactory to all cooperators, can be identified and put into action.

Different Landowner Objectives Respected

Private industrial forestlands are owned and managed for very different objectives than public lands. Private industry has a fiduciary responsibility to its shareholders or owners to effect an economic return from its operations and ownerships. A failure to accomplish this could result in millions of acres of forestland converting to other uses or developments. This economic return should not be at the cost of resource degradation. For example, Boise Cascade Corporation has a philosophy and standards for its forest management activities that states that the company will manage its forest to provide the best sustained harvest of forest products with acceptable economic returns, and will maintain or enhance wildlife, watershed, soil and recreational values. Jones and Lloyd (1993: 196) stated, "Innovative companies are considering the effect of management practices on other societal goals of interest and even providing certain benefits while providing an acceptable level of profit margin for their shareholders." This will mean that different management activities may occur on private forestlands than on public lands, but does not decrease the significance of the contribution of private industrial forestlands to ecosystem management objectives. This difference in land ownership objectives must be recognized and respected by all cooperators in a partnership, and should not be confused with the agreed upon goals and objectives of the partnership.

Respect of Private Property Rights

The rights of private landowners to manage their lands to meet their objectives without undue regulatory constraints is a critical component of partnerships. Ecosystem management involving private lands will not be successful if attempted as a regulatory activity. As mentioned previously, this will only lead to increased legal and political debates. Failure to recognize these concerns over private property rights will cause immediate polarization of views and make effective partnerships impossible.

Economic Incentives

Because private industrial forestlands are owned and managed for an economic return, the cost of any activity to a company is a concern. Ways to provide economic incentives to private landowners for modifications of activities to address ecosystem management objectives would greatly enhance partnership effectiveness. At the least, economic disincentives need to be avoided if partnerships are to be successful. For example, if a company were willing to manage a component of its lands on a longer timber rotation to provide enhanced late successional conditions for certain desired ecosystem management objectives, and an endangered species such as a spotted owl then moved onto these lands, the present economic consequences of this could be great. Ways must be found to make management for desired conditions which might include endangered species habitat a positive or at least neutral economic condition. Ticknor (1993: 265) stated, "We can overcome economic disincentives with regulations and penalties and taxes, and this seems to be the route we prefer. But I suggest that it will be far more effective to obtain alignment of economics with environmental values, so that economics reinforces good environmental practices. The considerable creativity and energy of forest managers will then more often be directed toward implementing beneficial programs instead of minimizing the costs of compliance."

Jones and Lloyd (1993: 196) addressed economic concerns for private landowners, stating that, "Economic incentives must be available for private landowners to provide nontimber values. For instance, private landowners are providing wildlife values because of the market-driven demand for hunting leases. On the other hand, private landowners are providing wetland values through a politically driven process that considers the desires of an urban society at the expense of rural, private landowners." Daniels (1991: 104) stated, "Ecosystem management is a different socio-biological task than we have traditionally undertaken, and there is no reason to assume that the market is the appropriate tool for it." Sample (1993) discussed many of the types of incentive programs that might be appropriate to encourage private landowner participation in ecosystem management.

Technical Considerations

With the above considerations recognized and valued, effective partnerships still will not be possible without attention to certain key technical considerations. These include such aspects as compatibility of land classifications, compatibility of data collections and analysis tools, and ability to quantify contributions toward objectives.

Compatibility of Land Classifications

Ecosystem management involves considering land management at different spatial and temporal scales than most previous planning efforts. For it to be implemented in partnerships across land ownerships, compatible systems of land classifications must be used. These classifications do not have to be identical, but it must be possible to relate information for the entire landscape under consideration. Effective ecosystem management will require more than a classification of existing vegetation. An ecological description of a landscape is needed to understand the influence of disturbance regimes and successional pathways (Haufler and Irwin 1993, Haufler 1994). It should not matter whether the ecological descriptions of sites follow the USDA Forest Service's ecological classification system (Ecomap 1993), habitat typing (e.g., Steele et al. 1981), landscape characterization (Bourgeron et al. 1994) or other ecological classifications, as long as mechanisms exist to at least allow the classifications to be cross-walked. Similarly, any descriptions of existing vegetation must have the ability of being cross-walked across the landscape as well. A method for quantifying a landscape into an ecosystem diversity matrix was discussed by Haufler and Irwin (1993) and Haufler (1994). This type of diversity matrix has been developed by Boise Cascade for central Idaho (Figure 1). A hierarchical classification (e.g., Ecomap 1993) also is important to understand and set ecological boundaries. Grumbine (1994) noted that recognition of a hierarchical context was an important component discussed in the literature on ecosystem management.

Compatible Data and Analysis Tools

In addition to a compatible ecological land classification system, the partners in a cooperative ecosystem management effort will need to identify the types of data and analysis tools needed to assess the agreed upon objectives. For maintaining ecosystem integrity, an objective might be to provide adequate ecological representation (Haufler 1994) of ecosystems across the planning landscape as defined by an ecosystem diversity matrix. If further species assessments are desired, then data describing the species' habitat requirements or measures of the quantity of habitat available might need to be provided by the various partners. These data must be in a compatible format to allow for analysis. In addition, appropriate and agreed upon analysis tools must be selected both to ensure compatible outputs and provide a clear use and function for any shared data about the landscape.

Quantification of Contributions

While an essential first step in all partnerships for ecosystem management is discussions about goals, objectives, partnership expectations, obligations, etc., suc-

Vegetative Growth Stage	Dry Ponderosa Pine Overstory Species	Ac.	Dry Douglas-Fir; Moist Ponderosa Pine Overstory Species	Ac.	Dry Grand Fir Overstory Species	Ac.
	Habitat Type Class					
Grass/forb/seedlings						
Shrub/Seedling (L, M, H)	*Pinus ponderosa*		*(Populus tremuloides)* *(Pinus contorta)* *Pinus ponderosa*		*(Populus tremuloides)* *Pinus ponderosa* *Pseudotsuga menziesii*	
Sapling; Shrub/Seedling (L, M, H)	*Pinus ponderosa*		*(Populus tremuloides)* *(Pinus contorta)* *Pinus ponderosa*		*(Populus tremuloides)* *Pinus ponderosa* *Pseudotsuga menziesii*	
Small Trees; Sapling; Shrub/seedling (L, M, H)	*Pinus ponderosa*		*(Populus tremuloides)* *(Pinus contorta)* *Pinus ponderosa* *Pseudotsuga menziesii*		*(Populus tremuloides)* *Pinus ponderosa* *Pseudotsuga menziesii* *Abies grandis*	
With Historical Fire Regime (Crane and Fischer 1986)	Understory Burn 5-25 Years		Understory Burn 10-22 Years		Understory Burn 10-30 Years	
Small Trees; Shrub/Seedling (L, M, H)	*Pinus ponderosa*		*(Populus tremuloides)* *(Pinus contorta)* *Pinus ponderosa*		*Pinus ponderosa*	
Medium Trees; Shrub/Seedling (L, M, H)	*Pinus ponderosa*		*(Pinus contorta)* *Pinus ponderosa*		*Pinus ponderosa*	
Large Trees (L, M, H)	*Pinus ponderosa*		*Pinus ponderosa*		*Pinus ponderosa*	
Large Trees; Medium Trees (L, M, H)	*Pinus ponderosa*		*Pinus ponderosa*		*Pinus ponderosa*	
Without Historical Fire Regime Stand Destroying Wild Fire Inevitable						
Medium Trees; Small Trees; Sapling; Shrub/Seedling (L, M, H)	*Pseudotsuga menziesii* *Pinus ponderosa*		*Pinus ponderosa* *Pseudotsuga menziesii*		*Pseudotsuga menziesii* *Pinus ponderosa* *Abies grandis*	
Large Trees; Medium Trees; Small Trees; Saplings; Shrub/Seedling (L, M, H)	*Pseudotsuga menziesii* *Pinus ponderosa*		*Pseudotsuga menziesii*		*Pinus ponderosa* *Abies grandis* *Pseudotsuga menziesii*	
OLD GROWTH (L, M, H)	*Pinus ponderosa* *Pseudotsuga menziesii* Infrequent Snags Infrequent DWD >5 Trees >20" DBH		*Pseudotsuga menziesii* >1 Snag >20" DBH >1 Piece DWD >12" dia.		*Abies grandis* >2 Snags >20" DBH >2 Pieces DWD >12" dia.	

Figure 1. An example of the ecosystem diversity matrix developed by G. Roloff, R. Steele and J. Haufler for Boise Cascade Corporation's Idaho ecosystem-management demonstration project and surrounding landscape. When filled, the matrix will quantify acres of each ecological unit (cell) occurring in the landscape. Habitat type classes based on Steele et al. (1981). Old growth definitions

Habitat Type Class									
Wet Grand Fir		Cool, Moist Douglas-Fir		Warm, Dry Subalpine Fir		Warm, Moist Subalpine Fir		Hydric Subalpine Fir	
Overstory Species	Ac.	Overstory Species	Ac.	Overstory Species	Ac.	Overstory Species	Ac.	Overstory Species	Ac.
(Pinus contorta) (Larix occidentalis) (Pinus ponderosa) Pseudotsuga menziesii		(Pinus contorta) (Populus tremuloides) (Pinus ponderosa)		Pseudotsuga menziesii (Pinus contorta)		(Pinus contorta) (Larix occidentalis)		Pinus contorta	
(Pinus contorta) (Larix occidentalis) (Pinus ponderosa) Pseudotsuga menziesii		(Pinus contorta) (Populus tremuloides) (Pinus ponderosa)		Pseudotsuga menziesii (Pinus contorta)		(Pinus contorta) (Larix occidentalis)		Pinus contorta	
(Pinus contorta) (Larix occidentalis) (Pinus ponderosa) Pseudotsuga menziesii (Picea engelmannii)		(Pinus contorta) (Populus tremuloides) (Pinus ponderosa) (Pseudotsuga menziesii)		Pseudotsuga menziesii (Pinus contorta)		(Pinus contorta) (Larix occidentalis) Pseudotsuga menziesii Picea engelmannii		Picea engelmannii Pinus contorta	
Fire Mosaic 25-100 Years		Fire Mosaic 5-6 Years		Fire Mosaic 50-90 Years		Stand Destroying Wild Fire & Some Understory Burn		Stand Destroying Wild Fire 100-400 Years	
(Pinus contorta) (Larix occidentalis) (Pinus ponderosa)		(Pinus contorta) (Populus tremuloides) (Pinus ponderosa)		(Pinus contorta)		(Pinus contorta) (Larix occidentalis)			
(Pinus contorta) (Larix occidentalis) (Pinus ponderosa)		(Pinus ponderosa) (Pinus contorta)		Pseudotsuga menziesii (Pinus contorta)		(Pinus contorta) (Larix occidentalis)			
(Larix occidentalis) (Pinus ponderosa)		(Pinus ponderosa)		Pseudotsuga menziesii		(Larix occidentalis)			
(Larix occidentalis) (Pinus ponderosa)		(Pinus ponderosa)		Pseudotsuga menziesii		(Larix occidentalis)			
Pinus ponderosa Pseudotsuga menziesii (Larix occidentalis) (Picea engelmannii)		(Pinus ponderosa) Pseudotsuga menziesii (Pinus contorta)		(Pinus contorta) Pseudotsuga menziesii Picea engelmannii		(Larix occidentalis) Pseudotsuga menziesii Picea engelmannii		Picea engelmannii Pinus contorta	
Pinus ponderosa Pseudotsuga menziesii (Larix occidentalis) (Picea engelmannii) Abies grandis		(Pinus ponderosa) Pseudotsuga menziesii		Picea engelmannii Abies lasiocarpa		(Larix occidentalis) Picea engelmannii Abies lasiocarpa Pseudotsuga menziesii		Picea engelmannii Abies lasiocarpa	
Abies grandis >2 Snags >20" DBH >2 Pieces DWD >12" dia.		Pseudotsuga menziesii >1 Snags >16" DBH >2 Pieces DWD >15" dia.		Picea engelmannii Abies lasiocarpa >2 Snags >10" DBH >16 Pieces DWD >8" dia.		Abies lasiocarpa Picea engelmannii >2 Snags >12" DBH >1 Piece DWD >12" dia.		Picea engelmannii Abies lasiocarpa >2 Snags >12" DBH >1 Piece DWD >12" dia.	

based on Hamilton (1993). Species in parentheses only occur in some stands. L = low canopy coverage (10–40 percent); M = medium canopy coverage (40–70 percent); H = high canopy coverage (70+ percent); DWD = downed woody debris.

cessful partnerships need to set clearly stated objectives and quantify contributions and progress toward these objectives. The compatible classifications, data and analysis methods discussed above provide mechanisms for quantification. A further step is to identify who will be responsible for compiling data, analyzing progress and reporting results. Because of the complexities in dealing with landscape management, GIS technologies will be necessary for conducting this step. Thus, successful partnerships will need to have a mutually acceptable data management center with GIS capabilities and with sufficient funding and personnel dedicated to the partnership to provide the needed technical support. Handling and dissemination of data or results must be agreed upon up front, so that all partners are comfortable with how any proprietary information will be handled.

Boise Cascade Corporation Ecosystem Management Partnerships

Boise Cascade Corporation has initiated three ecosystem management demonstration projects located in central Washington, Idaho and Minnesota. Each of these projects is designed to provide Boise Cascade Corporation with the ability to understand and quantify how its lands fit into and contribute to a broader landscape in an ecosystem-management framework. The Idaho and Washington projects were initiated in January of 1994, and each involves a project advisory committee comprised of state and federal agency representatives, conservation organizations, and other landowners. The advisory committee has functioned to provide communication on mutual goals, cooperative research efforts, and compatibility of classifications, data and analysis tools. In addition, technical committees have been established to deal specifically with implementation of these issues.

Specifically, the objectives of Boise Cascade's ecosystem management demonstration projects are to:

1. Develop an integrated forest management information system that incorporates data and analytical capabilities for timber, fish and wildlife, and watersheds.
2. Document abundances of wildlife and other species that can be supported consistently in managed forest environments.
3. Demonstrate, using cooperative research efforts, silvicultural options that can be used to produce or maintain selected ecological conditions in forested landscapes.
4. Document present and future contributions from Boise Cascade Corporation lands to landscape goals for ecosystem diversity.
5. Facilitate interactions among landowners and various publics in terms of setting landscape-level goals for ecosystem management.
6. Establish Boise Cascade Corporation's objective of contributing to regional landscape and biodiversity goals while maintaining a focus on commodity production from its land base.

Integrated Forest Management Information System

Boise Cascade Corporation needs to be able to document the interaction of its silvicultural programs with wildlife and fish habitats, watersheds, and special areas such as wetlands. This documentation needs to be quantitative and reproducible. To accomplish this, an integrated forest management information system is being developed.

Any forest management system has as its basis a classification of the forest land base. The integrated forest management information system will have as its basis a classification system comprised of a description of the existing stands of vegetation (vegetative growth stages, Figure 1) and a delineation of habitat types (e.g., Steele et al. 1981). These two classifications are being designed to be compatible, to the maximum extent possible, with those being used by surrounding landowners. These two mapping layers have been overlaid using GIS to create polygons of ecological units (cells within the ecosystem diversity matrix, Figure 1) that will be used for wildlife habitat analysis, as well as one component in watershed analyses. These area classifications also will be mapped relative to a larger hierarchical classification (Ecomap 1993), as this is developed by federal agencies to allow watersheds and regional landscapes to be interpreted and modeled in an appropriate manner.

The integrated forest management information system is designed to evaluate fish and wildlife habitats on Boise Cascade and surrounding lands. Wildlife habitat for selected species is being evaluated using habitat suitability indices. These indices determine potential habitat quality for any selected wildlife species based on measured habitat variables potentially limiting to each species. Each region has prepared a list of species in order of priority for that region. The list includes endangered, threatened and sensitive species, species of high public visibility or demand, and species that are indicators of selected ecological conditions. Habitat suitability models for these species are being developed if they are not already available. These models are programmed into the GIS to facilitate use. Habitat variables needed to drive the models have been identified and appropriate sampling methods described. Habitat variable sampling is ongoing to provide estimates of mean values and variances for each habitat variable in each type of ecological unit occurring in the landscape. The habitat evaluation models will be validated for accuracy in future years by comparing projected habitat potentials of areas with actual population indices, or other appropriate population parameters, for the species of interest. In addition, fish habitats, using stream reaches as analysis units, are being sampled and evaluated.

The hierarchical classification of the landscape is being used to delineate geological and climatic influences on watersheds. Topography, soils (where available) and vegetation layers in the GIS facilitate a watershed analysis process. Watershed analyses are being conducted in both the Washington and Idaho regions.

Wetlands will be identified and delineated for Boise Cascade land holdings. These wetlands will be classified according to the U.S. Fish and Wildlife Service classification system (Cowardin et al. 1979) and appropriate state systems.

To be utilized as a dynamic planning tool, successional change is incorporated into the integrated forest management information system through the use of stand projection models. This requires quantifying change over time for all variables of interest, for each ecological unit in the ecosystem diversity matrix. Additional information may be needed through monitoring and research activities to adequately describe these relationships.

The wildlife, fish and watershed components of the integrated forest management information system are being linked with a forest planning model. In this way, potential land-management activities related to fish and wildlife habitats or watersheds will be analyzed and evaluated relative to their interactions with economic projections.

Documentation of Species on Boise Cascade Lands

Private industrial forest lands are viewed by many as being unproductive of anything besides timber. Abundant and diverse wildlife and fish populations occur on Boise Cascade's managed forest lands. In addition to describing habitat quality, as explained above, populations of selected wildlife are being documented to demonstrate fish and wildlife populations that can be produced in conjunction with timber production. For example, in 1994, sampling of bird abundances revealed 74 species of birds occurring in six ecological units (cells) within the ecosystem diversity matrix (Figure 1). In addition, populations of small mammals, bats, amphibians and reptiles using selected ecological units also are being documented.

Biodiversity documentation will allow for comparisons of the influence of habitat type, vegetative growth stage and past management practices on the occurrence of various species. These data then will assist in the evaluation of the integrated forest management information system in forest planning activities, as well as for quantifying fish and wildlife populations being supported on Boise Cascade's managed forest lands.

Silvicultural Options for Meeting Ecological Objectives

Silvicultural prescriptions that produce timber products while meeting appropriate ecological objectives need to be researched if silviculture is to be used most effectively in ecosystem management. While the use of silviculture to produce many ecological objectives has been well documented, its use to create newly articulated objectives for specific stand conditions is not as well quantified. Data that quantitatively show the suitability of silvicultural prescriptions in specific situations are needed. In cooperation with other landowners, Boise Cascade has planned silvicultural experiments that will be used to provide this needed information.

Document Contributions to Regional Ecosystem Diversity

An appropriate landscape goal for ecosystem management is to maintain an adequate ecological representation of ecological units across the landscape to maintain biodiversity. Boise Cascade lands contribute to this goal through the ecological units maintained on its land base. To document these contributions, an ecosystem diversity matrix (Figure 1) has been developed, and ecological units occurring on Boise Cascade's lands are being quantified into this matrix. The matrix also must be expanded to include agency lands in the region, as well as other private lands, where feasible. This matrix will quantitatively describe what Boise Cascade is contributing and also provide a basis for discussions of regional ecosystem management goals (Haufler 1994).

In addition, timber cruise data collected from 1914–1916 for approximately 200,000 acres (80,972 ha) in western Idaho have been digitized and entered into the GIS system. These data will serve as a valuable tool for understanding landscape changes and defining the vegetative growth stages in the ecosystem diversity matrix.

Facilitate Partnerships

Another objective of the ecosystem-management demonstration projects is to facilitate discussions and partnerships involving federal, state and county (Minnesota) land-management agencies, other private landowners, interested publics, and Boise

Cascade in terms of regional ecosystem-management goals. With clearly stated ecological objectives and a methodology to obtain these objectives, consensus building, as to appropriate management of specific landscapes, will be enhanced.

Demonstrate Private Industrial Forestland Compatibility

The final objective of Boise Cascade's ecosystem-management demonstration projects is to establish Boise Cascade Corporation's objective of contributing to regional landscape and biodiversity goals while maintaining a focus on commodity production from its land base. Such efforts are needed to understand better how different components of a landscape can be managed with a different emphasis, but all can contribute to a common set of goals and objectives.

Conclusions

Ecosystem management will need to consider planning at different spatial scales if it is to achieve its long-term goals. Planning at these scales will be most effective if multiple landowners can be considered in the planning process. Private industrial forestlands can make significant contributions to ecosystem-management efforts. However, for these landowners to be willing to be active partners, a number of concerns relating to their primary objective as producers of timber products must be recognized and respected. If such concerns can be addressed, then many effective partnerships can be formed. Boise Cascade Corporation's ecosystem management demonstration projects are examples of constructive partnerships in the implementation of ecosystem management across ownership boundaries.

References

Bourgeron, P. S., H. C. Humphries and M. E. Jensen. 1994. Landscape characterization: A framework for ecological assessment at regional and local scales. J. Sustain. For. 2: 267–281.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildl. Serv. FWS/OBS–79/31. 103 pp.

Crane, M. F. and W. C. Fischer. 1986. Fire ecology of the forest habitat types of central Idaho. USDA For. Serv. Gen. Tech. Rept. INT–218. 86 pp.

Daniels, S. E. 1991. An economic perspective on ecosystem management. Pages 97–105 *in* D.C. Le Master and G. R. Parker, eds., Ecosystem management in a dynamic society. Proc. Conf. Dept. For. and Natur. Resour., Purdue Univ., West Lafayette, IN.

Davis, L. S. and K. N. Johnson. 1987. Forest management. McGraw Hill Book Co., New York, NY. 790 pp.

Ecomap. 1993. National hierarchical framework of ecological units. USDA For. Serv., Washington, D.C. 18 pp.

FEMAT. 1993. Draft supplemental environmental impact statement on management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. USDA For. Serv., Washington, D.C.

Grumbine, R. E. 1994. What is ecosystem management? Conserv. Biol. 8: 27–38.

Hamilton, R. C. 1993. Characteristics of old-growth forests in the intermountain region. USDA For. Serv., Intermountain Region, Ogden, UT. 86 pp.

Haufler, J. B. 1994. An ecological framework for planning for forest health. J. Sustain. For. 2: 307–316.

Haufler, J. B. and L. L. Irwin. 1993. An ecological basis for forest planning for biodiversity and resources use. Proc. Intern. Union Game Biol. 21: 73–81.

Jones, S. M. and F. T. Lloyd. 1993. Landscape ecosystem classification: The first step toward ecosystem management in the Southeastern United States. Pages 181–210 *in* G. H. Aplet, N.

Johnson, J. T. Olson and V. A. Sample, eds., Defining sustainable forestry. Island Press, Washington, D.C.

Kaufmann, M. R., R. T. Graham, D. A. Boyce, Jr., W. H. Moir, L. Perry, R. T. Reynolds, R. L. Bassett, P. Mehlhop, C. B. Edminster, W. M. Block and P. S. Corn. 1994. An ecological basis for ecosystem management. USDA For. Serv. Gen. Tech. Rept. RM-246. 22 pp.

Sample, V. A. 1993. Workshop synthesis: Building partnerships for ecosystem management on forest and range lands in mixed ownership. Yale School of For. and Environ. Studies, New Haven, CT.

Steele, R., R. D. Pfister, R. A. Ryker and J. A. Kittams. 1981. Forest habitat types of Central Idaho. USDA For. Serv. Gen. Tech. Rept. INT-114. 138 pp.

Ticknor, W. D. 1993. Sustainable forestry: Redefining the role of forest management. Pages 260–269 *in* G. H. Aplet, N. Johnson, J. T. Olson and V. A. Sample, eds., Defining sustainable forestry. Island Press, Washington, D.C.

USDA Forest Service. 1994. Deadwood landscape analysis. USDA For. Serv. Lowman Ranger District, Boise Nat. For., Boise, ID.

West, N. E. 1994. Biodiversity and land use. Pages 21–26 *in* W. W. Covington and L. F. Debano, tech. coords., Sustainable ecological systems; Implementing an ecological approach to land management. USDA For. Serv. Gen. Tech. Rept. RM-247.

Accomplishing Partnerships in the Boreal Mixed Wood Forests of Northeastern Alberta

Daryll M. Hebert, Doug Sklar, Shawn Wasel, Elmer Ghostkeeper and Tom Daniels
Alberta-Pacific Forest Industries, Inc.
Boyle, Alberta

Introduction

Alberta-Pacific Forest Industries, Inc. began developing a sustainable forest management program in 1991, that significantly altered the sustained-yield model which had been used for decades. The program incorporated many of the concepts of forest ecosystem management, especially that of coarse-filter management, but also included many of the cultural and socioeconomic components required for sustainable development. The complexities and cost of any sustainable program are beyond the capabilities of any single company and/or agency and must include a variety of partnerships to be successful. The technical portions of forest ecosystem management were constructed using independent researchers from three universities (University of Alberta, University of British Columbia and University of Calgary) and the Alberta Environmental Centre. Other partnerships and programs were developed through: a Public Involvement Task Force, Aboriginal communities, government agencies, the forest and petroleum industries, the provincial education system, and, most importantly, by actually implementing its many strategies.

Forest Ecosystem Management

The boreal mixed-wood forest of northeastern Alberta is a fire-dominated forest that harbors about 250 vertebrate species. Forest ecosystem management, using a coarse-filter approach and an approximation of the natural disturbance regimes, was examined at three levels: the Forest Management Area (FMA) level, the landscape (pattern) level and the stand (structure) level.

At the FMA level, timber volume or Annual Allowable Cut was identified and allocated to old growth requirements, large river protection (Athabasca River), potential forest fire loss, riparian buffer strips and stand structure.

At the landscape level, two- and three-pass forest harvest systems were changed to dispersed harvest systems based on the stochastic nature of lightning fires. Patterns describing core areas and fragmentation levels were examined using edge-area ratios and adjacency patterns through geographic information systems.

At the stand level, standing and dead and down structure was left as residual material. Spatial patterns within cutblocks and amounts of standing and downed material were adjusted as biological requirements were identified.

In order to design and implement forest ecosystem management, a variety of research programs (approximately 60–70 researchers) were undertaken to examine process, pattern and structure at the three scales. Using the three-dimensional criteria of natural forest fires identified by Swanson et. al. (1993), a landscape-scale experiment was designed for each criteria: age or fire return interval, size of the fire and severity of the fire. Many associated research projects at the species and/or community level were undertaken with each experiment. For example, leave blocks attached to buffer strips were used to examine connectivity. Debris was spread, piled or rowed in a variety of spatial configurations to examine small mammal utilization of the harvested area. In addition, aquatic programs were designed to examine stream protection using buffer strips and the rate of extraction and spatial distribution within watershed sub-units, in order to assess natural disturbance regimes and their relationship to watershed protection. Landscape patterns, including questions of adjacency currently are being examined, but, due to the complexity involved, research will continue for sometime.

Funding and partnerships were constructed among industry, universities, federal/provincial funding agreement's Partnership Agreement in Forestry (PAIS), National Science and Engineering Research Council (NSERC), etc. Recently, Alberta-Pacific participated in the development of a large Tri-council proposal (social, medical, science granting councils) with the University of Alberta to examine the social, cultural and economic implications of forest ecosystem management and sustainable development. In addition, Alberta-Pacific is working with the University of Alberta, other major forest companies and 23 universities across Canada to obtain a National Centre of Excellence (NCE) which will examine sustainable development in the Canadian boreal forest.

Consensus Building Program

The Consensus Building Program is innovative and goes beyond the normal parameters of public involvement. One of the key components of ecosystem management is a mechanism to address the compromises required to attain the optimum mix of economic, environmental and social values. A public forum was developed in 1992 that made it possible to build consensus among the various stakeholders or interest groups who have a direct interest in management practices and plans for the FMA area. The involvement of an experienced and independent facilitator/mediator was determined to be important to all participants.

In order to explore the use of such a process, Alberta-Pacific considered a number of organizations and individuals involved in the emerging mediation/facilitation "field." Dr. G. Cormick was contracted to meet with a number of representatives of potential stakeholder groups to ascertain their interest. Generally, the interest was high and, soon after, the Alberta-Pacific Forest Management Task Force was developed. The Task Force is made up of six different caucuses, with each caucus representing a value relating to forest management. These include the environmental, user-group, Aboriginal, company, government and quota-holder caucuses.

As a result of its initial exploration of the important elements in such a process, Alberta-Pacific found it useful to consider two distinct phases. The first phase involved developing and convening a process acceptable to participants. The terms of reference included: membership, funding, access to information, reporting, decision-making mechanisms, etc. The second phase involved the actual use of the process to address the agreed-upon documents and issues of concern.

Representatives of the provincial government sit on the Task Force as equal members, rather than in their normal role as independent decision makers. The Minister retains decision-making authority, but generally accepts consensus recommendations of the multi-stakeholder group.

The group first met in 1992 and, to date, consensus has been reached on the "Interim Timber Harvesting and Operating Ground Rules" which provide guidelines for the Company to conduct harvest operations, forest protection, road construction, reforestation and camp set-up. In addition, consensus was reached on the Preliminary Forest Management Plan, a long-term plan outlining management strategies for the Forest Management Area. One of the most important achievements of this process has been the educational value for all parties. Those unfamiliar with forest management have been quickly schooled on what forest management is all about, while those familiar with forest management have been rapidly educated as to the feelings, wants and needs of those that view the forest for things other than fibre. It is interesting to note that with Alberta-Pacific's adoption and implementation of Forest Ecosystem Management, the groups do not seem as polarized as those in the more classic confrontation between a forest company and environmental groups.

Education

While initiating the paradigm shift to Forest Ecosystem Management, it was determined at a very early stage that an effective education and/or re-education campaign would be required. In the final analysis, it is the pubic that ultimately determines the overall acceptability of any new concept. Education generally is a long-term process, although there are short-term initiatives which can serve the educational needs of specific segments of the population. Through the Alberta Forest Products Association, the forest industry in Alberta has developed a strong partnership with a bias-balanced environmental education group, Friends of the Environmental Education Society of Alberta (FEESA). Using this existing partnership, Alberta-Pacific supported a number of teacher training workshops, educational tours and forums. Informal research indicates that teachers are eager to provide their students first-hand knowledge of environmental issues facing society today. If that information is not forthcoming from an objective industry, academic institutions or the Department of Education, it generally comes from the media.

Since Alberta-Pacific was developing a new model for forest management, it provided an opportunity for FEESA and Alberta-Pacific to develop extensive teacher training through summer workshops, forums and presentations to regional teacher groups, and the science teacher workshops for Alberta.

In addition, educational videos have been developed on woodland caribou biology and management, and on management of the boreal forest.

Industry partnerships with educational institutions should not necessarily concentrate on students per se. Rather, they should concentrate on training teachers, information dissemination and actual field workshops.

Industry Partnerships

The forest industry in Alberta, and in Canada in general, has been relatively passive in the development of partnerships and less than proactive in modifying the sustained-yield model. While Alberta-Pacific was developing a forest ecosystem model based on natural disturbance regimes, it met with its industrial neighbors many times at the levels of Chief Executive Officer, pulp mill and woodlands manager, and operating forester. Cooperative research and management programs began to develop (woodland caribou research, central reference service, etc.) and culminated in support of the NCE program worth about $2 million. In addition, Alberta-Pacific worked with the University of Alberta and several provincial government Ministers (Family and Social Services, Economic Development, Science and Technology) to obtain provincial support of the NCE of $3 million.

Alberta-Pacific has worked with the oil and gas industry, the University of Alberta, and several government agencies to develop and implement a large-scale woodland caribou research program in northeastern Alberta, the North East Regional Standing Committee (NERSC). The program included: collection of baseline data (movements, home ranges), habitat utilization, inventory, calf mortality, disturbance impacts and predator/prey relationships, at a total cost of approximately $1 million. At present, the caribou data base is the largest wildlife data base in the province.

Provincial Partnerships

Partly, if not largely as a result of research programs (initiated and/or supported by Alberta-Pacific) investigating forest ecosystem management and caribou biology, the provincial government initiated a Forest Conservation Strategy to provide broad framework organization at a provincial level.

The Forest Conservation Strategy developed a forest ecosystem management base and attempted to integrate other topics such as forest practices, economics, protected areas, Aboriginal requirements, etc. The forest industry served as co-chair of the steering committee, along with the provincial government and NGO representatives, and served on all the associated sub-committees.

The Caribou Conservation Strategy used extensive research information, largely collected by industry (NERSC) and analyzed by Alberta-Pacific staff, to develop timing guidelines on caribou range, map all northern Alberta caribou habitat, and examine the role of wolf predation and other limiting factors.

In general, the industry was one of the driving forces behind these programs, supporting the much-needed research and data analysis to develop new management models and actively participating and/or leading discussion that provided new problem-solving approaches.

Aboriginal Partnerships

Alberta-Pacific's Corporate Culture is about people; their beliefs, values, behaviors and relationships, and the places they work, live and play. The challenge for Alberta-Pacific was to transfer their Corporate Culture into the Aboriginal communities, containing approximately 43,000 people. Senior management has attempted to enhance the well being of Aboriginal people by including their values in Company endeavors (employment, fur management, moose production, grave sites, etc.). The strategy for achieving their goal was the creation of an Aboriginal Affairs Management Guide. Implementation of the guide will occur by developing partnerships and partnership agreements with Aboriginal communities.

Partnership is a concept that is not foreign to Aboriginal traditional knowledge and it has a spiritual depth to its meaning.

Between 1992 and 1995, Alberta-Pacific, along with the provincial and federal governments, supported the collection of tradition with the Athabasca Native Development Corporation. This information was incorporated into a Parallel Aboriginal Process designed to allow Aboriginal communities to negotiate their values with Alberta-Pacific.

The most recent example of a partnership between Alberta-Pacific and an Aboriginal community is the Wabasca Desmarais Economic Development Society Partnership Agreement in Principle of November 21, 1994, which was negotiated by consensus. The community of Wabasca Desmarais has three cultural groups consisting of Indian, Metis and White. The people from these three cultures make up the Board of Directors of the Society. A Memorandum of Understanding signing ceremony on February 17, 1995 at Wabasca, formalized the Partnership Agreement in Principal. The Partnership Agreement is comprised of sections entitled: community relations, business, employment, training, trapping management, Aboriginal education, Aboriginal traditional knowledge and Aboriginal affairs management team. The intent is to enter into contracts under each section. An example of a partnership agreement is a complete road construction contract by Bigstone Band Enterprises. Other contracts are in various stages of negotiations and development under the Partnership Agreement. The reciprocity of the partnership will include contracts for the community and a guarantee by the community of wood fibre supply to the millsite.

Implementation

In order to improve the process successfully, each partnership had to have goals, objectives or procedures that could be or could be seen to be implemented in some real way. As such, the Public Task Force reviewed and approved the Operating Ground Rules and the Preliminary Forest Management Plan. At present, they are reviewing and modifying the Detailed Forest Management Plan.

A technical group, the Forestry/Wildlife Integration Technical Committee (made up of government, industry, academic and NGO individuals) led by Alberta-Pacific, reorganized the traditional forest management plan, helped write much of it and should continue to modify it until it is approved. In the past, the plan would have been written by the industrial company and reviewed by government, through the referral process until the company "got it right."

The extensive research being supported and undertaken by Alberta-Pacific will continue for many years and will continue to be implemented into its planning and forest practice procedures. Some examples of implementation include: retention of residual white spruce, protection and retention of snags, retention of green tree clumps, wet depressions, understory, woody debris, etc.

The industrial partnerships only now are coming to fruition. More companies will be hiring biologists or forest ecologists. The industry is learning to develop common research questions that can have broad application when implemented. Most importantly, the industry is less wary of ecological research and is learning that they can help direct the process. Success in obtaining large-scale funding, such as the National Centre for Excellence or Tri-Council grants, will further consolidate the industry and improve research and problem solving for everyone.

Throughout the process, all parties were re-educated and will continue to be re-educated about science, cooperation and problem solving. Industry must have the cooperation and support of its CEO and Board of Directors; government must allow its Ministers to instill flexibility in its regulations, procedures and personnel, and public groups must address complex science better than they ever have done in the past.

As the process improves, leading-edge science and cooperative procedures must be integrated into the public school system. Science must teach teachers and teachers must teach students. As always, it will be the next generation that will be the world's best problem solvers. We must continually strive to maintain the building blocks that will allow them to do that.

References

Swanson, F. J., J. A. James, D. A. Wallin and J. Cissell. 1993. Natural variability—Implications for ecosystem management. Pages 85–99 *in*: M. E. Jensen and P. S. Bourgeron, eds., Ecosystem management: Principles and applications. USDA For. Serv. North. Reg., Missoula, MT.

Proactive Endangered Species Management: A Partnership Paradigm

James F. Bullock, Jr.
Union Camp Corporation
Savannah, Georgia

William A. Wall
Potlatch, Inc.
Lewiston, Idaho

> *. . . sound partnerships may prove our best and surest vehicle yet to carry forth a full and rich biological community into the twenty-first century.*
>
> J. Turner

Introduction

In today's world, the phrase "endangered species" too often is equated to the word "conflict." Any proposal to list a species under the auspices of the Endangered Species Act (ESA) is certain to generate considerable controversy. Some groups propose listing species as a surrogate to achieve other objectives; others oppose listing without consideration of the fate of the species. Some groups view protection of species through ESA regulation as their salvation; others view listing as detrimental to their well-being, denying private landowners and wildlife experts both the latitude and incentive necessary to protect and manage for the species. Too often, with regard to endangered species, adversarial situations develop that polarize entire communities or regions and result in more energy and resources expended to battle an opposing view rather than to resolve the issue. It would seem prudent that resource managers and policy-makers seek to avoid such non-productive situations and work to develop strategies that are proactive in nature, strategies that bring all stakeholders to the same table and promote cooperation rather than confrontation.

Proactive partnerships also may be the key to successful implementation of an ecosystem-based natural resource management strategy. Regardless of the delineation system employed, ecosystem boundaries almost always encompass both public and private (non-industrial and industrial) landholdings. Thus, cooperation and coordination among stakeholders when planning and implementing land-management strategies seem prudent. However, political and proprietary barriers inherent to the diversity of ownership objectives and constraints must be overcome before real progress can be achieved (Sample 1994).

Because most land in the United States is privately owned, it is clear that any effort to conserve an endangered or threatened species or implement an ecosystem or landscape-management strategy is more likely to succeed if the private sector is a willing participant. This is particularly salient in the Northeast and South, where approximately 90 percent of all forested lands are in private ownership (Powell et al. 1994). With regard to one southern species, the Louisiana black bear (*Ursus* *americanus luteolus*), the concept to develop a partnership to integrate species' needs with stakeholder objectives and constraints began with private landowners and grew to fruition with the formation of the Black Bear Conservation Committee (BBCC). This paper discusses evolution of the BBCC and how the factors which contributed to its success can be adapted to the implementation of an ecosystem-based natural resource management strategy that conserves ecological values, considers ownership goals and encourages public/private landowner cooperation.

Partnership Formation

Of the 16 identified subspecies of black bear, those animals found in east Texas, the lower two-thirds of Mississippi and all of Louisiana are referred to as belonging to the subspecies *luteolus* or, more commonly, the Louisiana black bear. In June 1990, citing extensive habitat loss and human exploitation as primary threats, the United States Fish and Wildlife Service (USFWS) published a proposal to list this bear as threatened under the auspices of the ESA.

On July 19, 1990, the Louisiana Forestry Association hosted a meeting of all interested stakeholders in the tri-state region to discuss the proposed listing and management alternatives. At that meeting, Dr. Michael Pelton of the University of Tennessee, an internationally recognized authority of black bear, planted the seeds for formation of the BBCC when he stated: "The primary responsibility for insuring the future survival and viability of present black bear numbers in the Southeast Coastal Plain, and Louisiana specifically, shall fall on a number of public and private agencies that control the lands containing black bear habitat or potential habitat. To do so will take a concerted and coordinated effort among these groups."

On December 30, 1991, the USFWS made public its decision to list the Louisiana black bear as a threatened species. The final rule, published in the *Federal Register* on January 7, 1992, also designated all other black bears within the historic range as threatened due to similarity of appearance. Important to the listing decision was inclusion of a special rule allowing normal forest-management practices in occupied bear habitat, with certain limitations to active or candidate den trees. This was significant because more than 90 percent of the historic range of the Louisiana black bear is today in private ownership. During the listing process and the public comment period, much of the opposition to listing came from private forest landowners, who perceived the bear would become the "spotted owl" of the South. They feared the listing would either severely curtail forest management and harvesting operations in the region, or adversely impact their other rights and exercise of private land ownership. Based on best-available scientific data and in response to the concerns of forest landowners, the USFWS publicly took the position that habitat needs of the Louisiana black bear were compatible with normal forest management as practiced in the region. Therefore, as part of the final rule, the Service promulgated a special rule exempting normal forest-management activities from the take provisions of the ESA. The only restrictions in the special rule applied to maintenance of actual or potential den trees occurring in occupied habitat. This special rule had a positive impact, particularly on private industrial landowners, and quickly turned management of forest land for bear habitat into an asset for both the animal and the landowners, rather than a liability.

The BBCC has evolved from an initial gathering of 18 individuals to a present-day 60+ member coalition of landowners, state and federal agencies, private conservation organizations, forest industry, agricultural interests, and academia (Table 1). Since its inception, the broad objective of the BBCC has been to stabilize and manage existing bear populations, and restore black bear populations to suitable habitats within the tri-state region to a level whereby it can delisted. Initially, four subcommittees were established to work with basic problems and issues: habitat and management, information and education, research, and funding. To date, the BBCC has made significant progress toward its overall objective, including the following accomplishments: (1) increasing the public's awareness about the black bear, its status and management needs; (2) promoting the bear as an asset to private landowners, rather than a liability; (3) creating, staffing and funding a full-time coordinator to serve administrative and extension capacities; (4) coordinating regional research efforts and helping secure more than $700,000 in research funds; (5) publishing a "Black Bear Management Handbook" to assist landowners and land managers who wish to maintain or enhance bear habitat; (6) developing a protocol for handling nuisance bear and mediating bear/human conflicts; and (7) completing a comprehensive restoration plan for bear in the tri-state region which sets objectives for restoration, identifies management needs, establishes local "bear management units" and designates those responsible for implementation. Authored cooperatively by all interested public and private stakeholders, this plan also served as the template for the USFWS Draft Recovery Plan for the Louisiana black bear.

The BBCC has had three primary beneficiaries. First, each individual stakeholder partner has benefited, both tangibly (i.e., by realization of individual objectives) and intangibly (i.e., by increased credibility with other stakeholders). Second, as discussed in more detail below, the BBCC has become a public/private partnership model as to how resource management issues can be addressed through cooperation rather than confrontation. Third, the resource has benefited, as the probability of restoration of the black bear to the point it can be delisted has improved markedly because of efforts of the BBCC to date. People are learning that, with responsible planning and management, the bear can coexist with many land uses, including forestry, agriculture, oil, gas and mineral exploration, and outdoor recreation.

A Partnership Model

As the diversity of landowners, land managers and other entities came together, a number of individual agendas emerged: to keep the bear from being listed; to list the bear; to keep regulatory burdens from interfering with the management and productivity of private lands for forest, agricultural, oil or gas or other interests; to be aboard the best vehicle to level the playing field and balance all stakeholder interests; to advance scientific study or secure research funding; to demonstrate that a species can be "recovered" through a proactive, voluntary approach; to resolve species/human conflict or be compensated for bear-related property damage; to have enough bears to reopen a hunting season; to raise funds for conservation-based organizations or projects; to keep swamps from being dredged or hardwood forests from being converted to other uses; to obtain consulting jobs; to satisfy personal resource stewardship ethics; etc. However, the sole criteria for membership in the BBCC was, and continues

Table 1. Black Bear Conservation Committee membership; January 1995.

American Forest and Paper Association
Anderson-Tully Company
Arkansas Game and Fish Commission
Audubon Institute
Bancroft Paper
Bayou State Bowhunters
Boise Cascade
Cavenham Forest Industries
Champion International
Crawford and Bourland, Inc.
Defenders of Wildlife
Delta Environmental Land Trust Association
Delta Wildlife Foundation
Deltic Farm and Timber, Inc.
Georgia Pacific Corporation
International Paper Company
James River Corporation
Louisiana Cooperative Fish & Wildlife Research Unit (LSU)
Louisiana Department of Wildlife and Fisheries
Louisiana Farm Bureau
Louisiana Forestry Association
Louisiana Landowners Association
Louisiana Office of Forestry
Louisiana Operation Game Thief
Louisiana State University, School of Forestry, Wildlife and Fisheries
Louisiana Tech University, School of Forestry
Louisiana Wildlife Federation
Miami Cooperation
Mississippi Beekeepers Association
Mississippi Delta Council
Mississippi Department of Wildlife, Fisheries and Parks
Mississsippi Forestry Association
Mississippi Forestry Commission
Mississippi Museum of Natural Science
Mississippi State University; Department of Wildlife and Fisheries
Mississippi Wildlife Federation
National Council for Air and Stream Improvement, Inc.
The Nature Conservancy of Louisiana
The Nature Conservancy of Mississippi
Orleans Chapter of the National Audubon Society
Safari Club, Central Louisiana Chapter
Safari Club, Louisiana Chapter
Sierra Club; Delta Chapter
Stephen F. Austin University
Temple-Inland Corporation
Texas A&M University; Kingsville
Texas Forest Service
Texas Forestry Association
Texas Parks and Wildlife
United States Army Corps of Engineers; Lower Mississippi Valley Division
USDA/APHIS Animal Damage Control
United States Fish and Wildlife Service
United States Forest Service
United States Forest Service; Mississippi National Forests
United States Forest Service; Southern Hardwoods Laboratory
United States Soil Conservation Service
University of Tennessee; Department of Forestry, Wildlife and Fisheries
Virginia Tech University; Department of Fisheries and Wildlife Sciences
Virginia Cooperative Fish and Wildlife Research Unit
Wildlife Technical Services, Inc.
Williamette Industries

to be, when you come to the BBCC table, the needs of the resource are given highest priority. All other agendas are checked at the door. Whatever the reason for involvement, all participant organizations, without exception, have met this membership criteria and elevated the needs of the resource above individual or organizational bias.

A major factor contributing to the growth of and support for the BBCC is that it began as a local or regional initiative. In fact, during its formative period, national organizations were welcomed to participate but discouraged from formally applying for membership because it was felt that the initiative would receive stronger support if people within the region knew local entities were the driving force. To their credit, the national organizations and agencies instrumental to the recognition and success of the BBCC also recognized the value of conflict resolution from the "bottom up," or at the local scale. Successful partnerships depend largely on local, private-sector initiative and leadership. National governmental agencies in particular may serve such initiatives best by being a "catalyst organization" which facilitates goal setting, stakeholder identification and meeting logistics (Sample 1994). This is a lesson with direct application to implementation of an ecosystem-based management strategy. Any initiative crossing multiple ownerships has a higher likelihood of success if it begins with affected landowners at the local level. Local or regional stakeholders and landowners must feel they are driving the wagon, not just hanging on for dear life or being run over!

As the opening quote by then USFWS Director John Turner suggested, partnerships are the "best and surest vehicle to carry resource management into the twenty-first century" (Bullock 1994). In the past few years, many public and private stakeholders have discovered the value of cooperative partnerships to address resource management on various landscape scales or to resolve resource management conflicts between diverse entities (Wigley and Sweeney 1992), particularly on regional scales involving multiple landowners. From the rural environs of Louisiana to Capitol Hill in Washington, D.C., from Florida to Maine to Washington state, the BBCC is under scrutiny as the model for cooperative partnership resource conflict resolution.

One example of a successful initiative modeled after the BBCC is Project SHARE (Salmon Habitat and River Enhancement), a cooperative of landowners and agencies in Maine whose goal is to enhance habitat quality for Atlantic salmon (*Salmo salar*) populations in downeast Maine. Like the BBCC, Project SHARE is based on the operating principle that participation is open to all stakeholders who can contribute to the conservation of the Atlantic salmon. Key to successful cooperation is a focus on the resource, not on the politics or implications of a listing. The stakeholders involved also recognize that this type of cooperative effort extends beyond an endangered species, as evidenced by the following: "Given the enthusiasm and support from all sectors, Atlantic salmon will undoubtedly benefit from Project SHARE. But the larger benefit will be the lasting standard of cooperation that is established from dealing with endangered species concerns. The resource, the act, and a significant component of Maine's economic base will all be the better for it, rather than the lesser because of it. We are hopeful that the trust established between cooperators will expand to the conservation and use of other resources in Maine. We are also confident that this process can be applied in many other areas" (Sweeny and Nickerson 1995).

We believe there are four primary reasons for the success of the BBCC. The first reason is the characteristics of the BBCC that make it a true partnership: (1) the requirement that all participants leave their organizational bias at the door, (2) the open door for all willing stakeholders to participate as equal partners, (3) the mutual respect among BBCC members for the objectives of each individual participant, (4) the forum for open and credible communication, (5) the fact that all members make some contribution no matter how small, and (6) the effort to identify initially common ground among participants from which a base of mutual trust could be established.

The second reason for the success of the BBCC has been the efforts to identify incentives to make the species an asset, rather than a liability to the private landowner—a most important factor given that 90 percent or more of the bear's habitat is in private ownership! The principal regulatory agency, the USFWS, deserves special recognition for its efforts to support this approach. The special rule promulgated as part of the listing procedure exempted normal forest management activities from the take provisions of Section Nine of the ESA and provided incentive for the maintenance, management and restoration of bear habitat. Another incentive is that lands identified as occupied habitat have received a higher priority for acceptance into Wetland Reserve or similar habitat restoration programs. Recognition that the black bear is an indicator of the health of the bottomland hardwood forest ecosystem and the demonstration that good bear management benefits a wide array of other game and non-game wildlife species also have been incentives, as has been a very active campaign to quickly and positively respond to adverse human/bear situations.

The third success factor has been the political support given the Committee. More and more wildlife management decisions are being made based on political expediency, popular assumption and human emotion rather than on biological dictates or scientific evidence. Science is the final arbiter when the BBCC makes a decision, which helps the 60+ member organizations reach consensus and function as a powerful advocate for biological integrity when in the political arena. As Senator Trent Lott of Mississippi succinctly stated: "I've got forest industry, environmental groups, landowners, and state and federal agencies all asking me for the same thing. You better believe I'll give it [the BBCC] my utmost support" (Senator T. Lott personal communication: 1992).

The fourth reason for success is that the BBCC developed locally from the "bottom up" and has as its inner strength the commitment of its membership. Committee participants sincerely believe the best hope for black bear restoration in the region rests with the continued efforts of the BBCC, a sentiment stated in a letter from the BBCC to the USFWS: "If restoration of the black bear is to be successful, we believe it will be through this new alliance of public and private interests working together solely for the sake of the resource and nothing else. The Black Bear Conservation Committee pledges to continue its role to that end" (Bullock 1994).

Future Management Implications

The BBCC has successfully demonstrated that economic goals and ecological responsibilities of private land ownership are not necessarily mutually exclusive. As a "charismatic megafauna," the black bear has come to symbolize [bottomland hardwood] ecosystem health and the BBCC has emerged as a cornerstone of trust and cooperation for other more complex resource management and conservation projects in the region. Many, these authors included, believe the BBCC's greatest contribution is that its future impact on resource management may extend to reauthorization of the ESA, paving the way for prelisting partnership opportunities that offer the "carrot" of incentive, rather than the "stick" of regulatory burden. Protection of threatened or endangered species no longer is an issue to be decided under the mantle of regulation or inside the sanctity of a courtroom. A far more palatable alternative is a proactive approach whereby all stakeholders who have opposing points of view are willing to sit at the same table and seek common ground on which to formulate a management strategy. A phrase coined by one of the original participants in the BBCC, Murray

Lloyd, puts this in perspective: "Feed bears, not lawyers." This means each stakeholder devotes their time, money and effort toward the resource, rather than squandering them trying to achieve other agendas.

We believe innovative approaches in lieu of listing, such as greater application of conservation agreements, should continue to be explored. Legislation could be written when the ESA is reauthorized to streamline and encourage implementation of this strategy and create a framework to involve stakeholders in applicable situations. The process could follow this format: (1) identify species of concern and threats to its well-being or reasons for decline; (2) establish a committee of major stakeholders who have the resources or control the land base providing habitat for the species; (3) the committee develops a plan of action and signs a memorandum agreeing to implement species protection; (4) the USFWS dedicates funds or existing personnel for a specified period of time to administer and coordinate committee efforts; and (5) should any stakeholder not live up to their commitment as outlined in the memorandum, or if factors change that place the species in greater risk of survival, the USFWS could trigger the emergency listing procedure.

The advantages of such an approach include: (1) more flexibility in management options; (2) removal of an immediate regulatory burden; (3) removal of the threat of incidental take for private landowners; (4) restoration efforts move from the bottom up, rather than the top down; (5) cost effectiveness; (6) all willing stakeholders are equal partners; (7) no time constraint during the listing process, thereby reducing litigation; (8) species protection ensured; (9) participation by the private sector is promoted; and (10) possible application to address multiple species or issues on a landscape basis. We believe prelisting management agreements would be particularly effective for wide-ranging species, such as the Florida black bear (*U. a. floridanus*), or species groups tied to specific ecosystems which cross multiple ownerships and wide geographic boundaries. Proactive partnerships also should encourage ecosystem management at the landscape scale, particularly when sustainable management of forested lands for multiple values is viewed as the key to avoiding intensive, crisis-driven efforts to find workable solutions (Sample 1994).

In a 1936 essay titled "Threatened Species," Aldo Leopold (1991) called for the formation of a joint committee of stakeholders to inventory and define the management needs of the "threatened members of our fauna and flora." Once identified, each species would be assigned a custodian-ranger, warden, game manager, chapter, ornithologist, farmer, stockman or lumberjack. Public and private sector cooperation would be essential, and Leopold's belief in the inherent nature of humans to be responsible stewards of the land and its associated natural resources gave rise to his optimism for the success of this approach: "I am satisfied that thousands of enthusiastic conservationists would be proud of such a public trust, and many would execute it with fidelity and intelligence. I can see in this set-up more conservation than could be bought with millions of new dollars, more coordination of bureaus than Congress can get by new organization charts, more genuine contacts between factions than will ever occur in the war of the inkpots, more research than would accrue from many gifts, and more public education than would accrue from an army or orators and organizers" (Leopold 1991).

A proactive partnership such as the BBCC is not unlike the strategy proposed by Leopold in 1936: put the responsibility in the hands of those that own or have management responsibility for the resource, oversee the process and encourage creative management strategies. The BBCC is an example of the success of this approach, a model that, when expanded to other ecosystem or landscape-based management strategies across multiple ownerships, will continue to result in a win-win for all stakeholder partners and, more importantly, for the resource itself.

References

Bullock, J. F., Jr. 1994. Management for endangered species: The proactive approach. The Wildl. Soc. and The Soc. of Amer. Foresters Joint Meet., Nacogdoches, TX. Unpubl. manus. 8 pp.

Leopold, A. S. 1991. Threatened species. Pages 230–234 *in* S. L. Flader and J. B. Callicut, eds., The river of the mother of God and other essays by Aldo Leopold. Univ. Wisconsin Press, Madison. 384 pp.

Powell, D. S., J. L. Faulkner, D. R. Darr, Z. Zhu and D. W. MacCleery. 1994. Forest resources of the United States. USDA For. Serv. Gen. Tech. Rept. RM–234. 132 pp. + map.

Sample, A. V. 1994. Building partnerships for ecosystems management on mixed ownership landscapes. J. Forest. 92(8): 41–44.

Sweeney, J. M. and P. Nickerson. In press. Project SHARE: Atlantic salmon habitat enhancement for Maine's down east rivers. Endangered Species Update, Univ. Michigan, Ann Arbor.

Wigley, T. B. and J. M. Sweeney. 1992. Cooperative partnerships and the role of private landowners. Pages 39–44 *in* D. M. Finch and P. W. Stangel, eds., Status and management of neotropical migratory birds. USDA Gen. Tech. Rept. RM–229.

Finding the Common Ground in the Horicon Marsh Ecosystem

Lynn E. Hanson and Richard A. Hunt (retired)
Wisconsin Department of Natural Resources
Horicon

David Neuendorf
University of Wisconsin—Extension
Juneau

Patti A. Meyers
U.S. Fish and Wildlife Service
Horicon National Wildlife Refuge
Mayville, Wisconsin

Janet Scalpone
Citizen's Natural Resource Association
Oshkosh, Wisconsin

Introduction

Finding the common ground in the Horicon Marsh ecosystem is a "developing social process" that the authors and others initiated in 1993. Major concerns for Horicon Marsh and its surrounding environment are changing land uses, loss in surface water quality, loss of agricultural land base and declining wildlife habitat.

In searching for the common ground, the highly controversial historical background must be recognized. A long history of conflicts over flooding caused by dam operation, restoration of the marsh after drainage for farming, land acquisition, crop depredations, goose hunting regulation, build-up of goose populations and public relations sets the tone in working to address the issues.

The objective of this paper is to discuss the building of a public/private partnership between many interests to address these complex social, political and biological issues.

Description of the Horicon Marsh Ecosystem

Wisconsin's Horicon Marsh, located in eastcentral Wisconsin, is nearly 32,000 acres (13,000 ha) in size, making it the largest freshwater cattail marsh in the United States. The northern two-thirds consist of the Horicon National Wildlife Refuge (HNWR), which is administered by the U.S. Fish and Wildlife Service (USFWS); and the southern one-third consists of the Horicon Marsh Wildlife Area (HMWA), administrated by the Wisconsin Department of Natural Resources (WDNR). A total of 263 species of birds have been recorded in the vicinity of the marsh, including state endangered and threatened species (USFWS 1994a). A rookery located in the marsh contains as many as 1,000 nesting pairs of great blue herons (*Ardea herodias*), double-crested cormorants (*Phalacrocorax aurifus*), black-crowned night herons (*Nycticorax nycticorax*) and great egrets (*Casmerodius albus*). More than 80 percent of the Mississippi Valley Population (MVP) of Canada geese (*Branta canadensis*) stop in the vicinity of Horicon Marsh during migration. In 1990, Horicon Marsh was designated as a Wetland of International Importance by signatories to the RAMSAR Convention (International Union for the Conservation of Nature 1990).

While publicly owned Horicon Marsh makes up the core of the ecosystem, the activities on private land in the surrounding drainage basin play a significant role in determining the condition of the marsh and its future management.

The watershed of Horicon Marsh represents 448 square miles (116,000 ha) of the headwater tributaries of the Upper Rock River (Fix 1994). The communities of Waupun, Mayville and Horicon are located adjacent to Horicon Marsh. Development has moved out from these communities to the edge of the Marsh.

Agriculture is the primary land use. The surrounding counties rank as leading dairy producers. The primary crops grown are corn for silage and grain, and alfalfa for hay. Large acreages of snap beans, sweet corn and peas also are grown for commercial canneries (Wisconsin Agriculture Statistics Service 1994).

Manufacturing is a major economic factor for the area. More than 75 industries, concentrating in printing, metal fabrication, and lawn and garden equipment, are located within several miles of Horicon Marsh. The two largest employers have 1,800 and 1,400 employees and increased hiring is projected. (Dodge County Planning and Development Department 1991).

Tourism, including hunting and goose viewing, generates $40 million annually for the local economy. An estimated 400,000 visitors come to the Horicon Marsh vicinity each year. The Horicon Zone, a goose hunting permit area, attracts 30,000 waterfowl hunters each year. Seventy-five percent of Wisconsin's population is within one hour's drive of the marsh.

Historical Perspective

Since settlement, the area has undergone dramatic changes (Shafer 1934, Hanson 1977). In 1846, the marsh was dammed and flooded providing power generation and a large man-made lake suitable for steamboat navigation. In 1869, the dam was removed and returned to marsh land. Private duck hunting clubs controlled hunting and excluded local hunters. In the early 1900s, an effort to ditch and drain the marsh for agricultural production began. Farmers tried to raise root crops, carrots and potatoes. By the early 1920s, agricultural efforts had failed. Horicon Marsh lay devoid of water, stripped of wetland vegetation, ditched, tiled and burned. The wasteland lay useless to people and wildlife (Dodge County Tourism Council 1994).

In 1927, conservationists, led by the Izaac Walton League of America, successfully urged the passing of the Horicon Marsh Wildlife Refuge Bill (Palmer 1962–63). It provided funding to buy land and construct the dam which still is operating today. It was not until 1943 that the dam was closed, restoring the water levels to recreate the marshland (Vanderwall 1994). In 1941, the USFWS established the Horicon National Wildlife Refuge. Major land acquisition programs were carried out by both

Wisconsin and the USFWS. Condemnations used by agencies left bitter community/agency relations.

Canada goose management programs became a high priority in the 1950s for both state and federal wildlife agencies. A managed goose hunt (Hunt et al. 1962) was established to distribute hunting and harvest opportunity. In 1960, Wisconsin and Illinois agreed to a harvest quota system to address concerns brought up in the Mississippi Flyway (U.S. General Accounting Office 1986). By 1965, goose numbers in excess of 200,000 were causing crop damage, and legislative action established a crop damage law. Continued high numbers of geese brought concerns about disease outbreaks, short stopping of geese, continuing crop damage and harvest quotas (Reeves et al. 1968). Goose hazing, dewatering, and changes in cropping programs to encourage earlier migration and distribution of geese by agency managers created extensive public reaction. Damage abatement and compensation programs, adjustments in hunting quotas, and broader distribution of geese have diffused the situation around Horicon Marsh today. Canada goose management still plays a key role but individual species management now is being considered in a broader ecosystem approach (USFWS 1994b) in the management of public lands.

In many of these past issues, legislative and court actions, and overriding agency regulations have imposed solutions for the conflicts. Power struggles, public reactions to agency management approaches and controversial public issues have set the tone for the future of resources in the ecosystem of Horicon Marsh.

Taking a Different Approach

Catalyst Role of Citizen's Natural Resource Association

Because of the many diverse stakeholder interests, someone needed to serve as a catalyst to bring people together. One stakeholder that was a logical choice for a leadership role was the Citizen's Natural Resources Association of Wisconsin, Inc. (CNRA). The organization had a long involvement with the Horicon Marsh and previously had addressed a number of environmental issues.

CNRA is an organization of Wisconsin citizens devoted to the preservation of the integrity of the natural environment. Established in 1951, CNRA has used both education and citizen action to guide pubic policy and individual responsibility. In the 1960s, CNRA initiated a challenge to ban the pesticide, DDT. During the "Goose Wars" of Horicon Marsh, CNRA was a major opponent of federal and state dewatering and hazing tactics for Canada goose management. Other CNRA projects included a study of flood control alternatives to the damming of the Kickapoo River Valley, a plan to control industrial pollution of the Wisconsin River Basin and a statewide project to establish natural vegetation on roadsides (Scalpone 1991).

CNRA met in 1991 to update its members on the status of Horicon Marsh. Impending threats to the marsh were identified as: uncontrolled runoff and erosion degrading water quality; encroachments by residential, industrial and commercial development; decline of endangered species; and issues regarding public access. Most concerns related to issues occurring on private lands surrounding Horicon Marsh rather than with issues related to management strategies of state and federal agencies. Because CNRA had neither the financial resources nor sufficient local membership to solve these problems on its own, another approach was needed.

Obstacles to an Alternative Approach

History of Conflict

The social fabric of the Horicon Marsh ecosystem might best be described by the term "conflict." The long history of highly visible conflicts highlights the need to address social and political issues, as well as ecological issues. Conflict resolution has not been a standard approach over the many years. Old feelings and memories of past concerns still exist and influence attitudes toward new programs and activities.

Multiple Jurisdictions

The watershed of Horicon Marsh encompasses more than 50 governmental units, including towns, villages, cities, counties, and state and federal agencies. The various governmental bodies have differing, overlapping and often conflicting roles in decision making, land-use planning and zoning.

Complexity of Issues

Complex social issues in the Horicon Marsh ecosystem were identified by research studies conducted by the Wildlife Ecology (Keith 1964, Craven 1978, Heinrich and Craven 1992), Agricultural Economics (Stier and Bishop 1978) and Rural Sociology (T.A. Heberlein personal communication: 1995) Departments of the University of Wisconsin, Whiting (1990) compiled a bibliography listing more than 500 publications dealing with the many biological, social and political issues concerning Horicon Marsh and its surroundings.

Dialogue Started

Early in 1993, CNRA approached local groups to establish a cooperative dialogue over the future of Horicon Marsh and the surrounding area. The result was the "Horicon Marsh Forum." The goal of the forum was to bring together diverse groups and find common ground among them. The forum was planned by a steering committee chaired by CNRA, with representation from seven co-sponsors: WDNR, USFWS, University of Wisconsin—Extension (UWEX), Dodge County Planning and Development Department, Dodge County Tourism Council, Fond du Lac County Audubon Society and Wisconsin Waterfowl Association (WWA). The committee met from February through September, 1993, to design the forum structure, invite participants and assign responsibilities for the events and activities. UWEX community development and dynamics specialists at the county and university levels recommended methods for issue identification and group processes.

About 80 area residents, representing diverse interest groups, attended the forum. Using a nominal group process, the forum found common ground on eight priority concerns and identified 25 action plans. The priority concerns identified were: (1) lack of comprehensive planning; (2) degradation of water quality from urban/rural runoff; (3) unregulated development; (4) loss of farming and farmland; (5) degradation of wildlife habitat; (6) need for education; (7) recreational access; and (8) lack of coordination among all interests.

Individuals representing each of these concerns were selected from forum participants to join the forum planning committee in an effort to develop an organization to continue the dialogue. That organization became the "Horicon Marsh Area Coalition" (HMAC).

Building a Partnership: The Horicon Marsh Area Coalition

Integrated watershed

A broader approach that could address issues on a landscape or drainage basin level was a primary consideration in building a new partnership. The scope of activity was defined as the watershed boundary for the East and West branches of the Upper Rock River. Various scales of effort within that boundary will occur depending on the issue and which decision makers or stakeholders would need to be involved.

Land use. The awareness of important land-use issues recently has come to the front. Secretary George Meyer of the WDNR has stated that, "Perhaps the single most important, long-term environmental issue facing Wisconsin is the land use decisions we make today" (Margerum et al. 1994). Significant sources of land-use changes are population and demographics trends, which indicate increasing development pressure throughout the state. These impacts point to the need to address land use and more effectively consider land-use decisions. The vast majority of land in Wisconsin is privately owned, and local governments are the primary administrator of land-use decision making.

Water quality. The primary water-quality problems in the Upper Rock River Basin containing Horicon Marsh are caused by surface runoff from Urban and rural agricultural non-point sources. But water is just one part of the ecosystem. It no longer is practical to look at single issues without accounting for the whole. An integrated approach is needed to address the land that drains to the water. WDNR has used a watershed approach to target these issues and clean up the water (Turville-Heitz 1994).

Public support. Public support is essential. Increasingly complex societal concerns require involvement of those stakeholders affected by the organizations and agencies mandated to deal with the concerns. To have successful policy implementation, people must be involved directly in all planning and implementing stages.

Organizational Structure

Several structural models were considered for HMAC. The initial thought was to create a traditional, self-sustaining membership organization with its own charter, by-laws and elected officers. A review of literature on forming partnerships (Jones and Malloy 1988, Miller et al. 1992), coalitions and collaborative efforts (Gray 1989, Mattessich and Monsey 1992, Chrislip and Larson 1994); conflict resolution (Carpenter 1989); and public policy education (Dale and Hahn 1994, Project Public Life 1992) suggested that a different type of organizational structure should be adopted.

The needs to *look for comprehensive solutions, deal with a wide range of issues and interests, find "win-win" solutions, encourage coordination and cooperation between many entities, resolve conflict, encourage information sharing* and *develop* *a common base of knowledge* indicated that an informal coalition or collaborative would be more appropriate.

A "collaborative" works together to combine resources and efforts to achieve a common interest. Collaboration essentially is an emergent process, rather than a prescribed state of organization (Gray 1989). Participants first represent their own interests and then gradually begin to identify with the group and participate in group decision making. The resulting HMAC organization was kept simple, flexible and adaptive. Its first several meetings were spent in developing guidelines on how to operate.

A Steering Committee plans, designs, initiates and monitors all activities of the HMAC. The Steering Committee authorizes all subcommittees and issue work groups, and identifies guidelines the subcommittees and work groups are to follow. Membership on the steering committee should represent enough of the major stakeholder groups to allow it to effectively carry out its responsibilities and functions. Active participation includes the following stakeholder groups: (1) local government; (2) farming/agri-business; (3) environmental groups; (4) hunting/fishing/trapping; (5) county planning, zoning and land conservation departments; (6) USDA Wildlife Damage Control; (7) USFWS; (8) WDNR; (9) CNRA; (10) local and regional educational institutions; (11) tourism development and promotion groups; and (12) chambers of commerce/economic development organizations.

Issue work groups are formed to bring together diverse interests and perspectives of stakeholders affected by an issue. The groups jointly investigate the issue and search for mutually acceptable solutions. Several steering committee members serve as liaisons for each issue work group.

Other committees are created to carry out specific maintenance functions such as communications, education and finance.

Mission and Vision

The purpose of HMAC is to facilitate communication, cooperation and coordination among individuals, groups and agencies concerned with the Horicon Marsh and surrounding area.

HMAC envisions a vibrant Horicon Marsh area ecosystem comprised of healthy plant, animal and human communities, maintained in balance with each other.

Operational Principles

Consensus decision making. There is no voting, all decisions are made by consensus. In a consensus approach, parties work together to identify issues, educate each other about their respective concerns, propose options and reach agreements that all sides can accept.

Shared leadership. There are no elected officers, leadership functions are shared and rotated periodically.

Inclusiveness. Every attempt is made to include all stakeholders in planning and decision-making processes.

Implementation by participants. Results of the coalition's deliberations are disseminated by the organizations, agencies, governments and individuals participating in the coalition, and are incorporated into ongoing planning and action efforts.

Strategies and Methods

The following strategies and methods for fulfilling HMAC's vision were agreed upon by the participants. HMAC:

- creates a public space and process where diverse interests and perspectives can come together to search for mutually acceptable solutions to the regions' issues and concerns;
- promotes coordinated, cooperative and collaborative efforts and use of resources in implementing solutions to the major issues facing Horicon Marsh and its watershed;
- encourages coordinated and comprehensive studies to understand better the issues facing the Horicon Marsh area and the impact of alternative solutions;
- promotes the use of research-based and tested knowledge and information in all discussions, planning and decision making regarding the major issues of the Horicon Marsh and surrounding area; and
- promotes the use of concepts such as ecosystem approach to resource management, coordinated resource management, consensus problem solving, win-win negotiation, citizen politics, comprehensive planning and other strategies and techniques that consider the interrelatedness of the total human and natural interactions in the Horicon Marsh regional ecosystem.

What We've Done

Though still in its infancy, the group has made significant progress. In its first year, HMAC established itself as a formal organization with name, operational guidelines and mailing address.

Information has been shared at monthly HMAC meetings both through discussions of various topics and individual presentations by agency/individual stakeholders. These presentations provide a way of educating one another and understanding each stakeholder's interest.

One of the first things HMAC did was to participate in the five-year update of the Upper Rock River Basin Plan (Fix 1994). HMAC members recognized the importance of addressing water-quality concerns on a watershed basis. HMAC encouraged counties that implement the ten-year watershed projects to designate the East and West branches of the Upper Rock as WDNR priority watersheds. East Branch is scheduled for selection in 1997 and the West Branch is scheduled to be funded in the year 2000.

HMAC organized a Geographic Information Systems (GIS) work group which brought together individuals from different agencies/organizations in a cooperative project to obtain a regional GIS for the Rock River watershed. This effort will complement ongoing GIS development efforts (Gatti et al. 1994) for the Glacial Habitat Restoration Area Project, a landscape-scale effort to restore grasslands and wetlands for ducks and grassland-nesting birds. The work group identified needs of various managers; developed a coordinated funding proposal with Dodge County, WDNR, USFWS and USGS; and helped establish standards that would allow data sharing among various organizations. As a result, digital orthophoto bases and other information layers will integrate various data sources and aid in decision making for a comprehensive plan for the ecosystem around Horicon Marsh.

The HMAC group also spent a great deal of time attempting to resolve issues raised by proposed expansion to the Horicon National Wildlife Refuge (USFWS 1994a). As a result of additional dialogue between various groups, the USFWS reduced the size of the proposed expansion. Additionally, the USFWS agreed to work throughout the watershed to screen and identify areas in need of corrective treatment and to restore upland, wetland and riparian areas to enhance the ecological function of existing resources. The USFWS further agreed to a HMAC request to postpone land acquisition for a year, giving all parties the opportunity to continue to discuss important aspects of resource protection, such as watershed planning. Local town officials also were urged to delay land divisions on the immediate perimeter of public ownership.

The HMAC group has come a long way in one year. It is a group of people that has shared interests and listened to others. The members of this diverse group realize they never will be in total agreement on every issue, but also recognize they are moving in a direction of increased cohesiveness. The process has been slow but its results are anticipated to be well worth the effort.

What HMAC Hopes to Do

HMAC hopes to develop plans and agreements that balance community development and resource-management issues. Various work groups will focus on issues and provide suggested solutions. A newsletter will be used to share information and communicate progress and results. A series of public meetings will be held to exchange information. Accepted solutions will be carried out through cooperative agreements and partnerships.

HMAC will continue the dialogue established with the various stakeholders and bring additional people into the process.

Conclusions

The HMAC reflects a collaborative partnership that is defining an ecosystem approach. The partnership structure reflects the functional approach HMAC is taking. Natural resource protection and enhancement is too large a job for one person, group or agency to do alone. People need to work with others in a proactive manner to change behavior, processes, decisions and policies that initiated the problems in the first place. An interdisciplinary approach is needed that views ecosystems such as Horicon Marsh as a web of complex relationships and interwoven parts. Thinking must be long range, as comprehensive plans are developed to address the many issues, different interests and value systems. Coalitions such as HMAC should continue to seek the common ground for effective problem resolution.

Acknowledgments

We would like to acknowledge the large amount of effort the many participants in the partnership building process have contributed. Special thanks go to Lynn

Jacobson and Suzanne du Vair for literature searches; Tom Nigus, James March, Ron Gatti and LeRoy Petersen for their editorial review.

References

Carpenter, S. 1989. Solving community problems by consensus. MIS Report, Vol 21: 10. Int. City Manage. Assoc. New York, NY. 15 pp.

Chrislip, D. D. and C. E. Larson. 1994. Collaborative leadership: How citizens and civic leaders can make a difference. Jossey-Bass, San Francisco, CA. 191 pp.

Craven, S. R. 1978. Distribution and migration of Canada geese associated with Horicon Marsh, Wisconsin. Ph.D. thesis, Univ. Wisconsin, Madison. 135 pp.

Dale, D. D. and A. J. Hahn. 1994. Public issues education: Increasing competence in resolving public issues. Univ. Wisconsin—Extension, Madison. 53 pp.

Dodge County Planning and Development Department. 1991. Dodge County, Wisconsin overall economic development program: Economic development plan. Juneau, WI. 257 pp.

Dodge County Tourism Council. 1994. Dodge County: 1994 visitor's guide. Juneau, WI. 48 pp.

Fix, S. 1994. Upper Rock River Basin: Water quality management plan (Draft), Wisconsin Dept. Natur. Resour., Madison. 103 pp.

Gatti, R. C., D. W. Sample, E. J. Barth, A. Crossley, S. W. Miller and T. L. Peterson. 1994. Integrated grassland bird habitat restoration in Wisconsin using GIS habitat modeling. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 59: 309–316.

Gray, B. 1989. Collaborating: Finding common ground for multiparty problems. Jossey-Bass, San Francisco, CA. 329 pp.

Hanson, I.A., ed. 1977. Horicon Marsh: A history of change. Lore 27: 2, Milwaukee Public Mus., Milwaukee, WI. 42 pp.

Heinrich, J. W. and S. R. Craven. 1992. The economic impact of Canada geese at the Horicon Marsh, Wisconsin. Wildl. Soc. Bull. 20: 364–371.

Hunt, R. A., J. B. Bell and L. R. Jahn. 1962. Managed goose hunting at Horicon Marsh. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 27: 91–106.

International Union for the Conservation of Nature. 1990. List of wetlands of international importance as designated by the contracting parties of the Ramsar Convention. Montreaux, Switzerland. 17 pp.

Jones, B. and R. Malloy. 1988. Partnerships for improving schools. Greenwood Press, New York, NY. 179 pp.

Keith, L. B. 1964. Some social and economic values of the recreation use of Horicon Marsh, Wisconsin. Resour. Bull. 246, Univ. Wisconsin, Madison. 16 pp.

Margerum, R. D., D. J. Watermolen and E. M. Barosko. 1994. Land use in Wisconsin: A draft report of the DNR land use task force. Wisconsin Dept. Natur. Resour., Madison. 61 pp.

Mattessich, P. W. and B. R. Monsey. 1992. Collaboration: What makes it work? Amherst Wilder Found. 53 pp.

Miller, L. C., B. E. Rossing and S. M. Steele. 1992. Partnerships: Shared leadership among stakeholders. Publ. G3553, Univ. Wisconsin—Extension, Madison. 204 pp.

Palmer, V. A. 1962–1963. Horicon: The marsh that lives again. Pages 83–92 *in* Wisconsin Mag. Hist. 46: 2.

Project Public Life. 1992. The political educator's guide to citizen politics. Humphrey Inst., Univ. Minnesota, Minneapolis. 25 pp.

Reeves, H. M., H. H. Dill and A. S. Hawkins. 1968. A case study in Canada goose management: The Mississippi valley population. Pages 150–165 *in* Canada goose management: Current continental problems and programs. Dembar Educ. Res. Serv., Inc., Madison, WI.

Scalpone, J., ed. 1991. Managing Wisconsin's roadsides. Citizens Natur. Resour. Assoc. of Wisconsin, Inc. Wausau. 32 pp.

Schafer, J. 1934. The Horicon Dam question. Pages 212–231 *in* Wisconsin Mag. Hist. 18: 1.

Stier, J. C. and R. C. Bishop. 1978. Canada goose management and agriculture in the Horicon area. Univ. Wisconsin Ag. Econ. Res. Bull. 21, Madison. 4 pp.

Turville-Heitz, M. 1994. Wisconsin water quality assessment report to Congress. Publ–WR254–94–REV. Wisconsin Dept. Natur. Resour., Madison. 323 pp.

Whiting, B. 1990. The Horicon Marsh area bibliography. Center for Resour. Policy Studies, Univ. Wisconsin, Madison. 23 pp.

Wisconsin Agricultural Statistics Service. 1994. Wisconsin agricultural statistics: 1994. Wisconsin Dept. Ag., Trade, and Consumer Protection, Madison. 98 pp.

U.S. Fish and Wildlife Service. 1994a. Draft environmental assessment: Proposed additions, Horicon National Wildlife Refuge, Dodge and Fond du Lac Counties, Wisconsin. U.S. Fish and Wildl. Serv., Fort Snelling, MN. 68 pp.

———. 1994b. Defining our future: An ecosystem approach to fish and wildlife conservation. Pages 1–2 *in* Fish and Wildlife News. April. U.S. Fish and Wildl. Serv., Washington, D.C.

U.S. General Accounting Office. 1986. Resource protection: Mississippi valley Canada geese: Flyway management obstacles. Publ. GAO/RCED–86–31. Washington, D.C. 78 pp.

Vanderwall, E. J. 1944. The department reports on 1943. Wisconsin Conserv. Bull. IX: 1.

Setting Objectives for Ecosystem Management in the Mississippi Alluvial Valley

David Pashley
The Nature Conservancy
Leesburg, Virginia

Attention has been drawn to the plight of several groups of organisms in the Mississippi River Alluvial Plain, including forest-dwelling migratory birds, waterfowl, migratory shorebirds, the Louisiana black bear and others. Although there are differences in habitat needs among these groups of organisms, a conservation plan that simultaneously meets all of their needs should be more compelling and effective than the sum of individual plans. Partners in Flight, the North American Waterfowl Management Plan, Black Bear Conservation Committee, Western Hemisphere Shorebird Reserve Network and The Nature Conservancy all have worked on independent conservation plans. The effort described herein is one to consolidate the habitat conservation goals of these and other aspirations into shared objectives that are consistent with the economic and political realities of the region.

Among these various planning efforts, the one that perhaps is farthest along is the Lower Mississippi Valley Joint Venture of the North American Waterfowl Management Plan. The North American has set targets for numbers of waterfowl to be supported throughout the continent, and then has been apportioning responsibility among the various areas in the nation within Joint Ventures for provision of sufficient amounts of breeding and wintering habitat. The extensive bottomland hardwoods of the Mississippi Valley historically provided the primary wintering area in North America for mallards and was important for many other species. Loss of bottomland forests and extensive drainage have greatly reduced the capacity of the area to support wintering waterfowl. The general stated goal of the Joint Venture is to reverse the long-term trend of wetland loss by conserving existing forested wetlands and restoring and managing wetlands on marginal agricultural sites. Specifically, and within the context of continent-wide waterfowl goals, the objective is to provide adequate migration and wintering habitat on pubic and private lands to support a wintering population of 8.7 million ducks and 1.4 million geese during years of normal precipitation.

These overall targets for bird numbers are broken down into goals for each of the seven states in the lower valley. Based on assumptions as to numbers of days a unit of habitat can support a bird, they are further separated into habitat goals for forest, moist soil units, and agricultural areas on public and private land. Precise locations and configurations of land units on which these goals are to be achieved have only been very roughly defined.

The North American Wetlands Conservation Act includes instructions to "sustain an abundance of waterfowl and other migratory birds." Joint Ventures often have operated under the assumption that activities taken for ducks also provide benefits for other migratory birds. This is no doubt true, but concern has existed that the benefits do not apply to all wetland migratory birds, that they often apply very sparingly to non-wetland migratory birds and even that some migratory species of concern suffer from management efforts for waterfowl.

Early in 1994, the North American Wetlands Conservation Council, acting on recommendations of an Ad Hoc Working Group on Operations, asked that the Mississippi Alluvial Valley be used as a model in developing "regional wetland conservation plans." The intent was to coordinate better the activities of the North American Waterfowl Management Plan, Partners in Flight and the Western Hemisphere Shorebird Reserve Network.

Partners in Flight is a multi-organizational program, initially dedicated to improving the status of declining populations of neotropical migratory birds, that is moving in the direction of establishing priorities and implementing conservation plans for the protection of all of North America's avifauna. Working with the Lower Mississippi Valley Joint Venture presented an opportunity to attempt to apply principles of comprehensive, ecosystem-wide conservation planning to an area of great importance to birds in this continent. It also represented an opportunity to further demonstrate the non-confrontational, cooperative spirit of Partners in Flight and to downplay as much as possible the perception of conflict between goals for conservation of waterfowl and for non-game birds.

The Lower Mississippi Valley Joint Venture staff in Vicksburg took the lead in this effort, with strong support from elsewhere in the U.S. Fish and Wildlife Service, wildlife agencies from the seven states of the Mississippi Valley and non-government organizations (NGOs), such as The Nature Conservancy and the Tennessee Conservation League.

The goals were, first, to come up with objectives for the conservation of non-game forest breeding birds and for shorebirds at levels of details commensurate with the goals developed for waterfowl in the region; and, second, to attempt to integrate these goals with each other as much as possible, to come up with a single conservation plan for all migratory birds.

The first goal, setting objectives for an entire avifauna within a large, degraded ecosystem, had never been undertaken before. We only knew that BBS data showed that populations had declined, and that we wanted to stabilize populations, particularly of high-priority species, at higher levels than those that exist today.

Instead of relying on BBS results as a measure of future change, a decision was made to describe bird populations in terms of the status of apparently suitable habitat. It became necessary, then, to define the suitability of any particular block of habitat. Using the Partners in Flight prioritization scheme, we first determined those species that were of greatest conservation concern. In such a biologically uniform ecosystem, it came as no surprise that all of the high-priority species were dependent upon bottomland hardwood forest breeding habitat. Among the suite of species using this habitat, a few emerged as requiring greater amounts of area than the others. The conclusion was drawn that provision of a sufficient amount of area for a certain number of the most area-demanding species would be adequate for a like or greater number of individuals of all of the less area-demanding cohabitants of bottomland forests. Of course, there are differences in microhabitat needs among these species and these assumptions need to be tested. Those most area-demanding high-priority species are cerulean warblers in the north, Swainson's warblers throughout and American swallow-tailed kites in the south. It is difficult to set a defensible target population size for a single habitat block, but, for various reasons, again open to scrutiny, 500 pairs was chosen. Examination of the literature led us to believe that 500 pairs of Swainson's warblers need 10,000 acres, ceruleans need 20,000 acres and the kites need 100,000 acres for maintenance of even a much smaller population.

Next, we wanted to determine how many blocks meeting or exceeding these minimal geographic standards currently exist. This was done through a Geographic Information System analysis of forested blocks in the entire 21 million-acre valley. As it turns out, there are more than 36,000 blocks of forest in the Mississippi Alluvial Plain of 1 hectare or greater, but only 67 of these are in excess of 10,000 acres. The quality of most of these blocks, that is, their suitability for these birds based on anything other than size and configuration, still needs to be studied.

It then was decided that current conditions were insufficient for the long-term status of these birds. Deciding on a number of desired blocks always is going to be largely subjective, but we set a series of ambitious but realistic goals for maintenance, restoration or creation of blocks throughout the entire valley. This set of goals recently has been subjected to a wider round of review, and greater detail on the results of that review should be available soon.

The means of achieving these goals are flexible. In the Mississippi Valley, it generally means replanting marginal agricultural land into trees. This may be done on existing public lands, newly acquired public lands, private non-industrial lands through government incentive programs or private easements, or through expansion of the holdings or interests of the forest products industry. Once in woods, almost all of these birds are tolerant of a wide range of management practices.

At the beginning of this month, the assistance of the Western Hemisphere Shorebird Reserve Network allowed development of a reasonable means of setting objectives for the amount, distribution and standards of quality of habitat for in-transit migratory shorebirds. The Mississippi Valley is on the eastern periphery of the main mid-continental migratory pathway of many shorebird species of concern, but still must be considered important in-transit habitat for such species as Baird's sandpiper, white-rumped sandpiper, buff-breasted sandpiper and others. Rough estimates of numbers of migrant individuals adjusted by the time they would spend in the Mississippi Valley, their energy requirements, and availability of nutrients per unit area, mixed with awareness of rainfall patterns and seasonal habitat availability, led to a first approximation of numbers of acres that should be managed for shorebirds during autumn migration. The exact location of those acres is not critical and may shift from year to year, as long as they are distributed latitudinally and temporally to meet the needs of the birds. Implementation of some of these early goals on public lands in parts of the Valley may happen very soon.

The second goal for the migratory bird conservation planning process is attempting to maximize the integration of objectives for forest birds, waterfowl and shorebirds. Moist soil units flooded for August migrant shorebirds can be used by early blue-winged teal, then evaporated for plant growth and reflooded for later waterfowl. There will be costs associated with this, but multiple goals can be achieved on single pieces of land. Prothonotary warbler spring breeding habitat is great for mallards in winter. Not every acre, obviously, is going to be good for every target species. The goal, however, is to maximize the level of overlap, so that all of these conservation objectives can be met most efficiently and inexpensively.

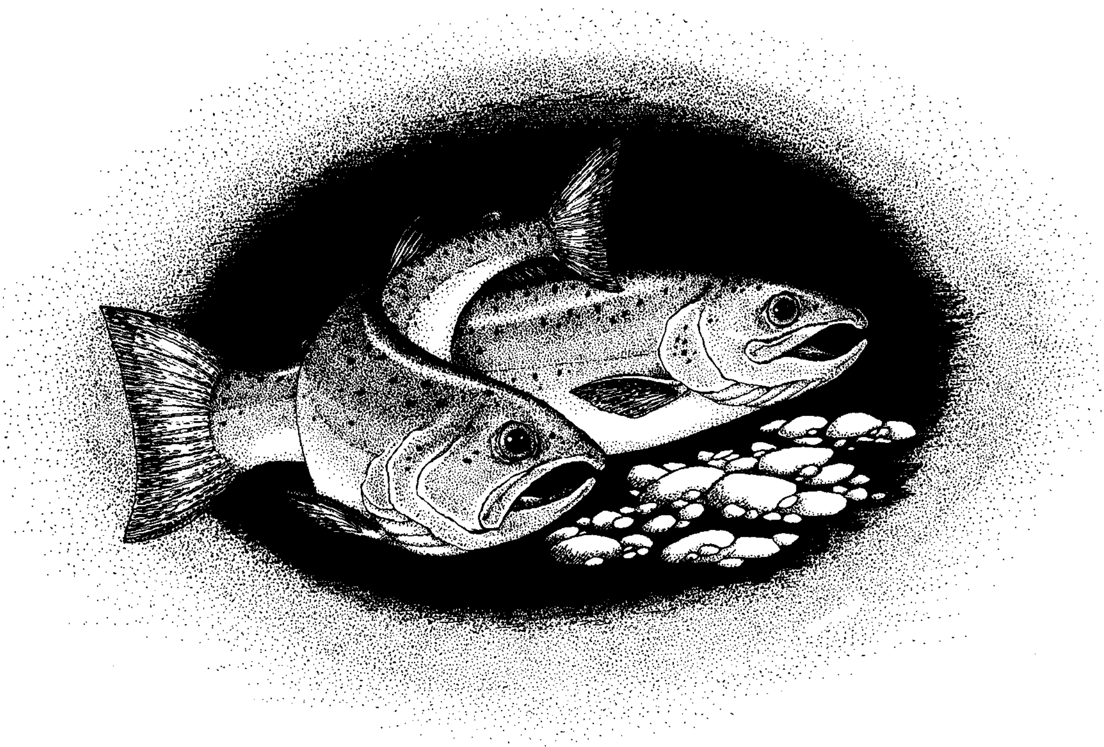
Waterfowl, forest-breeding migrants and shorebirds are three parts of the conservation picture for the Mississippi Alluvial Plain. Another key component, at least in the southern half of the region, is the Louisiana black bear. Bear conservation involves two big factors: management of humans and provision of habitat. Bears are generalists that require a landscape dominated by, but not exclusively occupied by, forest. The forest may be subject to a wide range of management activities, including most standard silvicultural practices. The difficulty in achieving minimum bear habitat blocks is quantity rather than quality. It may be that 100,000 acres that are largely forested is the smallest sized acceptable tract for long-term bear success in the Mississippi Valley. Fortunately, those 100,000 acres can include excellent waterfowl habitat, including some moist soil units managed for shorebirds, and can be suitable for all forest-breeding non-game species. In particular, tracts of this size may be necessary for American swallow-tailed kites, the most area demanding of birds within the Valley and the range of the Louisiana black bear. It is possible that a large block of habitat can be managed in such a way that the needs of wetland species and upland species, game species and non-game species, and resource extraction and rare birds all can be simultaneously satisfied with a minimum of conflict.

The process in the Mississippi Valley, I think, is a valid approach toward Ecosystem Management. Ecosystem Management implies that the whole of a system is a management unit, and that maintenance of the health of the whole will ensure the health of its component species, communities and processes. This may be true in general, and specifically may be true in systems that are relatively intact. In a system as degraded as the Mississippi Valley, the approach seems to be unworkable. Restoration of hydrology and natural communities throughout a system now dominated by agriculture, navigation and human habitation is not a reasonable aspiration. It is possible, however, to hope and plan for a system in which all the remaining parts will persist. In this situation, these remaining parts must be thought of as building blocks, and objectives for each of these blocks of biological diversity can be set independently. This, in itself, is not trivial, but it is only a step toward integration of all of the blocks, with as much overlap as possible, into a single conservation plan for the ecosystem.

In the Mississippi Valley, although many of the basic assumptions of this process need to be rigorously evaluated, we feel that we are on the right track toward conservation achievements at the ecosystem level regarding several key building blocks: bears and all manner of birds. There are, however, significant elements of biological diversity and socio-economic reality that have not yet been fit into the planning process. Rare plants, high-quality natural communities, big river fish and mussels all remain future challenges in this process.

The next part of the country for which this procedure of establishing non-game bird objectives and integrating them with waterfowl management is being attempted is in the Northern Great Plains, in the Prairie Pothole Joint Venture in the United States in conjunction with the Prairie Habitat Joint Venture across the border in Canada. The Prairie Pothole Management Board called for the establishment of a Technical Committee to deal with recommendations for waterfowl, non-game birds and ecosystem health in general. This Technical Committee now exists, has met, and has met as a subcommittee to start setting objectives in the ecosystem for non-game birds. A broad representation of biologists with expertise with these birds agreed on a list of species of concern, their habitat preferences, their relative importance in tallgrass, midgrass and short grass systems, suites of priority species that share habitats and may respond similarly to management practices, and began discussing the impacts of those practices that could benefit these birds most. During summer 1995, there will be a series of three subregional meetings to further investigate the relationships between management practices and conservation opportunities and the well-being of these birds. We also want to further pursue details of objectives for shorebirds.

There has been progress in bird conservation planning along the lines seen in the Mississippi Valley and Northern Prairies in a number of other ecosystems. Details of these processes will be presented at the upcoming national Partners in Flight workshop, to be held in Cape May, New Jersey, from October 1–5, 1995. Examples will be drawn from the Mississippi Valley, Prairie Potholes, Sierra de Manantlan in Mexico, and elsewhere around the hemisphere. We are learning that Partners in Flight has the capacity to help in the development of realistic plans and begin in their implementation. The intent is to develop and implement plans throughout the continent, and meld local efforts into regional plans and ultimately a national avifaunal conservation plan along the lines of the North American Waterfowl Management Plan. Partners in Flight is in the process of hiring a set of regional coordinators who will have the responsibility of making this planning process happen at local, regional and national levels. The people who attend the Cape May meeting will be the ones doing most of the work.



Special Session 8. *Triage and the Endangered Species Act*

Chair
RANDALL C. WILSON
North Carolina Wildlife Resources Commission
Raleigh, North Carolina

Cochair
WAYNE E. MELQUIST
Idaho Department of Fish and Game
Boise, Idaho

Triage and the Endangered Species Act

Randall Cortez Wilson
North Carolina Wildlife Resources Commission
Raleigh

Webster's Dictionary defines triage as the sorting of and allocation of treatment to patients, especially battle and disaster victims, according to a system of priorities designed to maximize the number of survivors. Under this "battlefield" philosophy, victims with the least chance of recovery receive only minor attention, while those most likely to recover receive a higher priority for treatment. Thankfully, most of us have never experienced the tragedies of the battlefield or a major natural disaster. Our appreciation of triage most often comes from the long-running television show called "M.A.S.H." This weekly show depicted the trials and trickery of the doctors, nurses and soldiers assigned to the 4077th Mobile Army Surgical Hospital. Each episode presented the television audience with a humorous outlet for their own weekly dose of stress. Doctors and nurses revealed the struggle for life by applying triage to the day's victims before the end of each show.

Natural resource professionals often are perceived to practice triage in an effort to save endangered species. We assign global, national and state priorities to each species based on levels of endangerment, not unlike what is done with trauma victims. We then provide funding and treatment to save the most critically endangered, which is exactly the opposite response required by triage. North American species such as the Florida panther, black-footed ferret and California condor receive this priority treatment and funding. Yet, do we ever assign species to the third triage classification, unrecoverable? The answer is no. The style of triage most often applied to endangered species is more akin to the philosophy of "Damn the mollusks; warm and fuzzies first." These decisions are made even though the mollusks may be recoverable, while warm and fuzzy species may be terminal. If we claim to practice triage on endangered species, then we should design a better system of priorities. This may not be possible. On the battlefield, no one is looking over the surgeon's shoulder and second guessing his medical decisions. In our democratic system, the public sector always is critical of our natural resource management decisions. While the mollusks may be recoverable, the public demands that the terminally ill ''warm and fuzzies'' receive the lion's share of the attention, treatment and funding. Wildlife managers are encouraged to practice ''warm and fuzzy'' triage or they could find themselves behind the battlelines facing another style of triage altogether.

We seldom give adequate consideration to the amount of suitable wildlife habitat and its threats. Also, we often ignore the conservation needs of other rare or declining species found in the same ecosystem. Our style of triage requires that those species also must become endangered before they can be treated. We neglect the processes leading to extinction of species and most continue undiminished.

Many of our endangered species are the result of habitat degradation, loss and fragmentation. Commendable efforts by local land trusts, spearheaded at the national level by The Nature Conservancy, aim to save the most desirable examples of biodiversity through land acquisition and conservation easements. If we save the most shining examples of these habitats, will that provide for the needs of our endangered species? Probably not.

Triage, as applied to endangered species' habitats, serves to ''treat'' or acquire the most critically endangered. Yet, we neglect the protection and management of habitats of greater availability. Wildlife habitat, in general, continues to decline as do the more common species found there. Yet, our efforts to protect these areas too often are limited until their status becomes critical.

Triage, as currently applied to endangered species and protection of their habitats, could only be considered analogous to triage performed on M.A.S.H. if the soldiers received no consideration until they were near death. Conservation of natural resources cannot succeed if we wait until only a remnant of the original populations and habitats remain. We must develop new initiatives and programs to address species endangerment before listings occur, and on a broader scale than a species-by-species approach. Consideration must be given to declining common species occurring in the same habitats as endangered species. Declining and endangered species often are symptoms of a sick ecosystem. If we continue to treat the symptoms and not the disease, the listing process will continue and endangerment will persist unabated.

This session of the 60th North American Wildlife and Natural Resources Conference is entitled ''Triage and the Endangered Species Act.'' This session will attempt to examine how we might improve our style of triage as it is performed on endangered species in the United States. This examination will be conducted through three panel discussions. The first panel will address the ''States' Efforts for Species Recovery.'' We will learn about Florida's detailed program for assessing species priorities and how these priorities relate to the mandates of the Endangered Species Act, as administered by the U.S. Fish and Wildlife Service. We will hear how the states' biodiversity leaders perceive the effectiveness of the current distribution of Section 6 funds and how sales tax dollars in Missouri have contributed to endangered species recovery.

Our second panel will address ''Prelisting Recovery'' as an effort to preclude listing and its implications. This panel will discuss the effectiveness of conservation agreements on species recovery as a way to preclude listing. We will conclude with our third panel investigating the topic of ''Conflict to Cooperation to Ingenuity.'' This group of speakers will address the implications of ecosystem management, endangered species recovery contracts and cooperation.

While we do not expect this session to solve our dilemma over endangered species, we hope that it will emphasize the need to improve cooperation between state and federal agencies, non-governmental conservation organizations, and private landowners. We must reassess our application of triage to endangered species. A critical assessment may show that must redirect some scarce resources away from the dying and to the front line, where early treatment pays big dividends.

Wildlife Conservation Priorities for Florida: The State's Perspective

Brian A. Millsap
Nongame Wildlife Program
Florida Game and Fresh Water Commission
Tallahassee

Introduction

One of the most pressing tasks facing state wildlife diversity programs is allocating limited funds across a seemingly endless list of poorly known taxa, and the ecosystems upon which they depend, to address information deficits and conservation requirements. A confounding factor is that federal funds and emphasis, which by default comprise a significant part of the direction for many state wildlife diversity programs (Edelson and Cerulean 1994), often are closely tied to suites of taxa or systems that do not necessarily correspond with higher state priorities. The purpose of this paper is to describe a system recently implemented by the Florida Game and Fresh Water Fish Commission (GFC) to direct and prioritize conservation activities of Florida's Nongame Wildlife Program (NGWP), and to examine how state-generated priorities correspond with federal initiatives and funding opportunities in Florida.

Florida Game and Fresh Water Fish Commission's Approach to Nongame Conservation Planning

From 1987 to 1990, NGWP staff effected a peer-reviewed numerical ranking of all of Florida's vertebrate nongame taxa with manageable populations (Millsap et al. 1990). The goal was to provide an objective scale by which to compare the relative need for conservation attention of wildlife taxa in Florida. As might be expected, the list of worthy candidates for attention was a long one; 294 (44 percent) taxa were identified as probably declining in Florida, and 113 taxa had biological vulnerability scores that equaled or exceeded the median for taxa included on the GFC's species of special concern list in 1990.

Following completion of that ranking project, NGWP staff initiated a long-range planning effort to identify and prioritize taxonomic, survey, monitoring, research, management, habitat protection and education projects needed to help conserve taxa identified by the ranking system as most vulnerable to extirpation or extinction. Many taxa in need of conservation attention in Florida occur sympatrically in discreet habitats and geographic regions. Sympatric imperiled taxa share many of the same information needs and may benefit from many of the same management practices. One focus of our long-range planning process was to identify regions of the state that support concentrations of imperiled vertebrate taxa, and to develop lists of needed projects that address multi-species and ecosystem-wide conservation needs within these areas. To accomplish this, NGWP staff overlaid maps of ranges of the 113 taxa with biological vulnerability scores equal to or greater than the median score for state-listed species of special concern (Millsap et al. 1990: 28–29) and identified regions with large cumulative biological vulnerability scores. This effort highlighted five discrete regions of the state as focal regions for wildlife diversity conservation efforts.

We next identified taxa with declining populations in Florida that had biological scores lower than the median for species of special concern that also occur primarily in these five regions. We evaluated the need for taxonomic, survey, monitoring, research, management, habitat protection and education projects for both declining and highly ranked taxa in each region. Project needs, objectives and tasks were summarized in a data base. This data base, which continually is updated as new needs become apparent, is used to plan the annual workload of NGWP staff. This approach facilitates selection of the highest-priority projects or tasks because projects can be ranked against one another based on the number of taxa addressed, the mean and cumulative biological vulnerability scores of the affected taxa, and the extent to which successful completion of a project will effect a positive change in the biological vulnerability score or knowledge base for affected taxa.

Florida Game and Fresh Water Fish Commission Conservation Priorities

The five targeted regions of the state were: (1) Florida's coastline, including primary dunes and beaches, salt marshes, tidal (mangrove) swamps, and maritime hammocks; (2) interior peninsular ridges and associated scrub and sandhill ecological communities, particularly scrubs on the Lake Wales Ridge system; (3) tropical hardwood hammocks, pine rocklands, and freshwater wetlands in southwest Florida, the Miami Rocklands and the Florida Keys; (4) interior peninsular prairies; and (5) Panhandle wetlands, streams and rivers (Figure 1). Collectively, these regions include large proportions of the state range of 69 percent of vertebrate taxa included on the state list of endangered and potentially endangered wildlife (Wood 1994).

The relative need for conservation attention in each of these regions was assessed by plotting Gausian bivariate 95 percent confidence ellipses (Wilkinson 1990) about centroids of the sample means for action (knowledge for management) scores and biological (vulnerability) scores of included taxa (Figure 2; scores are presented in the appendix in Millsap et al. 1990). The greatest mean biological vulnerability exists for taxa in the Florida Keys/Miami Rocklands group, followed by taxa in the peninsular ridge scrub/sandhill group and taxa in the coastal group. The greatest knowledge deficit exists for taxa in the Panhandle wetland group and taxa in the peninsular ridge scrub/sandhill group. Because of the combined high biological vulnerability and high knowledge deficit of included taxa, the peninsular ridge scrub/sandhill group stands out as the group most in need of conservation attention.

Federal Funding and Emphasis

The primary source of federal funding for conservation of imperiled nongame fish and wildlife in Florida is and traditionally has been grants-in-aid through Section 6 of the Endangered Species Act. Such Section 6 money can be used to fund projects addressing any conservation need of a federally listed threatened or endangered taxon,

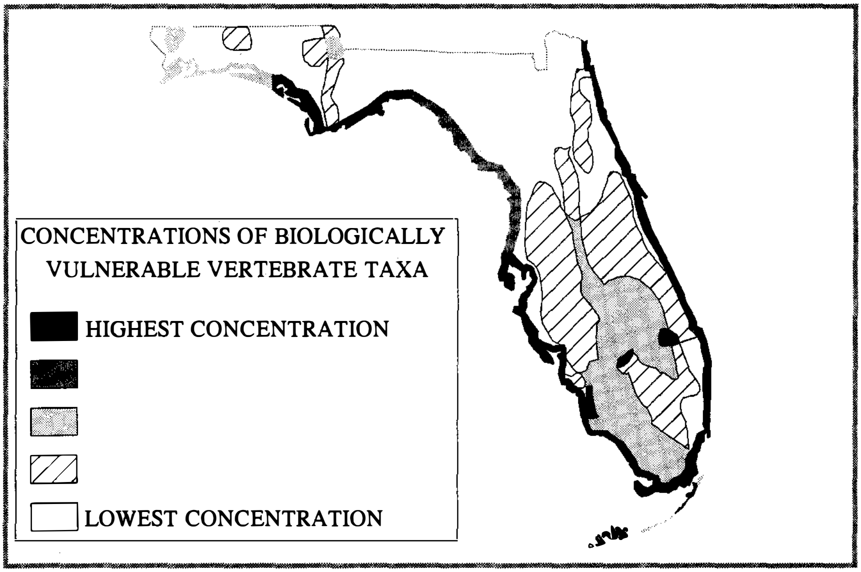


Figure 1. Map of Florida showing regions of the state with high concentrations of imperiled vertebrate taxa. Map was prepared by overlaying ranges of 113 taxa with biological vulnerability scores greater than the median for state-listed species of special concern (see Millsap et al. 1990) and summing overlapping scores. See text for description of high-priority regions.

as well as status surveys for formal candidate taxa. Section 6 dollars cannot be applied to projects that have unlisted or non-candidate taxa as part of their focus.

A second area of current emphasis among federal agencies, non-governmental organizations and many states is the Partners in Flight program. This program focuses conservation and education attention on neotropical migratory birds. Emphasis on neotropical migrants is effected through strong encouragement from federal agencies, non-governmental organizations and other states for each state agency to participate in various aspects of the program. Partners in Flight funding is limited at present, and most funding that is available is through non-governmental organizations.

The conservation priority of taxa addressed by both of these programs relative to that of the GFC-targeted groups identified above is shown in Figure 3. Federally listed taxa rank highly in terms of biological vulnerability but tend to be relatively well understood. Neotropical migrant birds are less imperiled on average than the other groups and are better understood on average than taxa in most NGWP-highlighted groups.

Although difficult to categorize but mentioned here for completeness, GFC has conducted numerous specific projects that targeted imperiled nongame wildlife with non-Section 6 funds from the U.S. Fish and Wildlife Service and funds from other federal agencies to cooperatively address joint nongame wildlife conservation needs. Examples include U.S. Fish and Wildlife Service-funded surveys for the Florida snowy plover (*Charadrius alexandrinus tenurostris*, Gore and Chase 1989), Florida mastiff bat (*Eumops glaucinus floridanus*, Robson 1989), Santa Rose beach mouse (*Peromyscus polionotus leucocephalus*, Gore and Schaefer 1993), long-tailed weasel

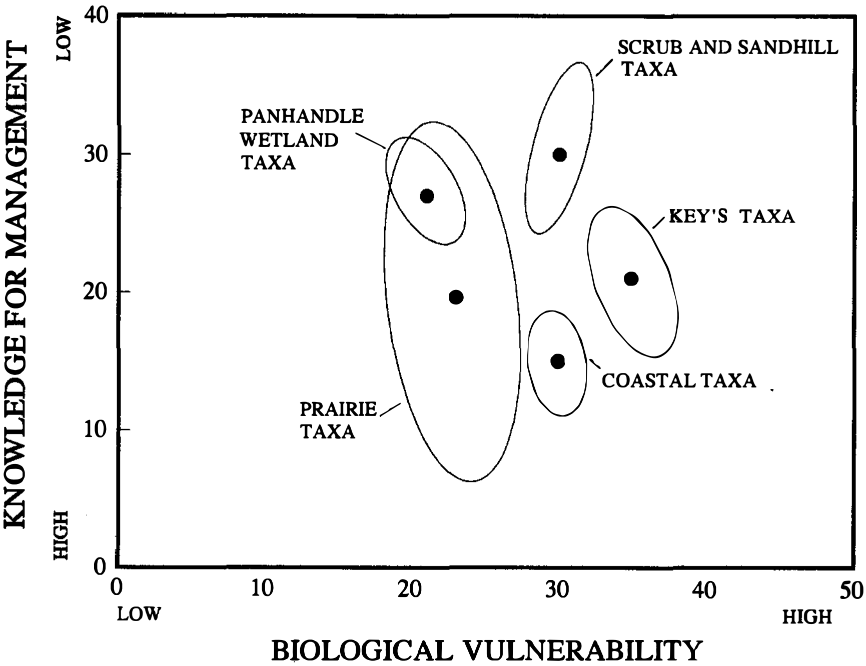


Figure 2. Centroids and Gausian bivariate 95-percent confidence ellipses around intersection points for mean biological (vulnerability) scores and mean action (knowledge for management) scores of imperiled and declining taxa that occur in the priority regions of Florida identified in Figure 1.

(*Mustela frenata*, Hovis 1993), and a U.S. Navy-funded research/survey project targeting the Lower Keys marsh rabbit (*Sylvilagus palustrius hefneri*, Forys and Humphry 1994). Funds for such projects are, however, only intermittently available, and are not under any single federal funding umbrella. Additionally, federal agencies like the U.S. Fish and Wildlife Service and Department of Defense have numerous initiatives coordinated with the State of Florida that address NGWP priorities, but do not provide funds. As examples, the U.S. Fish and Wildlife Service (through the National Wildlife Refuge System) and the State of Florida (through the Preservation 2000—Conservation and Recreation Land program) are cooperating to acquire critical scrub habitat on the Lake Wales Ridge and essential marine turtle nesting habitat in Brevard County on Florida's Central Atlantic Coast (Florida Department of Environmental Protection 1994).

Availability of Federal Funds to Address Florida Game and Fresh Water Fish Commission Conservation Priorities

The GFC data base presently contains 144 projects to address conservation needs of imperiled and declining taxa in the five priority regions listed above. Of those, 113 (78 percent) are not eligible for federal funding under Section 6 because they do not specifically address federally listed or candidate taxa. Only five (3.5 percent)

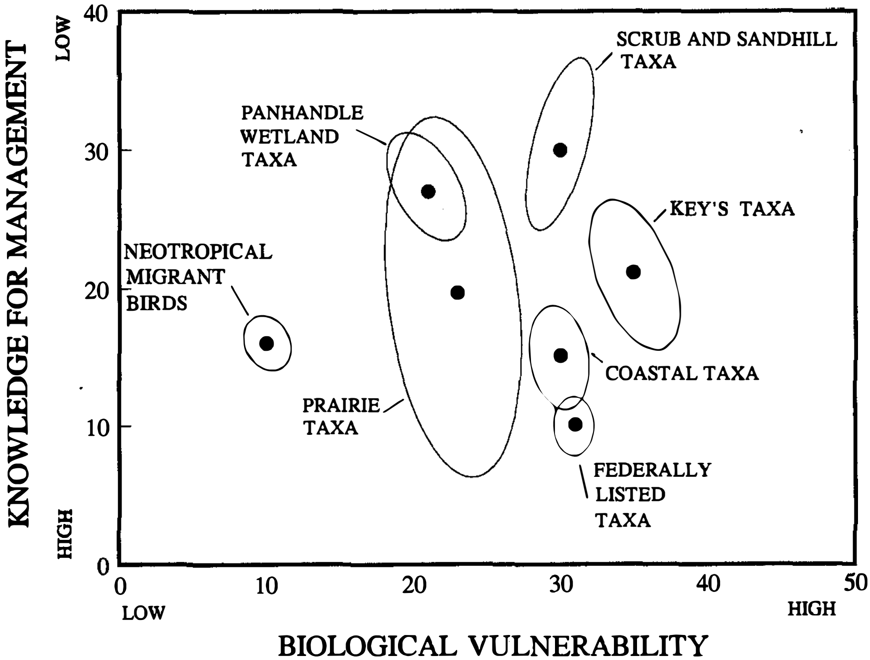


Figure 3. Centroids and Gausian bivariate 95-percent confidence ellipses around intersection points for mean biological (vulnerability) scores and mean action (knowledge for management) scores of federally listed taxa and neotropical migrant birds compared with those for imperiled and declining taxa that occur in the priority regions of Florida identified in Figure 1.

priority projects specifically address neotropical migratory birds, thereby qualifying for considerations for Partners in Flight funding.

Projects that do qualify for federal Section 6 funds tend to be of low to moderate relative priority (Figure 4) because the NGWP system highly ranks projects that simultaneously address conservation needs of large numbers of taxa (e.g., multi-species and ecosystem projects), and these often include non-federally listed taxa. The few neotropical migratory bird projects that have been identified rank highly in terms of priority because they address the needs of a large number of species simultaneously.

Since July 1992, GFC has budgeted approximately $570,500 for priority NGWP projects. Of this amount, $539,300 (94 percent) was Florida's Nongame Wildlife Trust Fund money, and $31,200 (5.5 percent) was federal Section 6 funds and federal funds provided through miscellaneous contracts. GFC's annual share of Section 6 funding has ranged from about $204,000 to $254,700 during this period. More of this money has not gone to priority NGWP projects, partly because of ongoing commitments to other long-term GFC Section 6 projects and because of the aforementioned ineligibility of most high-priority NGWP projects because of their inclusion of non-listed taxa.

It is important to acknowledge that federal agencies are playing a major role toward achieving some of the highest-priority conservation goals in Florida, although through

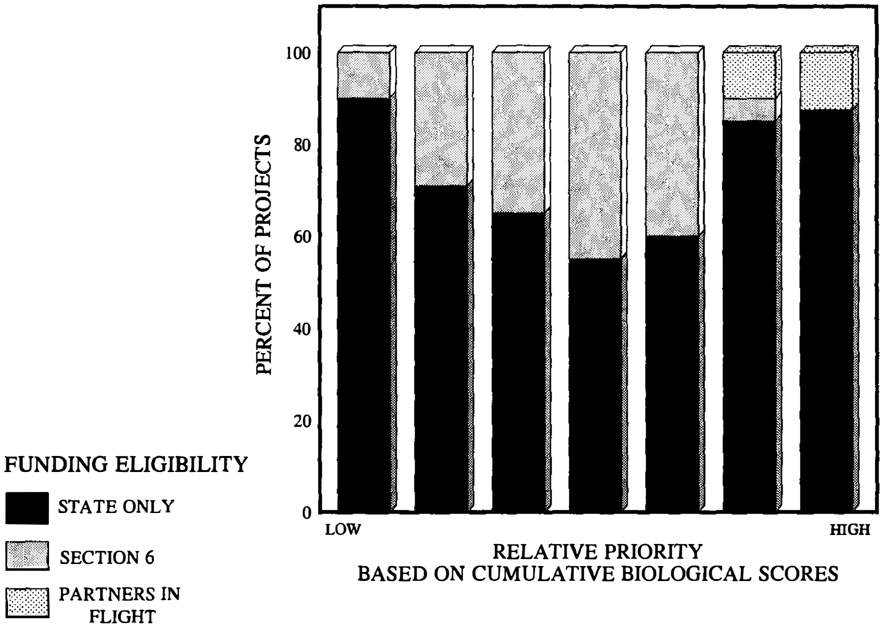


Figure 4. Histogram showing percentage of 144 GFC-identified projects addressing conservation needs of imperiled nongame vertebrates that are ineligible for funds provided under Section 6 of the Endangered Species Act, that are eligible for Section 6 funds and that deal with neotropical migrant birds. Projects have been divided into seven categories based on relative priority, which was determined by the cumulative biological vulnerability scores of included taxa.

mechanisms that are not the focus of this paper and, thus, are not considered in the above figures. For examples, the highest-ranking projects in the NGWP data base involve identifying and securing critical lands in the priority regions of the state. The aforementioned joint U.S. Fish and Wildlife Service/State of Florida land acquisitions along the Lake Wales Ridge and Brevard County coast directly relate to these high-priority tasks (Florida Department of Environmental Protection 1994). In addition, the Department of Defense is engaging in research and active management for interior prairie birds and highly ranked Panhandle reptiles and amphibians on several of its installations (B. Progulske personal communication: 1995).

Conclusions

Federal funds available to state wildlife agencies have not been an important source of money for GFC projects that address GFC-identified imperiled nongame wildlife conservation priorities. The most significant reason for this is that the GFC's highest-priority projects are not eligible for Section 6 funding as they do not focus specifically on federally listed taxa. Moreover, another area of national conservation emphasis, the Partners in Flight initiative for neotropical migrant birds, focuses on taxa that, on average, are not as biologically imperiled nor as poorly known as taxa groups identified for priority conservation attention by the GFC. Thus, GFC has not devoted a significant portion of its limited nongame wildlife conservation resources to the Partners in Flight program.

It should be noted, however, that the fact that Section 6 money has been of little value in addressing nongame conservation priorities in Florida should not be taken as an indictment of this program. To the contrary, funds provided under Section 6 have been instrumental in furthering recovery programs for many endangered species in Florida and elsewhere in the United States. Additionally, recent policy changes in the administration of the federal endangered species program offer hope that more of our priority projects may become eligible for such funds in the future.

We also are optimistic about recently established and potential new sources of federal funds to state agencies. Funds available under the Partnerships for Wildlife program, although limited, could be used to fund priority GFC conservation projects. Additionally, the ongoing federal Wildlife Diversity Funding Initiative offers tremendous funding potential for priority GFC conservation projects. However, for either of these programs to meet our needs, national initiatives and priorities must not be afforded primacy over our carefully identified state priorities in the fund allocation process.

References

Edleson, N. and S. Cerulean. 1994. State wildlife diversity program funding: A 1992 survey. Int. Assoc. Fish and Wildl. Agen., Washington, D.C.

Florida Department of Environmental Protection. 1994. Conservation and recreation lands annual report 1994. Florida Dept. Environ. Protection, Div. St. Lands, Tallahassee.

Forys, E. A. and S. R. Humphrey. 1994. Ecology and status of the Lower Keys marsh rabbit. Final Rept. to U.S. Navy and Florida Game and Fresh Water Commiss., Tallahassee.

Gore, J.A. and T. L. Schaefer. 1993. Santa Rosa beach mouse survey. Final perform. rept., Florida Game and Fresh Water Fish Commiss., Nongame Wildl. Program, Tallahassee.

Hovis, J. A. 1993. Distribution of the long-tailed weasel in Florida. Florida Field Natural. 21: 101–128.

Millsap, B. A., J. A. Gore, D. E. Runde and S. I. Cerulean. 1990. Setting priorities for the conservation of fish and wildlife species in Florida. Wildl. Monogr. 111.

Robson, M. 1989. Status survey of the Florida mastiff bat. Final perform. rept., Florida Game and Fresh Water Fish Commiss., Nongame Wildl. Program, Tallahassee.

Wilkinson, L. 1990. Sygraph: The system for graphics. SYSTAT, Inc., Evanston, IL.

Wood, D. A. 1994. Official lists of endangered and potentially endangered fauna and flora in Florida. Florida Game and Fresh Water Fish Commiss., Tallahassee, FL.

Funding Endangered Species Recovery through Section 6 of the Endangered Species Act

Wayne Melquist
Idaho Department of Fish and Game
Boise

Introduction

Resident wildlife normally is viewed as property of the state. State natural resource agencies thus are charged with managing populations of these species for the good of the people. Once a species or particular population of a species becomes listed under the Endangered Species Act (ESA) of 1973, as amended, primary responsibility for the recovery of that species or population shifts either to the U.S. Fish and Wildlife Service (Service) or National Marine Fisheries Service. In carrying out the recovery program authorized by the ESA, the Secretary of the Interior may enter into a cooperative agreement in accordance with Section 6 of the ESA with any state that establishes and maintains an acceptable program for the conservation of endangered and threatened species (U.S. Fish and Wildlife Service 1988). Section 6 also authorizes the allocation of funds to the states with signed cooperative agreements, based on a set of requirements identified in the 1988 amendments to the ESA, for the implementation of recovery programs. In most cases, this funding is crucial to the recovery process.

Currently, all states have signed cooperative agreements for animals, and 44 states have plant agreements. In some cases, such as in Idaho, these agreements are with two different state agencies. Section 6 thus serves as a mechanism for state and federal cooperation in endangered and threatened species recovery to meet the goals of the ESA.

In order to carry out the provisions of Section 6 of the ESA, Congress is authorized to deposit into a special fund, known as the cooperative endangered species conservation fund, an amount that is equivalent to 5 percent of the combined annual allocation of federal aid to wildlife restoration fund (Pittman-Robertson Act) and Sport Fishing Restoration Account (Dingell-Johnson Act), or approximately $18 million annually. The current appropriation is approximately one-half that amount. The U.S. General Accounting Office, in an evaluation of the federal endangered species program, concluded that the current approach to species recovery at existing funding levels probably is hurting recovery more than helping.

In 1994–95, I surveyed individuals from state and federal agencies involved in the endangered species program in order to understand better the current Section 6 allocation process and how it is viewed by the states. This paper reports on the results of the survey.

Methods

Service personnel in each of the seven administrative regions were contacted by telephone with a request made for information explaining the process by which

Section 6 funds are allocated to the states within their jurisdiction. I also distributed a questionnaire consisting of 23 questions in order to survey state personnel and obtain their opinions regarding various aspects of the Section 6 allocation process. I attempted to have the questionnaire completed by one person per state, preferably the person most knowledgeable with the Section 6 process. Several of the questionnaires were completed over the telephone. However, most were sent by facsimile once I obtained the appropriate person's name and facsimile number. Respondents were requested to return the completed questionnaire either by facsimile or regular mail. I would remind the reader that this information is based largely on the opinions of numerous individuals, including me. Consequently, there is inherent bias in the results, which should be viewed accordingly.

Results and Discussion

The Allocation Process

The Section 6 allocation process is a step-down process. At the national level, the Service distributes monies to each of its seven administrative regions based on the percentage of the number of federally listed endangered and threatened species found within that region. Therefore, those regions with the greatest number of listed species receive the greatest share of the funds. At the regional level, each Regional Director has the discretion to decide how funds are allocated to the states. Consequently, the allocation process is somewhat different in each region. The entire process has led to considerable confusion and dissatisfaction.

There are some similarities in the manner in which Service regional offices allocate Section 6 funds to the states, including the following.

1. Project proposals generally are initiated jointly by the state and appropriate Service field office, which then must compete for available funds from the region.
2. Section 6 funds generally are apportioned among states based on the percentage of the region's species found in each state.
3. Virtually all regional offices use a set of criteria, including recovery priority guidelines published in the *Federal Register* (Volume 48, Number 184) on September 21, 1983, for ranking Section 6 recovery project proposals.
4. There tends to be priority for ongoing, multi-year projects previously approved and funded.
5. Final ranking of project proposals are made at the regional level, with final approval given by the Regional Director.

I was able to obtain written procedures and guidelines for Region 1 (U.S. Fish and Wildlife Service 1993), Region 2 (U.S. Fish and Wildlife Service 1994a), Region 3 (U.S. Fish and Wildlife Service 1994b) and, to some extent, Region 4 (Moreno 1992). Similar written guidelines may be available for other regions.

The Region 1 office recently has developed an allocation process that appears to satisfy some of the concerns of many states based on the survey results I received, and thus warrants further review. In Region 1, prior to 1993, all projects competed for funding with allocation based on the merit of the project with respect to preventing extinction and/or declines, assisting recovery, and the species' recovery priority. Long-term planning was difficult because of the uncertainty of continued funding.

In 1993, the region developed new guidelines for allocating funds to the states (U.S. Fish and Wildlife Service 1993). These guidelines were a considerable improvement in the allocation process and provided a somewhat discretionary funding base to each of the states. The Service field office and the state now jointly develop both noncompetitive and competitive projects. Fifty percent of allocated funds consist of noncompetitive base and are allocated proportionally in accordance with the number of candidates, proposed and listed species within each state. For example, California, with more than 1,100 species, receives 21 percent of the total noncompetitive base; Hawaii receives 15 percent. The remaining states and territories receive in the range of less than 1 percent (Guam) to 5 percent (Oregon). For those states which have more than one cooperative agreement (Idaho, Nevada, Oregon and Washington), a noncompetitive base is established for each of the cooperative agreements. Whether they have one agreement or two, each state is to receive a minimum of $50,000.

While this formula does not seem equitable, especially if you are one of the states receiving 5 percent of the funds or less, it does allow for the development of long-term recovery and monitoring projects with some degree of confidence that at least some funds will be available each year. The remaining funds are allocated in a manner similar to the method previously used.

In 1993, noncompetitive projects could be submitted and approved for funding as early as the start of the fiscal year in October. This approach allowed the states to initiate field work on projects that were seasonal in nature. In 1994, the regional office decided to make the selections for competitive funding first, thus allowing the states to reprioritize projects and use noncompetitive funds for those projects that were not funded in the competitive process.

There also are some differences in the allocation process used by other regions worth noting. In Region 3, funds first are assigned to priority projects identified by Service personnel in the regional office (U.S. Fish and Wildlife Service 1994b). For fiscal year 1995, the priority projects included Kirtland's Warbler (*Dendroica kirtlandii*) recovery and Gray Wolf (*Canis lupus*) recovery. Following an assessment of the funding needs of ongoing projects, remaining funds are allocated based on the candidate and listed species priority matrices and a project evaluation criteria/ranking form. Not less than 20 percent or more than 40 percent of the remaining funds go to candidate species activities. Unlike other regions, there is a ranking panel consisting of two state and two Service representatives. There also is an evaluation committee (of similar composition) that reviews the process and provides recommendations for improvement.

In Region 4, an Ad Hoc Committee on Section 6 allocation was formed in 1990 to evaluate a request that the Directors of the Southeastern Association of Fish and Wildlife Agencies petition the Service's regional office to redistribute 1990 Section 6 funds among the states in a more equitable manner (Moreno 1992). The Committee rejected the request, but agreed that the current allocation formula needed revision. In their report, the group evaluated five approaches, including the actual process used.

In Region 7, where Alaska is the only state, the allocation of funds in the past has been quite informal. Funds are distributed to projects mutually agreed upon between the state and regional office. A more formal process likely will be developed in the future.

State Interpretation of the Process

The response of individuals from 30 states formed the basis for the following results. Not all questions were answered by every respondent. For example, one individual pointed out that a weakness in the survey was that I assumed people knew more about the process and what is occurring elsewhere than they actually did. This made answering some questions difficult. A couple of individuals failed to answer certain questions that they felt were confusing And finally, one individual indicated the survey had several loaded questions.

In order to save space, the results of each question will be enumerated with the response indicated as a percentage.

1. Sixty percent of the respondents were satisfied with the current process of allocating funds to the states, although several did not fully understand the process; 40 percent were not.
2. Fifty-three percent felt the current process was fair and equitable, and that the states have adequate say in which projects receive funds; 47 percent disagreed.
3. Respondents indicated that the prioritized projects they submitted to the Service for funding never were reprioritized (10 percent), occasionally reprioritized (63 percent) or frequently reprioritized (27 percent).
4. Seventy-nine percent of the respondents either agreed (43 percent) or strongly agreed (36 percent) that the states should have greater discretion over how funds are allocated to them.
5. Eighty-six percent of the respondents felt that the state and Service field office have a much better understanding than the regional office as to which projects need funding. However, four respondents surprisingly disagreed.
6. The majority of respondents (78 percent) also agreed that greater discretion by the states in project allocation would be more cost-effective.
7. Eighty-five percent of the respondents agreed that single-species recovery with funds earmarked specifically for an individual species was not the most effective approach and needed to be changed.
8. Eighty-six percent of the respondents supported placing greater emphasis on multi-species and ecosystem projects. One state indicated that efforts to obtain funding for ecosystem projects have been rejected by the region. Conversely, several of the 15 percent who disagreed also indicated that sometimes it is necessary in order to prevent extinction, and that the work often benefits other species (they act as umbrella species).
9. Respondents were asked to identify what is wrong with the current single-species funding approach. They were provided with the following options to chose from: "There is no problem in my view." "There simply is not enough money for each species." "Don't know (but there must be a better way)." "Other (please explain)." Thirteen percent indicated there was no problem, 63 percent indicated there wasn't enough money, 7 percent said they didn't know and 40 percent offered a variety of explanations. At least four mentioned that an ecosystem approach should be taken when possible. A balance between single-, multi-species and ecosystem projects was suggested. It was pointed out that too much emphasis is placed on the total number of species when funds normally are provided for only a fraction of them.
10. Eighty-three percent of the respondents would prefer to know the amount of Section 6 funds being awarded to their state prior to submitting project proposals to the Service. The rationale behind that is reflected in the next question.
11. Eighty-six percent of the respondents felt that prior knowledge of the amount available would allow for more effective allocation of funds to those projects

with the greatest need (provided greater discretion of project allocation is afforded).

12. When asked to prioritize those criteria used to determine which projects are submitted for funding consideration, ''probability of being funded'' ranked first (31 percent), followed by ''the need for more information'' (27 percent) and a ''joint decision based on meetings between the state and field office'' (19 percent). Collectively, 83 percent of all respondents identified ''probability of being funded'' as a criterium for determining which projects are submitted for funding. Greater state discretion for allocating funds would reduce the importance of this criterium.
13. Respondents were asked what they believe their role is in assisting the Service to fulfill its responsibilities under the ESA. A high percentage of respondents supported the options offered, including, to conduct field work on listed species (93 percent), maintain the primary database of all rare species (77 percent), monitor recovery of listed species (83 percent) and monitor candidate species in an effort to avoid listing (83 percent). Fourteen respondents (47 percent) offered a variety of other tasks, including to develop conservation plans, strategies and agreements for candidate species, groups of species and for ecosystem management; and that states should be responsible for identifying species potentially in trouble.
14. Sixty-seven percent of the 30 respondents felt that their future role in listed and candidate species recovery and management should be greater, while 30 percent felt it should remain the same. No state felt their role should be less.
15. Only one respondent felt federal funding was adequate to carry out recovery efforts in their state. Conversely, 97 percent disagreed that funding was adequate (69 percent of this group strongly disagreed).
16. Fifty percent of the respondents indicated that Section 6 funds currently constitute less than 25 percent of their annual endangered and threatened species recovery budget, 10 percent indicated that 25 to 50 percent of their budgets was Section 6, 17 percent of the respondents indicated that their budget was comprised of 51 to 75 percent Section 6, and seven respondents (23 percent) indicated that their state relied on Section 6 funds for more than 75 percent of the budget.
17. Sixty-six percent of the respondents felt that some states receive a disproportionate amount of Section 6 funds. Conversely, less than half (43 percent) supported a more even distribution of funds among the states in their respective region. The responses to these two questions seemed to be in contradiction. Two respondents declined to answer these questions because they did not know the level at which other states in their region were funded.
18. An overwhelming majority (96 percent) of the 30 respondents agreed that baseline federal funding should be provided to each state to help administer its endangered species program. If you recall, Region 1 does provide a noncompetitive base to each state (a minimum of $50,000) for their recovery program. Even though these funds are project-specific, the process does help to provide some stability in the state's endangered species program.
19. Sixty-one percent of the respondents felt that the current process of allocating Section 6 funds from the Washington, D.C. office to the regions based on the number of listed species found in each of the regions (i.e., regions with the greatest number of species receive the largest proportion of funds) was accept-

able. For those that disagreed with the current process, some did not offer alternatives, while 14 respondents offered suggestions as to a better method of allocation. Suggestions were made that a variety of factors be considered, rather than simply the total number of species found in each region. In a letter to J. Moreno (1992), D. Wood wrote: "... the existing formula, based solely on the number of federally listed species which historically have occurred in a given state, is not biologically defensible and is inherently inequitable, in that (1) the funds are allocated based on resources (-species) on which the funds will not be expended, and (2) those resources are equally weighted in importance from state to state, but in fact are not equally distributed from state to state. In terms of endangered and threatened species recovery throughout Region 4, then, the existing Section 6 allocation formula does not reflect regional needs and minimizes recovery efficacy." Others made similar comments and suggested that, because it is unlikely there ever will be enough money to recover each species, techniques such as gap analysis (Scott et al 1991) should be employed as a means of looking at clusters of rare species and threatened ecosystems. Distribution of funds should be based in a similar manner.

Summary

In the course of conducting this survey, I detected a clear desire to shift toward focusing on candidate and other "not-so-rare" species in an effort to avoid the normally time-consuming, costly and sometimes ineffective recovery efforts which often occur once a species is listed. Equally prevalent were concerns about the need to focus more on multiple species and ecosystems, and less on individual species. Regardless of our noble intentions to conserve all species, many factors will continue to allow certain species to become extinct. With the availability of geographical information systems (GIS) and gap analysis, we now have the tools to focus more on biodiversity and entire ecosystems. The challenge will be to convince those who control the funds.

If nothing else, I believe the results of this survey should give us some ideas of how state and federal agencies can become more effective partners in a role we must share. We need to do a better job at communicating. Several respondents suggested that an annual meeting among state, field and regional office personnel to discuss Section 6 allocation would go a long way toward solving communication problems and confusion. We must explore ways to accomplish more with less. And finally, we need to seriously evaluate the way we currently are doing business. Indeed, there is a better way.

For the most part, states feel a sense of responsibility for all wildlife. However, because the hunting and fishing community already funds most state wildlife programs, continued federal funding is critical for states to remain active partners in species recovery and the prevention of additional listings. The challenge will be to find a way to expend available funds in a manner that will ensure the continued integrity of native wildlife species, communities and ecosystems.

Acknowledgments

State and federal agency people kindly took the time to complete the questionnaires, share information over the telephone and send material that allowed me to complete this project. My assistant, Christine Saxton, the student interns, Kim Rose and Ben Rush, helped immensely by interviewing people and sending out questionnaires. I thank them all very much.

References

Moreno, J. A. 1992. Report of the ad hoc committee on Section 6 allocation. Final rept. to the Southeast. Assoc. of Fish and Wildl. Agen., Savannah, GA, April, 1992. San Juan, Puerto Rico. 19 pp.

Scott, J. M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D'Erchia, T. C. Edwards, Jr., J. Ulliman and R. G. Wright. 1993. Gap analysis: A geographic approach to protection of biological diversity. Wildl. Monogr. No. 123. 41 pp.

U.S. Fish and Wildlife Service. 1994a. Section 6 procedures and program guidance. Unpubl. rept. US Fish and Wildl. Serv., Region 2, Albuquerque, NM. 36 pp.

———. 1994b. FY 1995 endangered species Section 6 and discretionary projects. Memor. to field supervisors, U.S. Fish and Wildl. Serv., Region 3, Fort Snelling, MN. 15 pp.

———. 1993. Region 1 guidelines for allocation of Section 6 funds. U.S. Fish and Wildl. Serv., Region 1, Portland, OR. 9 pp.

———. 1988. Endangered species act of 1973, as amended through the 100th Congress. U.S. Fish and Wildl. Serv., Washington, D.C. 45 pp.

Making the Sales Tax Work in Missouri

James H. Wilson
Missouri Department of Conservation
Jefferson City

In 1976, after a long campaign, the people of Missouri voted their approval of a conservation sales tax—one-eighth of 1 percent of each dollar spent in the state—earmarked for a comprehensive conservation program that promised enhanced attention to a very broad spectrum of conservation issues—including endangered species. Since that time, the sales tax has provided $780 million for conservation. Today, the sales tax provides $64 million per year, or 64 percent of the operational budget of the Missouri Department of Conservation.

It is appropriate to ask—since Missouri has had the benefits of that sales tax for some 18 years—what has been done for endangered species? And, more to the point of today's discussion, what system of triage or other prioritization has been at work to direct these efforts?

In the beginning, there really wasn't any such system. We promised the people to take care of endangered species—presumably *all* endangered species. And what did we do?

We did research, of course. We did good, solid, long-term research on Indiana and gray bats, pallid sturgeon, least tern, prairie mole crickets and some other species. And we learned a lot. We learned about those species. But we didn't learn a lot about how to evaluate one against the other. We didn't learn much about triage or how to allocate resources better to protect the most important endangered species. That is not to say that we did nothing to protect species. We did, and we have and we are.

We bought land, for one thing—rather a lot of land. We have bought almost 400,000 acres since the sales tax was initiated and some 5,000 acres of that were aimed directly at endangered species protection. We have purchased bat caves, prairies and old-growth forests. We bought river sloughs, wetlands and sinkhole ponds. And in doing that, we have protected bats, turtles, insects, salamanders, wildflowers and a whole host of endangered species on both the state and federal lists.

It isn't always easy to identify endangered species habitat for acquisition. There is no recovery plan for most of the listed species in Missouri, and we do not want to buy land just because some kind of endangered species happens to occur on it. That is especially true of animal species. But we do have an acquisition plan that identifies needs for the most endangered species, where protected habitat is not present, by natural division and section of the state. We have no illusions about being able to recover all our endangered species by buying up the habitat, but we still think it is important. Habitat acquisition may be the best tool we have to stabilize some situations. We think our acquisition program may ensure that the habitat is not chipped away, a fragment at a time, in a way that precludes recovery forever.

Of course, it is not enough to buy habitat; habitat has to be managed if rare species are to benefit. We have done that. We have managed to enhance water quality and built a number of cave gates. We have changed how we use our prairies and carried out a successful eagle restoration project. We have built a dependable Heritage database and learned to use it not only for environmental review of federally funded projects, but for our own management work as well. We check Heritage records before timber sales, construction/development projects and major land-use changes that go along with everyday management. We try to manage by plan and manage by need, but we do not have a system that lets us evaluate the needs for prairie mole cricket against those for Mead's milkweed or bobwhite quail.

Is there a direction to this program that offers promise for endangered species? There is . . . through a process that we call Coordinated Resource Management. This really is an approach to management that recognizes that, to manage effectively, we must look beyond ourselves and our own boundaries. This big-picture approach recognizes needs and priorities at a regional level, and it recognizes endangered species concerns as a part of ecosystem management. We want to use research, land management and creative partnerships to try to effect endangered species recovery through an emphasis on the natural communities of which they are a part.

In the meantime, we will continue to direct efforts to a few charismatic species . . . or to those with a vocal constituency. We will recognize that directed recovery for all species is just too expensive to be practice. We will take advantage of opportunities where we can and try to stay ahead of a listing process that sometimes seems to box us in and not focus much on recovery.

Let me offer two points. First, money is nice, but it is not the only solution—and probably not even the best solution. Money has given us a buffer in dealing with endangered species. It may have allowed Missouri to take care of some critical needs while we worked out a philosophy that will promote and sustain the idea that taking care of everything is important. It is, in part, that philosophy that allows us to develop a positive program that is not driven by regulation, lawsuit and mitigation. Money also has given us a buffer against having our program direction completely dictated by the availability of federal funds.

A second and final thought is this. Triage right now must be aimed at saving the *concept* of endangered species in formulating worthwhile objectives for resource managers, other public agencies and private citizens alike. That is, and must be, our first concern.

Conservation Agreements: An Interim to Listing

Robert L. Parenti
U.S. Fish and Wildlife Service
Boise, Idaho

Introduction

The intent of the U.S. Fish and Wildlife Service (Service), and the Endangered Species Act of 1973, as amended, is to prevent the extinction of fish, wildlife and plants, and loss of their habitat. In addition, the Service is provided the authority to engage in conservation activities with non-listed species.

Congress, in section 2 of the Endangered Species Act, declares, "there is value in having incentives for conservation." A portion of section 2 reads: "The purposes of this Act are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in subsection (a) of this section." Even though this quote refers only to endangered and threatened species, it also has application for candidate species, as noted in the 1978 amendments concerning section 5.

Before its amendment in 1978, the section 5 authority to establish and carry out a program to conserve fish and wildlife was limited to those species listed as endangered or threatened species pursuant to section 4 of the Act. The 1978 amendments removed the limitation and broadened the authority to include all fish, wildlife and plants, and not just those listed as endangered or threatened, but all candidate species, as well.

To carry out the program to conserve fish, wildlife and plants, the Secretary of the Interior is authorized by section 5 of the Endangered Species Act, the Fish and Wildlife Act of 1956, and the Fish and Wildlife Coordination Act as authorities for the Service to enter into conservation actions with other parties. Agreements with other federal agencies, state and local agencies, and private individuals may be entered into to provide for various programs designed to assist the Service in carrying out its mission.

One of these early actions is the conservation agreement. The conservation agreement is one avenue through which the Service, other agencies and the private sector can initiate and carry out conservation actions for certain endangered, threatened, proposed and candidate species.

The conservation agreement may be useful as an interim solution to effect conservation measures quickly for some of the thousands of plant and animal candidate species known to the Service. Conservation agreements will allow the conservation of many candidate species. Priority for listing can be given to those species facing the greatest threats that would benefit most from the Endangered Species Act's protective measures. Conservation agreements help other federal agencies carry out their obligations under the Act. In addition, a conservation agreement will help other federal agencies facilitate following their own internal policies concerning the conservation of candidate species.

Conservation Agreements

While a working conservation agreement should be viewed as consistent with the intent of the Act, the Service and other parties should not approach conservation agreements as a compromise that may foreclose the possibility of listing. The conservation agreement approach for a species or group of species is not in lieu of listing. In preparation of proposed or final rules, the current status of the species must be considered. If a conservation agreement is in place and threats are verifiably removed, the listing decision should take that into consideration.

The direct, measurable result of a conservation agreement must be the removal of threats to the species to the point where the species is a lower-priority candidate for listing or it can be removed from candidate status. The key words here are "measurable results removing threats." The terms of a conservation agreement must be implemented, and the "on-the-ground results" must be verified via monitoring and reporting.

A conservation agreement must be considered as an interim to listing as long as the conservation agreement is in effect and the threats removed. The conservation agreement never should be thought of as a compromise foreclosing the possibility of listing. The conservation agreement approach may not be a permanent alternative to listing a species, but it could be a permanent solution for those species that are recovered as a result of an active conservation agreement. Careful monitoring is necessary to ensure that the proposed conservation agreement is working and corrective actions are being taken, including listing if necessary. In addition, listing should not be presented as something undesirable, but unnecessary; the conservation agreement should be an incentive in keeping with section 2 of the Act.

Note that a conservation agreement is not a legal contract, but a voluntary agreement between the U.S. Fish and Wildlife Service and other parties. A conservation agreement, therefore, has no binding obligations. However, the failure of a conservation agreement to adequately remove threats could be cited in a listing decision as cause for listing. That cite most likely would be addressed in relation to Section 4(a)(1)(D), "the inadequacy of existing regulatory mechanisms."

Criteria for Selection of Candidates for Conservation Agreements

Application of a conservation agreement approach requires a general knowledge of the status of the species. In addition, it requires a clear understanding of the conservation agreement concept, since it is not described in the Act. Among the criteria for consideration are:

1. only native species should be considered for conservation agreements;
2. the species has a definable range with determinable habits;
3. ownership and control of the habitat is limited to one or a few parties;
4. the threats to the species are high, but not too complicated, and are readily reversible;
5. there is minimal controversy or conflict concerning the conservation of the species;
6. management of the species to reduce threats and for species conservation can be dictated by the conservation agreement;
7. parties to the conservation agreement must have the legal capability, funds and

personnel to carry out their responsibilities under the conservation agreement; and

8. the species can be given greater management attention in an existing conservation program for an area, or in other conservation policies, by using a conservation agreement.

The purpose of these criteria is to confine application of a conservation agreement approach to those species not presently requiring a listing action under section 4 of the Act for their conservation. For those species requiring listing, benefits and protection under the provisions of sections 4, 5, 6, 7 and 9, listing should not be delayed. Negotiations should be initiated and conservation agreements completed for conservation actions only when conservation agreement development is a viable strategy to remove threats.

Procedural Guidance

Procedural considerations for conservation agreements include:

1. A signed conservation agreement will not remove a species from official candidate status (such as in a notice of review) until an accepted recovery level is achieved. The conservation agreement must significantly decrease the listing priority of the species and the immediate need to list it.
2. After initial contact with the other party(s) to decide that a conservation agreement is a viable strategy to remove threats, completion of a conservation agreement should take no longer than one year.
3. Before signing a conservation agreement, an independent third party, such as a state agency or Heritage Program, might be invited to evaluate the draft agreement. (Interested third parties should be aware that a conservation agreement is being developed for the species.)
4. A signed conservation agreement should be reviewed annually. An annual report of monitoring should describe the status of the species, actions accomplished during the year, measured and verifiable results of those actions and goal(s) for the next year. To ensure that the situation is monitored closely, the conservation agreement should have a termination date (such as after five years) unless renewed by the signature parties.
5. Careful records should be kept on the development of a conservation agreement and the adherence to the signed conservation agreement. The failure of a conservation agreement to reduce threats for a species provides evidence for the need to list it promptly, following section 4 of the Act. But failures should be few, because thoughtful selection of species and front-end negotiations with other parties should eliminate any species that would not fit those criteria described above.
6. Sometimes, there could be more than two parties to the conservation agreement. There also could be more than one conservation agreement for a species for separate and distinct habitat areas. But, as the number of parties or conservation agreements for a species proliferates, the suitability of the species for a conservation agreement approach decreases. Complex situations only rarely could be solved through this approach. More than one species endemic to a site could be included in one conservation agreement, presumably without complication.

The conservation agreement never should be viewed as "in lieu of listing," nor as a "deal" cut to prevent the listing of a species that needs the full protection of the Act.

Conclusion

The U.S. Fish and Wildlife Service's endangered species program serves as a safety net for species that are, or are likely to be, threatened with extinction. The need and the authorities exist to implement the Endangered Species Act with early actions that will contribute to the stabilization and potential recovery of species and their ecosystems.

It is the policy of the U.S. Fish and Wildlife Service to pursue and, when appropriate, implement opportunities to preserve candidate species. These opportunities (conservation agreements) should contribute to the reduction of threats to candidate species and the ecosystems that support them.

Conservation agreements undertaken on candidates may or may not reduce the need to list these species at a later date. Often, by the time the species are officially listed, the ecological situation is critical and available recovery options limited. The sheer magnitude of the situation often results in high costs for research and management.

Greater efforts in addressing the recovery needs of candidate species before their status becomes critical will provide conservation for systems of species and support the preservation of biological diversity. By undertaking conservation actions for candidate species, the Service retains more management flexibility, has the potential to reduce conflict with development and minimizes the potential need for restrictive land-use policies in the future. Conserving candidate species can avoid the confrontational atmosphere often encountered during listing actions.

Conservation agreements should be considered and selectively implemented for any candidate species. However, only those actions, individually or cumulatively, that have a high potential to reduce the listing priority of a candidate species (either Category 1 or Category 2) should be implemented.

It is the policy of the Service to pursue and, when appropriate, implement opportunities to conserve candidate species and their ecosystems. Taking advantage of opportunities, using conservation agreements and other effective conservation efforts, should contribute to the reduction of threats to candidate species. Effective candidate conservation efforts allow priority for listing to be given to those species facing the greatest threats and likely in greatest need of the full range of the Endangered Species Act's protective measures.

The Idaho Conservation Program: A Bureau of Land Management/USDA Forest Service Perspective

Lyle Lewis
Bureau of Land Management/USDA Forest Service
Twin Falls, Idaho

A proactive, interagency approach to rare and sensitive species management is logical, cost effective and protects ecological diversity. In spite of the many benefits, large-scale prelisting or rare species conservation programs are rare. One such program that currently is operational is in Idaho. Even this program is only making progress in fits and starts. The success of the Idaho program and other similar programs ultimately will be measured by species whose populations were stabilized at a level that prevented their listing as threatened or endangered.

An in-depth look at those aspects of the program that have worked and those that are impediments to progress will better aid other states or regions who either have an interest in developing a conservation program or may currently be working with a similar program.

Beneficial Aspects

Federally listed threatened and endangered species can and often do consume a great deal of available manpower and funding in agencies such as the USDA Forest Service (USFS) and Bureau of Land Management (BLM). The spotted owl and Snake River salmon both are examples. A species listing results in tremendous amounts of time and effort expended in writing biological opinions, coordinating with the United States Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS), and monitoring species habitat and populations. Although implementing conservation strategies also requires funding and manpower, it is at a fraction of what the same species would require if listed as threatened or endangered. The USFS and BLM deal with a tremendous variety and complexity of land-management issues. Being consumed by a species listing makes both agencies more susceptible to paralysis because of the tremendous drain on available resources. As a result, proactive species conservation initiatives are the most efficient land-management strategies and give taxpayers a better return on their tax dollar.

Stabilizing plant and animal populations above critical minimum population thresholds is the best insurance for the species. Often overlooked is that, by the time a species is listed, it is at a high risk of extinction. Most species undergo population fluctuations due to natural phenomena as well as human-caused phenomena. Once a plant or animal population becomes threatened to the point of listing, the odds of them not recovering from natural or human-caused population declines is much higher. Obviously, listing is no guarantee of species survival. The California condor (*Gymnogyps californianus*) and the dusky seaside sparrow (*Ammodramus maritimus nigrescens*) are examples of listed species that either are holding precariously to existence or are extinct.

The Idaho State Conservation Effort has allowed state and federal agencies to work together at a variety of levels to achieve common goals. The result has been numerous spinoff benefits.

An interagency approach has prevented one agency from leaving another agency ''holding the bag'' on controversial issues. In the past, it has been commonplace for one agency to legitimize their lack of action with ''that's their problem.'' This attitude also resulted in one agency taking all the heat on individual problems. With the organizational framework of each agency being a participant, individual agency's problems become collective agencys' problems. An extraordinary number of problems that surface within one agency can be solved by the mere support of other agencies. It some cases, a letter or a phone call from one agency to another at a variety of levels can resolve problems by refocusing agencies to a priority issue.

Individual agencies have a better rapport with some constituents than do other agencies. A multi-agency effort can, at times, dilute the controversy surrounding conservation initiatives as the result of the rapport developed with different constituents by different agencies.

Some agencies have more streamlined administrative processes (e.g., contracting) or better-staffed departments (e.g., public affairs) than other agencies and, where those capabilities or efficiencies exist, program responsibilities for that service in many cases migrate to that agency. This results in a more efficiently run program.

Working in an interagency forum results in peer pressure at all levels of program responsibility. When one agency is implementing difficult or controversial actions to conserve a species, there isn't much sympathy for other participating agencies that lack the fortitude to implement similar controversial actions. Conversely, when difficult decisions are made, the result is a quasi-support group where individuals within agencies can provide suggestions for dealing with or preventing controversy.

There also is the benefit of peer pressure by agencies to ensure other participating agencies maintain their level of commitment in terms of both funding and manpower. This can be extremely important with a preventative program such as this, where it easily can be ignored in favor of more crisis-oriented programs.

There is an inevitable turnover of personnel in government agencies that can and will disrupt any natural resource program. Participation by an interagency contingent can dilute that impact. Usually, new employees spend time learning about programs on their own with a minimal amount of assistance, usually from an immediate supervisor. With this program, it is in the best interest for members of interagency teams to bring new members up to the level of knowledge of their predecessor quickly. The program then can continue with the same level of support or participation from that member's agency as there was prior to the departure.

Agencies, oftentimes, unknowingly duplicate each other's efforts. Working with employees in other agencies on a regular basis eliminates redundancies that frequently occur. Communication on a regular basis can dissipate some problems before they develop.

Problem Areas

Despite the numerous benefits to initiating a rare species conservation program, there are reasons why these programs are not proliferating. A thorough analysis of problems and impediments will better prepare other states or regions for best implementing a similar program and what hurdles they can anticipate.

In many states, programs never get off the ground because of historical or current adversarial relationships between agencies or individuals within agencies. It's important for all agencies who work with fish, wildlife and plants within a state or region to be a participant if a program is initiated. Without one key participant, gaps in conservation develop, making meaningful progress difficult. Although differences between agencies exist in Idaho, as with almost all states, these differences have been tabled allowing this program to proceed.

The fear of making mistakes has prevented some states from initiating a species conservation program similar to Idaho's. Often, there is the tendency to wait until someone else has paved the way and solved all the problems. A thought process of "if they don't crash and burn then we'll try it" is prevalent. There are a number of problems that Idaho is attempting to work through that will be common to all states or regions. It is a certainty that each state or region will have to deal with its own unique set of problems.

Overcoming the cultural differences between agencies is difficult. All agencies have developed under different laws and regulations. Some are more regulatory in nature, others have been guided by the desires of recreational users such as hunters and fishermen, and yet others have evolved under the influence of commodity users. To overcome these cultural differences takes a great deal of empathy from both individuals and agencies. It also requires a willingness by agencies to become more like their partner agencies, as well as more knowledgeable about them.

For example, the USFWS, primarily a regulatory agency, must become better at working with other agencies and people. The BLM and USFS, agencies that historically have been given priority to resource extraction over species conservation, must take on more internal regulatory program responsibilities for the conservation program to succeed. The state departments of fish and game, and parks and recreation must become more knowledgeable about federal laws and regulations and the complexities of habitat management as it relates to species populations. The BLM, USFWS and USFS, on the other hand, must become well-versed with state laws and the intricacies of population management.

In all likelihood, this type of program always will be underfunded. Where money usually exists to deal with a crisis, there rarely is money to prevent one. Until such time as it is established as a priority base program, difficulty frequently will occur in funding the program. Inadequate funding also can result in limitations on the number of species that can be effectively addressed relative to the number that should be addressed.

The Federal Advisory Committee Act (FACA) has proved an impediment to this program, which is unfortunate because, for most purposes, it was a much needed law. The reasons for the enactment of FACA were to prevent: (1) committees or blue ribbon panels from making decisions rather than providing advice; (2) the expense of committees; and (3) committees giving biased proposals.

In Idaho, compliance with FACA has resulted in restructuring the species conservation program such that it is a state-led program and federal agencies are invited participants. Conservation strategies, the initial products of the program, require melding of species habitat needs and population biology into one document that, if implemented, would result in conservation of the species. In most western states, the federal government is charged with management of a majority of species habitat. States are charged with the management of wildlife populations. An inability to work as equal partners in the management of species populations and their habitat is counterproductive to the overall conservation of the species and leaves the perception that one component takes precedent over the other. The state and federal governments need the ability to work together as partners in the management of plant and animal populations without the restrictions imposed by FACA.

The National Forest Management Act (NFMA) and the Federal Land Policy and Management Act (FLPMA) both have provisions to conserve species. These laws and regulations that guide management of USFS and BLM lands, respectively, provide for the conservation of sensitive species.

Despite this legislation, many sensitive species have and are continuing to decline in abundance and distribution on federally managed lands. This problem is exacerbated by agency and political perceptions about the land-management decisions of line managers. As a general rule, the more controversy surrounding a line manager, the less desirable the manager. Conversely, it rarely is possible to manage sensitive wildlife or plant populations without some level of controversy. Because of the inevitable changes required in land management to promote species conservation, there almost always is controversy surrounding their management. Yet, avoiding controversy still is the best way to ensure job stability or facilitate career enhancement as a line manager in federal land-management agencies and, to a lesser extent, in state wildlife management agencies. Agencies need to expect controversy and be better prepared to deal with it. Managers who tackle difficult species conservation problems should be rewarded. Avoiding controversy will only lead to more species listings and more catastrophes.

Only the most progressive line managers who have not been directly impacted by the Endangered Species Act see the advantages of this type of program. Managers become so caught up in the day-to-day authorization of traditional uses and monitoring those uses that reprioritizing money and workloads for species conservation frequently isn't considered seriously. Delaying the implementation of proactive conservation measures and the resultant listings of species as threatened or endangered automatically will reprioritize money and workloads.

At least in its early stages, state- and regional-level managers have been the primary proponents of this program. Overseeing large areas puts them in a much better position to see how species, once listed, can consume entire offices on a regional basis. They have initiated the program in spite of skepticism within their own agencies. It is hoped that, as the program comes of age, lower-level land managers will become proponents for the program as well.

A gap always will exist between coordination requirements and coordination capabilities. The potential exists to coordinate with thousands of individuals within, between and outside agencies. Efforts are made to work with as many entities as possible, but when individuals aren't contacted in the manner they feel is appropriate, it often leaves them hostile, with a tendency to label the program "a failure."

In some instances, program responsibilities for completing tasks are given to resource specialists without any relief from other job duties. This can be overwhelming and also result in disenchantment with the program.

The National Environmental Policy Act (NEPA), which requires environmental analysis of actions affecting federal lands, also may prove an impediment to the goals of this program, particularly with wide-ranging species whose management can affect numerous programs and geographic areas. For these species, NEPA can be a very time-consuming process. Innovative efforts to streamline this process or initiate interim conservation measures will be necessary to prevent delays in implementing management changes that would conserve species and prevent their listing.

Recipe for Success

In order for a program like this to succeed, three things must occur. First, cooperating agencies must realize that the program is analogous to a marriage. There will be different levels of commitment by different agencies at different times. At any point in time, those agencies that are strongly committed to the program must be patient with those that are marginally committed and help them until such time as they become strongly committed again. Agencies should expect this "roller coaster ride" and be able and willing to deal with it.

Second, there must be a strong commitment by state and federal agency leaders to initiate and implement the program. They should expect a reluctance by line managers until such time as it becomes accepted as part of the base program. State agency leaders must be willing to make line managers responsible and accountable for the program.

Third, there must be recognition by resource specialists of the importance of this program. In many government jobs, personal initiative often can dictate where and how much work is accomplished. Resource specialists often are given more than one number-one priority. Looking at this program as "just another number-one priority," however, will result in tremendous time and funding commitments in dealing with additional species listings.

Summary

This program is the essence of ecosystem management. Ecosystems are unbelievably complex, to the point that many land managers and resource specialists are both frustrated and confused about what ecosystem management really means and how best to implement it. Ecosystem management can be a million different things to a million people.

Rather than asking—"what is ecosystem management?"—line managers could alleviate a lot of confusion and frustration by considering what ecosystem management isn't. Most obvious is that it isn't continuing to see species listed as threatened or endangered. The term ecosystem management would not be a key phrase right now if it weren't for species like grizzly bears, wolves, desert tortoise and spotted owls. At a minimum, ecosystem management means the successful implementation of rare and sensitive species conservation programs that stabilizes populations at a level where listing no longer is necessary.

Conservation Agreements and Listings Under the Endangered Species Act: A State Perspective

Steven M. Huffaker and Charles E. Harris
Idaho Department of Fish and Game
Boise

Introduction

The Endangered Species Act (ESA) of 1973, as amended, generally is regarded as the most comprehensive species protection program in the world. The purposes of the ESA are "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be necessary to achieve . . ." (Endangered Species Act as amended through the 100th Congress 1988). Since passage of the ESA, more than 900 species have been listed as threatened or endangered (U.S. Fish and Wildlife Service 1994) and about 4,000 have been identified as candidates for listing in the United States (Meese 1989).

Despite the ESA's best intentions, the list of threatened, endangered and candidate species continues to grow, listed and non-listed species are going extinct, recovery plans are available for only about half of the listed species, a large proportion of recovery funds are spent on very few species and recovery goals for species often are set at or below the population size at the time of listing (Tear et al. 1993). Given these trends, Scott et al. (1991: 283) concluded that the current endangered species program "has become essentially efforts to document the loss of species through the listing process." It seems clear that current listing and recovery programs alone are inadequate for protecting threatened, endangered and candidate species and the broader issues of ecosystems and biological diversity.

The objectives of this paper are to present our view of the ESA's effects on selected fish and wildlife management activities in Idaho, with a focus on Snake River salmon, and describe efforts we are undertaking to return to the defined purposes of the ESA to conserve species and ecosystems by entering into voluntary Conservation Agreements with multiple partners.

Effects of the ESA on Fish and Wildlife Management Activities in Idaho

The listing under the ESA of species found in Idaho, such as Snake River sockeye (*Oncorhynchus nerka*) and chinook (*O. tschawytscha*) salmon, gray wolf (*Canis lupus*), grizzly bear (*Ursus arctos*), woodland caribou (*Rangifer tarandus caribou*), bald eagle (*Halieetus leucocephalus*), and peregrine falcon (*Falco peregrinus anatum*), has had many effects on fish and wildlife management activities in Idaho. Some have been beneficial, some have not.

On the beneficial side, the ability of the federal agencies to protect listed species' habitats and water quality on federal land has been enhanced. Listed species then often act as "keystone" or "umbrella" species for other candidate and nonlisted species (Noss 1991). Constraints have been established on harvest of some chronically over-fished salmon stocks, hatchery production in both producing salmon for harvest and enhancing of depressed populations is being reviewed for efficacy and the fact that the Snake River hydropower system is developed and operated to the extreme detriment of aquatic species finally has come to national attention.

On the negative side, tremendous amounts of time and money have been wasted on bureaucratic processes rather than species conservation. We have been forced to work extensively on unimportant peripheral issues rather than focus on the major causes of the decline of the salmon. Our inability to develop and administer public policy that makes sense to those being governed and affected has created unprecedented polarization and a forum ripe for politicians and special interest groups to exploit. In January 1995, the Wilderness Society and Pacific Rivers Council filed a lawsuit with a federal judge in Hawaii to enjoin the U.S. Forest Service from conducting any activities related to mining, livestock grazing, timber harvesting and road building in six national forests in Idaho until they had consulted with the National Marine Fisheries Service (NMFS) regarding forest plans to protect salmon habitat. The plaintiffs succeeded in pitting agriculture against recreation, resident fish against anadromous fish, the peoples' rights against fish conservation, state's rights against federalism, and the state's congressional and legislative delegations against the ESA. Instead of focusing on salmon conservation, the issue became polarized at the extremes of fish versus Idaho jobs and economic survival. The vast opportunities for local government and private entities to work together to find solutions in the middle ground were lost.

The listing of Snake River salmon was, like many ESA listing petitions, an act of frustration. It was a desperate response to force federal agencies to deal with their failure to enforce other federal statutes, regulations and policies to halt the decline of a species. It was thought the listing finally would focus the attention of the region on the problem that biologists had been unable to overcome for decades, the operation of the Snake and Columbia rivers for hydropower at the direct expense of the salmon. Dams and water release operations had completely changed the natural migration corridor. The spring floods on which the salmon migrated to and from the ocean were impounded and stored for release in the winter when the power was worth more. The decline of the runs could be charted by the construction of the dams. Everyone who had studied the problem agreed that the dams and river operations were larger problems by orders of magnitude than any of the others. The response to the listing of Snake River salmon in 1994, however, was predictable. Everyone did exactly what they had done in the past: (1) deny the problem exists; (2) blame everyone else; (3) confuse the real issue; and (4) lobby hard to maintain the status quo.

The confusion and lobbying are working. The only way Idaho has been able to come even close to addressing the real issue, that of improving mainstem operation for migrating salmon and steelhead (*O. mykiss*), is through the federal courts.

We underestimated the ability of the affected utilities, industries and commercial interests to influence politicians and public opinion. The Pacific Northwest had bought off on the politically appointed Northwest Power Planning Council as an alternative to listing the salmon in 1980. The Council was given a mandate to balance the needs of fish, wildlife and hydropower. In 14 years of effort, this bureaucratic process has consumed the time and attention of the agencies and tribes, but did not stop the decline of the salmon.

NMFS has demonstrated remarkable ineptitude at dealing with political pressure or administering the ESA. They have been unable to provide the federal leadership needed to induce other federal agencies to make significant changes critical for salmon recovery.

In fairness, this listing has had a few beneficial effects. Unfortunately, most of them will contribute little to saving salmon in the Snake River. It is a fact that some production habitat for Idaho salmon can and should be improved. It also is a fact that salmon are going extinct in wilderness habitat essentially unaltered by the activities of man. We must focus conservation efforts on those threats having the most significant impact to the species rather than peripheral issues of little overall consequence of the species' survival.

If you are a hammer, everything looks like a nail. The ESA is regarded as the ultimate environmental hammer. It currently is being swung by a variety of people. Some of those people have a broad background and an appreciation for decisions that make a difference. They administer the ESA with a measure of common sense. Logical decisions based in sound biology generally are accepted. When they are challenged, they are defended by most resource professionals. The same hammer also is wielded by some who are long on ambition and theory, but short on expertise and field experience. They tend to swing full force at every nail they see, wrecking more than they build.

In the later cases, the biology is speculative. For example, a stocked fish might compete with a wild one; a boat might disturb a spawning salmon. Campgrounds are closed to keep people from trampling the river banks based on the logic that unless human activity is restricted, livestock activity cannot also be restricted. The justification for restricting the activities of people often is that they are relatively easy to administer. At the local level, threats to individual fish or their habitat are dealt with. Threats to species that are politically, socially and economically tougher to address are left to a higher authority where the concomitant greater costs and consequences usually result in no significant conservation actions being taken.

Conservation Agreements

A common criticism of the ESA and those agencies responsible for implementing it is that listing does not occur or is delayed until the species' populations and habitat are almost gone. Subsequent recovery efforts then are drastic, costly and controversial, with changes of successful recovery and delisting unlikely (Rohlf 1991).

The objective of the ESA is not to list species, but to conserve them. A listing should be regarded as a failure of agencies to properly manage species and habitats. State agencies generally possess the authority needed to become more proactive in protecting the populations and habitats of species "at risk" (candidates, sensitive or species of special concern) before they get to the point requiring the full protection of the ESA. States also have the authority and responsibility to monitor and manage listed and candidate species through Section 6 of the ESA. Many states also have their own threatened and endangered species programs that provide additional levels of protection and implementation of conservation actions.

Conservation Agreements are a preferable alternative to listing under the ESA. They are voluntary agreements between the U.S. Fish and Wildlife Service and other signatories specifying the actions that will be taken to remove the threats to a species and its habitat to the point where the species is a lower-priority candidate for listing or it can be removed from candidate status. They can be done at the lowest level by those with the best knowledge and experience as to what is realistic and sufficient to get the job done. They can be done on private lands or public, and with or without any state, federal or private funds. They are the exemplification of the term "partnership" that so many talk about and so few do anything about (Salwasser et al. 1987, Salwasser 1991).

The Idaho State Conservation Effort currently is developing conservation strategies for 45 candidate species or groups of species. Some, such as bull trout (*Salvelinus confluentus*), cutthroat trout species (*O. clarki* spp.), forest carnivores (lynx [*Lynx lynx*], wolverine [*Gulo gulo*], fisher [*Martes pennanti*], marten [*M. americana*]), and old-growth ponderosa pine dependents like white-headed woodpeckers (*Picoides albolavartus*) and flammulated owls (*Otus flammeolus*), will be more challenging because of the economic importance of the habitats they occupy or the large-scale nature of their habitat requirements (wilderness/roadless areas connected in the managed forest matrix by corridors and linkage zones). Others that occupy very limited or discrete habitats, such as the northern Idaho ground squirrel (*Spermophilus brunneus brunneus*) and Coeur d'Alene salamander (*Plethodon idahoensis*), will be less controversial.

By addressing the conservation needs of candidate and sensitive species in a proactive fashion using Conservation Agreements, federal, state and private entities can retain management flexibility, reduce conflict with economic development, minimize cost of recovery if listing is the best option to conserve the species, sometimes alleviate the potential need for restrictive land-use policies, and avoid the confrontational atmosphere often associated with listing.

We will close with pleas for common sense and action. Don't get caught up in peripheral issues that will not make a difference in terms of species conservation. Be sure your action will have a net beneficial effect on the BIG PICTURE. Try to implement species conservation goals and actions that are compatible with existing land-use practices and minimize conflicts with other resource users. We need as many allies as possible when important conservation decisions are made and actions taken. Talk to people who may have different views, not just those of like mind. Talk to the professionals and strive for objectivity and accuracy. Successful conservation of many species depends on our abilities to work together.

References

Meese, G. M. 1989. Saving endangered species: Implementing the Endangered Species Act. Pages 47–62 *in* G. Mackintosh, ed., In defense of wildlife: Preserving communities and corridors. Defenders of Wildl., Washington, D.C. 96 pp.

Noss, R. F. 1991. From endangered species to biodiversity. Pages 227–247 *in* K. A. Kohm, ed., Balancing on the brink of extinction: The Endangered Species Act and lessons for the future. Island Press, Washington, D.C. 318 pp.

Reffalt, W. 1991. The endangered species lists: Chronicles of extinction? Pages 77–85 *in* K. A. Kohm, ed., Balancing on the brink of extinction: The Endangered Species Act and lessons for the future. Island Press, Washington, D.C. 318 pp.

Rohlf, D. J. 1991. Six biological reasons why the Endangered Species Act doesn't work—And what to do about it. Conserv. Biol. 5: 273–282.

Salwasser, H. 1991. In search of an ecosystem approach to endangered species conservation. Pages 247–265 *in* K. A. Kohm, ed., Balancing on the brink of extinction: The Endangered Species Act and lessons for the future. Island Press, Washington, D.C. 318 pp.

Salwasser, H., C. Schonewald-Cox and R. Baker. 1987. The role of interagency cooperation in managing for viable populations. Pages 159–173 *in* M. E. Soule, ed., Viable populations for conservation. Cambridge Univ. Press. 189 pp.

Scott, J. M., B. Csuti, K. Smith, E. Estes and S. Caicco. 1991. Gap analysis of species richness and vegetation cover: An integrated biodiversity conservation strategy. Pages 282–298 *in* K. A. Kohm, ed., Balancing on the brink of extinction: The Endangered Species Act and lessons for the future. Island Press, Washington, D.C. 318 pp.

Tear, T. H., J. M. Scott, P. H. Hayward and B. Griffith. 1993. Status and prospects for success of the Endangered Species Act: A look at recovery plans. Science 262: 976–977.

U.S. Fish and Wildlife Service. 1994. Box score: Listings and recovery plans. Endangered Species Tech. Bull. 19(5): 20.

Conservation Agreements: Innovative Solutions or Missed Opportunities—A Corporate Lands Perspective

William A. Wall
Potlatch Corporation
Lewiston, Idaho

The significant problems we face cannot be solved at the same level of thinking we were at when we created them.

Albert Einstein

Introduction

Given the recent changes in our national political makeup, the current status of the Endangered Species Act (ESA) is tenuous. The majority of the United States citizens agree with the goals of ESA, but many fear the regulatory process which has evolved with implementation. Many important natural resource decisions now are relegated to the courts rather than natural resource professionals. During the evolution of the implementation of ESA, regulatory approaches altered the path of including or even encouraging people and institutions to be involved with conserving wildlife species. The current regulatory process is perceived by many in the private sector to be command and control rather than collaboration.

This paper: (1) explores opportunities and capabilities of private forest product companies' management of candidate species; (2) describes corporate concerns and needs for conservation agreements; (3) suggests adjustments in the administrative framework of conservation agreements; (4) addresses the need for philosophical changes for both agencies and industry. The opinion expressed are the author's.

Background

In a news release from U.S. Fish and Wildlife Service (USFWS) dated June 14, 1994, Secretary of the Interior, Bruce Babbitt, announced a series of new policies. The goal is to make the administration of the ESA more effective in the recovery process and enhance flexibility for business and private landowners (Parham et al. 1994). These policies focus on the creation of flexible approaches to maintain species viability. One of these approaches includes cooperative, ecosystem-based agreements to conserve listed and candidate species before crises arise.

The Idaho field office of USFSW, in cooperation with Idaho Fish and Game, Bureau of Land Management (BLM), and USDA Forest Service (USFS), has lead the way in development of administrative procedures for the creation of 29 conservation agreements in the state of Idaho. These efforts currently are evolving. The approach, not the concept, is being met with resistance from the private sector as well as from state legislators.

Industrial Forest Lands—Opportunities/Capabilities

Approximately two-thirds of the nation's lands are in private ownership. Non-industrial private owners account for 57 percent of the nation's 483 million acres of commercial forest lands, the USFS comprises 18 percent, other publicly owned forestlands about 10 percent and the forest industry owns 15 percent, or 72.5 million acres (National Hardwood Lumber Association 1992). These large industrial land holdings offer special opportunities for development of conservation agreements.

Over the past 20 years, many forest products companies have dramatically increased the number of wildlife professionals employed for research and management programs. In addition, many large land-managing companies have developed sophisticated GIS capability, assessing their managed acreage with detailed inventories of vegetation, geomorphology, roads, streams, soils and satellite imagery. These databases are kept accurate and current. Utilizing GIS technology, several forest products companies have initiated programs to develop landscape-planning and ecosystem-management approaches. Each company is treating these management programs as experiments with testable hypotheses for the maintenance of species viability and functioning riparian and aquatic systems. These approaches require large-scale species and watershed monitoring programs that demand significant corporate resources. The need, however, exists to develop manipulative experiments at multiple landscape scales to test many of the current assumptions developed under the context of conservation biology theory. Landscape experiments would generate greater predictive power for dynamics of habitat alterations and viability of rare species (Walter and Hollin 1990).

Currently, some industry programs developed with other private, federal or state partners facilitate species monitoring at several spatial scales simultaneously. For example, the Western Wood Products Division of Potlatch Corporation in northcentral Idaho has developed and is implementing a unique landscape planning process. The planning process is based on precise stand level information and aggregates of three spatial scales, including subbasin (2–5 thousand acres), landscape management unit (10–60 thousand acres) and Potlatch mixed ownership operating area (2.2 million acres). The process incorporates a coarse-filter approach for species diversity and a fine-filter approach for sensitive species and watershed analysis for stream and riparian habitats. This process, based on current landscape conditions and ecological capability, also creates 80-year projections for landscape plans. Wildlife and watershed monitoring serves as an adaptive feedback loop to improve the process. Several other corporations are developing similar programs.

Linkage of similar programs through compatible ecological classification schemes and monitoring protocols would increase understanding of the dynamics of ecosystems. One cooperative approach being developed is the monitoring partnership between Region 1 of the USFS (specifically the Clearwater and Nez Perce National Forests), Potlatch Cooperation and U.S. Fish and Wildlife Foundation. One of the objectives of this partnership is to monitor breeding landbirds at three scales: stands (50+ acres), landscapes (30 thousand acres) and across the mixed ownerships of northcentral Idaho. A second objective is to determine habitat associations, relative abundance, and forest management effects at the stand and landscape scales. It is hoped that this effort will expand to be linked with another compatible partnership being developed between Boise Cascade Corporation and Payette/Boise National

Forests in southcentral Idaho. These sorts of efforts are exemplary and could be used in conjunction with conservation agreements.

Industrial Forest Management—Needs and Concerns

True partnerships cannot evolve with private corporations unless their fiduciary goals as publicly owned entities are met. A regulatory approach is perceived as threatening. Thus, tremendous efforts are made by corporations to resist increased and costly regulation. There are several basic needs which drive corporations' willingness to develop partnerships on private industrial lands. These needs include: (1) reasonable risks for major investments; (2) competitiveness—the market is the driver; (3) management flexibility; (4) ownership in the development process by all participants; and (5) voluntary participation.

Assuring reasonable risk is a basic requirement for any profit-oriented organization, especially one that invests capital for long term in forests. Corporations which invest in monitoring efforts, habitat restoration or maintenance of habitat run the risk of willingly inviting or increasing candidate species on their lands. If the species is listed in the future, the perception is that no guarantee currently is provided to the landowner that its conservation efforts will not result in extensive land-management restrictions. This is a major barrier which must be removed if we are to take advantage of the partnership opportunities.

A basic principle in our market-driven economy is competition. If implementing landscape planning or signing a conservation agreement puts a company at a competitive disadvantage, there must be incentives which are advantageous. Several companies have stated goals to be industry leaders in environmental sensitivity. However, an understood caveat is to maintain a competitive cost structure. For example, the market has yet to recognize increased production costs for "green" lumber.

Management flexibility is essential for a corporation. The perception exists that specific land-management prescriptions developed in a conservation strategy for public lands will have a direct effect on private lands when interpreted by the courts. Once official prescriptions are written, the concern is that they set the standard and anything else must be proven successful before it can be implemented. Specific prescriptions and methods should be developed with a corporation, not for them. A collaborative approach builds ownership in the process rather than resentment and resistance.

Administrative Changes

Under the current approach, two primary documents are developed leading to a conservation agreement. First, a conservation assessment outlines the species' life history, habitat requirements, distribution and current status. Second, a conservation strategy outlines the threats to the species, goals for conservation and specific land-management prescriptions for removal of threats. The conservation strategy leads directly to an agreement that simply states each party's responsibility. The weak point of the process results from the prescriptive nature of the conservation strategy. When corporations are involved in agreements and a candidate species simultaneously progresses though the listing process, then the perception is that the specific prescriptions of the conservation strategy will become the guidance of "no-take" standards on private lands. This perception significantly reduces the willingness of corporations to support the conservation agreement process.

There are two changes which would reduce the reluctance to participate in conservation agreements. First, the conservation assessment and the conservation strategy should state: (1) current demonstrated knowledge about the species; (2) clearly identified assumptions; and (3) specific research needs. Clearly stating the difference between knowledge and assumption relieves the fear that bias for specific land-management approaches will drive the agreement process. A flexible approach would be to develop a conservation strategy which describes threats, goals for dealing with those threats (including building support from private landowners) and methods for adaptive management. Specifics of prescriptions should be left to the conservation agreement. The agreement then becomes a collaborative process with the public or private land-management institutions and affected parties. Specific approaches for conservation would reflect differences in land-management objectives and responsibilities for both public and private lands.

In addition, some guarantees must be made through the prelisting conservation agreement in the event of future listing. If a corporation follows their conservation agreement faithfully and the species still is listed, then provisions agreed to in the conservation agreement should carry through to habitat conservation planning or "no-take" agreement. This will give greater incentive to work to keep the species off the list and will give a level of regulatory certainty to the corporation.

Philosophical Changes

The intent of conservation agreements is to build formalized, voluntary support for the conservation of candidate species through innovative partnerships. The first step to building a good partnership is to create an atmosphere of trust and full participation in the development of the agreements. This starts with communication. Just as communication barriers exist between generations and world cultures, barriers exist between regulatory biologists and production-oriented forest products companies. To build support for this innovative process, much greater communication must be established.

The past ten years have brought many needed philosophical changes in the approach to wildlife and watershed management within the forest products industry. Industry has begun to recognize that the public, which gives them license to conduct business, is requiring greater accountability for resources other than wood fiber. At the same time, there is a natural resistance to inflexible and costly regulation imposed by government.

Ecosystem approaches are in their infancy, and many concerns exist about a regulated ecosystem approach. However, industry has tremendous capability to help lead the way in moving to ecosystem perspectives for management. An excellent approach is through landscape-management demonstrations and partnerships. These efforts then would demonstrate to the industry, agencies and the public an appropriate role for industry in maintenance of species viability and ecosystem dynamics within appropriate economic constraints. Industry must hold itself accountable.

The USFWS has an opportunity to help facilitate the growth of industry's new approaches by changing the agency's philosophy from strictly regulatory to a problem-solving approach. Conservation agreements can be an excellent vehicle. Many barriers have been created historically by lack of effective communication and outside participation during ESA implementation. USFWS field employees need to be empowered to create innovative solutions rather than simply following a dictated regulatory process. A major perception by industry is that the agency and advocate groups use the regulatory authority of ESA to impose their values for land management rather than seeking solutions for the affected species and landowners. The agency must create internal accountability which directs employees to create solutions.

Conclusions

In 1940, at the Fifth North American Wildlife Conference, Aldo Leopold (1941) made the following comments regarding partnership approaches described in 1930: "One of the fundamental things laid down in the American Game Policy was the recommendation that no sound scheme in the farmer-sportsman relationship was at all likely to be evolved in the brain of a planner, that these were human institutions that had to evolve in history and not in somebody's mind. The American Game policy ended up with a recommendation which I may briefly state in this way: 'Try as many schemes as possible and see how they work'. . . . I hope to have in print the complete history of that area, including not only the story of what I consider its present success, but more particularly the story of its many false starts, its mistakes, its false assumptions."

Four years earlier, in 1936, Leopold (1991) essentially described the essence of conservation agreements in an essay titled "Threatened Species." He called for a joint committee of stakeholders to inventory and define management needs of sensitive species and suggested that the people with vested interest should be made custodians (Bullock and Wall 1995).

Perhaps Leopold was saying the best approach is to have voluntary participants empowered with flexible approaches rather than coerced and reluctant participants who do the bare minimum as dictated through a regulatory process. The conservation agreement strategy is an innovative, solution-oriented approach. Its time is long overdue. Dedicated professionals within Idaho agencies who have worked hard to initiate this effort deserve our thanks. The process is new and has been initiated in an environment of concern generated from a regulatory and confrontational ESA process. However, there is an opportunity to enlist corporate partners with their tremendous potential to support the process of conservation agreements. This effort deserves the chance to evolve as a human institution into a process which encourages people and corporations to be involved in conservation of rare species and sustainable ecosystems.

References

Bullock, J. F. and W. A. Wall. 1995. Proactive endangered species management: A partnership paradigm. Trans. No. Amer. Wildl. and Natur. Resour. Conf. Current volume.

Leopold, A. 1941. Recorded comments. Trans. No. Amer. Wildl. Conf. 5: 77–78.

———. 1991. Threatened species. Pages 230–234 *in* S. L. Flader and J. B. Callicut, eds., The River of God and other essays by Aldo Leopold. Univ. Wisconsin Press, Madison. 384 pp.

Parham, G., F. Fisher, V. M. Boatwright and D. M. Hawkins. 1994. News release. U.S. Fish and Wildl. Serv., Atlanta, GA. 5 pp.

National Hardwood Lumber Association. 1992. Forest resource fact book. Nat. Hardwood Lumber Assoc., Memphis, TN. 19 pp.

Walter, C. J. and C. S. Hollin. 1990. Large-scale management experiments and learning by doing. Ecology 71: 2,060–2,068.

Is Triage Necessary with Ecosystem Management: The Longleaf Pine Example

Dennis L. Krusac
USDA Forest Service
Atlanta, Georgia

Introduction

Triage, in the most basic sense, is setting treatment priorities based on need. It appears, in many cases, that threatened and endangered species management priorities are not based solely on need, but on marketability, public support or controversy. It is critical to acknowledge the importance of public support and marketing, because without public support, these programs would not exist. However, there must be a balance between managing for marketability of the program and managing those species truly in need. In 1991, seven species (1.1 percent of the listed species) accounted for 51.5 percent of threatened and endangered species expenditures by federal and state agencies. Fifty-one species (7.9 percent of the listed species) accounted for more than 90 percent of total threatened and endangered species expenditures (U.S. Fish and Wildlife Service 1992). An ecosystem management approach may provide the needed balance.

The USDA Forest Service recently completed a red-cockaded woodpecker (*Picoides borealis*) recovery strategy for southern national forests based on managing southern pine ecosystems, rather than the endangered species itself (Krusac and Dabney 1994, Krusac et al. 1994). The red-cockaded woodpecker (RCW) is most closely associated with longleaf pine (*Pinus palustris*) ecosystems, which historically dominated between 60 and 80 million acres (24.3 and 32.4 million ha) of the southeastern coastal plain region (Wahlenberg 1946, Croker 1987). Today, less than 4 million acres (1.6 million ha) of the original longleaf pine type remain as second-growth forests (Landers et al. 1989, Kelley and Bechtold 1990).

The RCW has received considerable management attention in the past, as evidenced by it ranking fifth in total endangered species expenditures in 1991, with more than $7 million spent by federal and state agencies (U.S. Fish and Wildlife Service 1992). Even with all the past management, most RCW populations still are declining. Most management activity concentrated on protecting individuals and their immediate habitat, which, at best, can maintain current conditions. There are 125 other threatened, endangered or sensitive (TES) species occurring in longleaf pine ecosystems that have received significantly less attention, even though some species appear to be more at risk than the RCW. Using a triage approach to set priorities for these species would be time consuming and expensive. An ecosystem approach using the following process may be more effective for managing threatened, endangered or sensitive species.

The Process

The following process could serve as the foundation for developing an ecosystem management strategy for any ecosystem.

Other Threatened, Endangered or Sensitive Species

The first step in the process is to identify all TES species that occur or are likely to occur in the ecosystem, or species known not to occur but for which suitable habitat exists. In the longleaf pine ecosystem, an example of the last category would be the Florida panther (*Felis concolor coryi*). There are 126 TES species associated with longleaf pine, including 78 plants, 10 mammals, 7 birds, 13 reptiles, 6 amphibians, 11 insects and 1 arachnid. Of these 126 TES species, 24 species are listed and 58 species are candidates for listing (U.S. Fish and Wildlife Service 1993, 1994a, 1994b).

Species Associations

The next step in the process is to analyze species associations and the knowledge of habitat needs and management of these species. This step will narrow the scope of further analysis. Establishing species associations should identify some keystone species. In longleaf pine ecosystems, the gopher tortoise (*Gopherus polyphemus*) and red-cockaded woodpecker are examples. Associated with tortoise burrows are 14 species that currently are listed or are candidates for listing. None of these 14 species or the gopher tortoise is known to have increasing populations (U.S. Fish and Wildlife Service 1994b). Little is known about the four species of tortoise commensal scarab beetles or the two species of tortoise commensal noctuid moths. Should limited endangered species funding be used to obtain more knowledge of their biology? I would say no even though these species may rank high if triage was applied. These species are associated with gopher tortoise and any management to benefit the tortoise should benefit these species. The final process of this step is to identify the species or small group of species for further analysis. The species should be a good indicator of ecosystem health, respond readily to management, have a large geographic range and be easy to monitor. It does not have to be a species that would rank high with a triage approach. Our analysis was based on the RCW, which I would not rank high with a triage approach because of its extensive distribution and existing populations. Once a species or group of species has been selected, determine primary causes of population declines. Analyze past management to determine what worked and what did not.

Natural Vegetation and Disturbance Processes

One of the most critical steps is to identify what the natural vegetation was and what the historical disturbance processes were. Understanding natural processes is important to maintain and/or restore natural ecological systems and viability of species and communities associated with these systems. Control of fire and other alterations of natural processes have influenced the structure, function and composition of most ecosystems (Samson 1992). Suppression of fire in ecosystems dominated by fire-adapted species can severely disrupt ecosystem processes that have implications for the conservation of native fire-tolerant species (Christensen 1977, Hobbs and Huenneke 1992).

As previously stated, the original longleaf pine forest consisted of 60 to 80 million acres (24.3 to 32.4 million ha) along the Atlantic and Gulf Coastal Plains. Many of the descriptions of the original longleaf pine forest create images of an all-aged landscape composed of even-aged stands ranging in size from a few hundred square feet to many acres, with an irregularly open canopy (Schwarz 1907, Chapman 1909, Wahlenberg

1946). Less than 4 million acres (1.6 million ha) of longleaf pine forest exist today. Much of this remaining forest has been managed in a manner that created a more uniform stand structure and more closed canopy condition than existed historically.

In longleaf pine ecosystems, fire control and changes in fire frequency and intensity has drastically altered natural vegetation and disturbance regimes. The total extent of fire in the southeastern United States has decreased almost 95 percent in the past 50 years (Simard and Main 1987). The effects of changes in disturbance regimes are evidenced by the number of fire-adapted plant species that are listed or are candidates for listing. Fire control and changes in disturbance regimes have affected entire plant and animal communities.

Management Recommendations

The final step is to synthesize the information gathered into management recommendations. Recommendations can be categorized either as ecological management elements or intensive management. Ecological elements are designed to create habitat conditions across the landscape for population expansion of numerous TES species and restore the ecosystem to the degree practicable. Intensive management may be necessary to reverse downward population trends and overcome the effects of past management. Both elements are critical. If we concentrate solely on the individuals, recovery may be impossible. If we concentrate solely on the ecosystems involved, the species may go extinct before the systems are functional and return to their natural state, or as close as we can get to natural.

Margules et al. (1988) and Sanders et al. (1991), when discussing managing for biodiversity in an already fragmented system, state that the first step in management must be the determination of the minimum subset of existing remnants required to represent the diversity of a given area. Habitat management areas (HMAs) were delineated for RCWs as the first step in the process and represent a landscape-scale management strategy. Within HMAs, approximately 1 million acres (0.4 million ha) will be managed for longleaf pine forests. To achieve this objective, longleaf pine restoration must occur. Restoration will include harvesting existing off-site pine species and planting longleaf seedlings. Within HMAs, timber rotations will be extended to provide for large trees and a full range of vegetation management techniques will be used to create the desired stand structure and composition. Most importantly, a prescribed fire regime with burning frequency of every three to five years, with emphasis on growing season burns, will be introduced to mimic the natural disturbance processes (Chapman 1932, Heyward 1937, Komarek 1964, 1974). The above management recommendations are ecological elements in that they create conditions across the landscape to benefit numerous TES species.

Intensive management elements are those targeted at individual species to overcome some existing condition. In the case of the RCW, artificial cavity construction and translocation of juvenile birds are examples of intensive management. Artificial cavities provide nesting and roosting sites in trees that may not be old enough to allow natural cavity construction. Translocation creates potential breeding pairs and is used to help overcome demographic isolation. Intensive management also is occurring with some plant species. At the Francis Marion National Forest seed orchard, two endangered plants are being propagated for outplanting in existing populations or are being used to create new populations in suitable habitat.

Summary

Continuation of a triage approach to set threatened and endangered species management priorities will continue to hamper our ability to recover numerous species. Currently, less than 2 percent of the listed species are accounting for more than 50 percent of the total expenditures. A process is described that could serve as the foundation for recovery through ecosystem management. The process includes identifying all TES species in the ecosystem, analyzing species associations, identifying the natural vegetation and disturbance regimes, and developing management recommendations based on this information. A landscape-scale approach to TES species conservation should provide more benefits that using a triage approach.

References

Chapman, H. H. 1932. Is the longleaf type a climax? Ecology 13: 328–334.

Christensen, N. L. 1977. Fire regimes in southeastern ecosystems. Pages 112–136 *in* Fire regimes and ecosystem properties. USDA For. Serv. Gen. Tech. Rept. WO–26.t al.

Croker, T. C. 1987. Longleaf pine: A history of man and a forest. USDA For. Serv. Rept. R8–FR7. 37 pp.

Heyward, F. 1939. The relation of fire to stand composition in longleaf pine forests. Ecology 20: 287–304.

Hobbs, R. J. and L. F. Huenneke. 1992. Disturbance, diversity, and invasion: Implications for conservation. Conserv. Biol. 6:324–337.

Kelley, J. F. and W. A. Bechtold. 1990. The longleaf pine resource. Pages 11–22 *in* Proceedings of the symposium on the management of longleaf pine. USDA For. Serv. Gen. Tech. Rept. SO–75.

Komarek, E. V. 1964. The natural history of lightning. Proc. Tall Timbers Fire Ecol. Conf. 3: 139–183.

———. 1974. Effects of fire on temperate forests and related ecosystems: Southeastern United States. Pages 251–277 *in* C. E. Ahlgren and T. T. Kozlowski, eds., Fire and ecosystems. Academic Press, New York, NY.

Krusac, D. L. and J. M. Dabney. 1994. Red-cockaded woodpecker recovery: An ecological approach to managing biological diversity. Trans. No. Amer. Wildl. and Natur. Resourc. Conf. 59: 386–394.

Krusac, D. L., J. M. Dabney and J. J. Petrick. 1995. An ecological approach to managing southern national forests for red-cockaded woodpecker recovery. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 48: in press.

Landers, J. L., N. A. Bryd and R. Komarek. 1989. A holistic approach to managing longleaf pine communities. Pages 135–167 *in* Proc. of the symposium of the management of longleaf pine. USDA For. Serv. Gen. Tech. Rept. SO–75.

Margules, C. R., A. O. Nicholls and R. L. Pressey. 1988. Selecting networks of reserves to maximize biological diversity. Biol. Conserv. 43: 63–76.

Samson, F. B. 1992. Conserving biological diversity in sustainable ecological systems. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 57: 308–320.

Saunders, D. A., R. J. Hobbs and C. R. Margules. 1991. Biological consequences of ecosystem fragmentation: A review. Conserv. Biol. 5: 18–32.

Schwarz, G. F. 1907. The longleaf pine in virgin forests. John Wiley and Sons, New York, NY. 135 pp.

Simard, A. J. and W. A. Main. 1987. Global climate change: The potential for changes in wildland fire activity in the southeast. Pages 280–308 *in* M. Meo, ed., Proceeding of the symposium on climate change in the southern United States: Future impacts and present policy issues. Univ. Oklahoma, Norman.

U.S. Fish and Wildlife Service. 1992. Federal and state endangered species expenditures fiscal year 1991. U.S. Govt. Print. Off., Washington, D.C. 39 pp.

———. 1993. Endangered and threatened wildlife and plants; Plant candidate review for listing as endangered or threatened Species, proposed rule. Fed. Reg. 58: 51,144–51,190.

———. 1994a. Endangered and threatened wildlife and plants. U.S. Govt. Print. Off. 42 pp.

———. 1994b. Endangered and threatened wildlife and plants; Animal candidate review for listing as endangered or threatened Species, proposed rule. Fed. Reg. 59: 58,982–59,028.

Wahlenberg, W. G. 1946. Longleaf pine: Its use, ecology, regeneration, protection, growth, and management. Charles Lathrop Pack Forest. Found., Washington, D.C. 429 pp.

Contracting for Recovery of Endangered Species

Gregory T. M. Schildwachter
Boone and Crockett Wildlife Conservation Program
University of Montana
Missoula

This paper considers the possibilities of using contracts to aid in recovering endangered species. Recovery is a service, therefore, we may be able to arrange its delivery through recovery firms. For example, recovery might be arranged by contracts similar to those in a franchise arrangement (Davis 1995). In this scenario, the U.S. Fish and Wildlife Service (USFWS) would sell permits for conducting reintroduction projects. Firms who qualify to purchase these permits then would sell services like reintroduction to private-citizen conservationists.

Some contracts already are familiar in conservation (e.g., Conservation Reserve Program contracts and conservation easements), so I analyzed these and others to identify the general considerations in contracting. I employed a transaction cost/contracting analysis (Coase 1988, Allen 1991) which essentially dissected contractual agreements into their basic terms and identified some key terms on which potential traders must agree (Schildwachter 1994a). The key terms, or components, of these contracts were: (1) the parties involved; (2) the "good" purchased; (3) the extent to which the good is defined; (4) the method by which the good is measured; and (5) the timing of payment and delivery. Goods usually have multiple attributes, each of which can be valued differently by different people. For example, cropland is valuable as a place both to control erosion and to raise crops. To a conservationist attempting to control erosion, soil stability is the valuable attribute of land. This attribute can be defined more or less specifically; for example, stable soil can be defined by assessing turbidity of runoff either visually or by measuring milligram per liter of suspended solids. Specific definitions generally provide more certainty in the outcome of exchange and also cost more to establish. The concept of attributes and the extent to which they are defined is central to transaction cost/contracting analysis.

By documenting the key terms in some familiar examples of contracts for conservation (identified in the text), I identified considerations likely to arise in contracting for recovery of endangered species. All conservation organizations contracted both with their customers and with landowners who provided land for the conservation project. Considerations that arose are explained below. These are: (1) choosing surrogate attributes; (2) agreeing to general measures of attributes; (3) accounting for risk of uncontrollable ecosystem events; and (4) controlling the cost of multiple contracts. A final consideration is the need for a tradable property right that, when sold, promotes recovery.

Surrogate Attributes

The Conservation Reserve Program (CRP) of the U.S. Department of Agriculture (USDA) and the Adopt-A-Pothole program (AAP) of Delta Waterfowl Foundation (DWF) illustrate how the end purpose of an exchange can be attained by purchasing a surrogate attribute. The purposes of CRP and AAP are to stabilize soil and increase waterfowl reproduction, respectively. Neither of these ends, however, is measured in the contracts with landowners. Instead, both USDA and DWF document the establishment of vegetation appropriate to their desired end. USDA requires landowners to demonstrate the establishment of soil-retaining vegetation. DWF requires landowners to demonstrate establishment of grasses conducive to waterfowl nesting. These contracts are cheaper to execute by observing vegetation than by measuring successful nesting or turbidity in runoff.

General Measures of Attributes

The value of land for recovery is its capacity to support endangered species. This attribute is best measured by assessing the viability of the target population. Analyzing populations is expensive, but this cost can be controlled by agreeing to use general measurements in the contract. For example, DWF measures recruitment in order to satisfy its contributors. The contract between DWF and its contributors is based on the capacity of land to produce waterfowl, as measured by aerial surveys for ducklings. Reports to contributors admit that "waterfowl surveying is not an exact science" (Delta Waterfowl Foundation 1992), but this general measure of the waterfowl-production attribute apparently suffices.

Using inexact science is a strategy for controlling measurement costs. I classified the extent to which existence of species can be measured as macro-, meso- or micro-level. The cheapest and least informative is macro-analysis: this level includes surveys which tell only that the species presently exists. Of greater expense and greater value is meso-analysis, which describes environmental conditions such as habitat quality and interspecific interactions. The most expensive and most informative level is micro: this level entails measurements of populations. Population analyses range in complexity from parameter estimates (e.g., recruitment) to viability assessments (e.g., minimum viable population size). Improvements in technology, of course, could reduce the scale of measurement costs across all levels.

Accounting for Risk of Uncontrollable Ecosystem Events

Management efforts do not always produce desired results, which poses a risk that investments may be lost. A landowner who executes his or her contractual responsibilities will want compensation even if a random event, such as a hurricane, destroys the conservation value of the project. To solve this, traders might specify performance as the basis for the contract. An example of how this could be done is found in the Ranching for Wildlife (RFW) program of the Colorado Division of Wildlife (CDW). Landowners who demonstrate acceptable management of their property are sold allotments of big game hunting tags that they can retail to private hunters. In this arrangement, CDW acts as a franchiser by requiring specified performance from landowners, the franchisees, who purchase rights to conduct business. Just as restaurateurs can purchase the rights to offer patented menus when they follow marketing guidelines from the parent corporation, so landowners can purchase the rights to big game hunting when they follow guidelines of professional wildlife management.

Not only does this arrangement account for unforeseen ecosystem events, it could offer a public agency supervisory control over rights to manage protected species. A trust agency, acting as a franchiser, could hold the franchisee to high professional standards before selling rights to handle rare species. The franchisees, having demonstrated competence, could purchase the right to handle an endangered species and sell their services as reintroduction specialists to anyone who wants to promote recovery.

Controlling the Cost of Multiple Contracts

The Nature Conservancy (TNC) has shown how to control the costs of conserving wildlife and other natural resources across many private holdings. TNC chooses a means of contracting with landowners according to the importance of the private holding to TNC's mission of protecting biodiversity. Importance is decided from a geographic database on rare and endangered animals, plants and ''natural communities,'' classified by occurrence in the world and within local areas of interest (Hill 1988: 4, Koeln et al. 1991). Upon discovering an area likely to be altered unfavorably, TNC will negotiate a contract from one of three types depending on the importance of protection. These contracts include hand-shake agreements, transfers of limited interests (e.g., conservation easements) and fee-simple acquisitions. Hoose (1981) presents a comprehensive review of these types of contracts.

New Property Rights

In order to trade, parties must hold and transfer property rights. For example, when TNC negotiates a conservation easement, it receives from a landowner some portion of his or her legal claims (e.g., the right to control access or build structures, roads, etc.). Similarly, a recovery firm would need to purchase a property right to handle endangered species. This right was established by the Endangered Species Act (ESA), which authorizes only federal agents conducting recovery activities to pursue and capture individuals of an endangered species. For anyone else to undertake these activities is to ''harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect'' [ESA §3(18)]. In amendments to ESA [§10], conditions were described under which violations of the federal property right would be allowed. In other words, the right to affect endangered species adversely was made transferable.

The Red Wolf Recovery Program (RWRP) of the U.S. Fish and Wildlife Service is one of the programs that has used the amendments of the ESA to transfer a right for incidental taking. When planning the reintroduction of red wolves to coastal North Carolina, RWRP personnel concentrated their efforts on engendering support for the project (Moore and Smith 1991, Schildwachter 1994b). They learned that local communities highly valued their traditional access to hunting and trapping opportunities in what was to become the reintroduction area. RWRP decided that permitting access to the area would not adversely affect the wolves any more than the activities of the recovery program personnel themselves. Special less-restrictive prohibitions on human activities in the project area were written under authority of ESA that forgave incidental harm to red wolves when the incident was reported immediately (Parker and Phillips 1991). The experimental status proscribed by the special regulations transferred from RWRP to recreationists the legal right to trap reintroduced red wolves accidentally.

The existing property right authorizes incidental harm; new property rights could authorize intentional benefit. Already, there are private initiatives to enhance recovery efforts with private funds. Defenders of Wildlife (DOW) pays landowners in western Montana $5,000 when grey wolves (*Canis lupus*) den and reproduce on private property. DOW draws these payments from a fund of contributions. In arranging this exchange, DOW recognizes that although a landowner does not have the legal right to disrupt a den, he or she does have the necessary control over the den to do so. With a new property right that authorizes private recovery, DOW could employ biologists to reintroduce endangered species and conduct other recovery projects.

Conclusions

The difference between the force driving conservation and the strategy for delivering it must be clear before we consider the relative merits of contracting for recovery. Contracting works only when customers hire recovery firms and remain satisfied with the service and the price. A similar test of satisfaction is run by citizens supporting public conservation. Although public and private delivery may differ in efficiency, neither will produce more conservation than people are willing to support. In short, the question of how to supply conservation is secondary to the question of how much conservation people want. In the current debate over how to supply conservation, few have considered the possibility of supplying conservation services such as recovery of endangered species through voluntary agreements (i.e., contracts). Contracting for recovery would require customers, agents and landowners to overcome the costs of measuring recovery, managing numerous contracts, protecting themselves from variations in ecosystems and creating legal ownership that enables trade. If successful, contracting for recovery would bring additional land, labor and expertise into averting extinction.

References

Allen, D. W. 1991. What are transaction costs? Res. Law and Econ. 14: 1–18.

Coase, R. H. 1988. The firm, the market, and the law. Univ. Chicago Press, Chicago, IL.

Davis, R. K. 1995. A new paradigm in wildlife conservation: Using markets to produce big game hunting. Pages 109–125 *in* T. L. Anderson and P. J. Hill, eds., Wildlife in the marketplace. Rowman and Littlefield Publ., Inc., Lanham, MD.

Delta Waterfowl Foundation. 1992. Adopt a pothole summer report. August 1992. Delta Waterfowl and Wetlands Res. Sta., Deerfield, IL.

Hill, R. A. 1988. Imagined pond. Maine Legacy, Newsletter of the Maine Chapt. of The Nature Conserv. February: 1, 4–6.

Hoose, P. M. 1981. Building an ark: Tools for the preservation of natural diversity through land protection. Island Press, Covelo, CA.

Koeln, G. T., S. Konrad and D. Muchoney. 1991. Generating information for fish and wildlife management: Summary from the private sector. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 56: 113–117.

Moore, D. E. III and R. Smith. 1991. The red wolf as a model for carnivore re-introductions. *In* J. H. W. Gipps, ed., Beyond captive breeding. Symp. Zool. Soc., London 62: 263–278.

Parker, W. T. and M. K. Phillips. 1991. Application of the experimental population designation to recovery of red wolves. Wildl. Soc. Bull. 19(1): 73–79.

Schildwachter, G. T. M. 1994a. Contracting for endangered species recovery. Boone and Crockett Wildl. Conserv. Prog. Work. Paper, WP 94–8. School of Forestry, Univ. Montana, Missoula.

———. 1994b. The pilot-reintroduction of red wolves in Great Smoky Mountains National Park. M.S. thesis, Univ. Tennessee, Knoxville.

Moving Endangered Species Management from Conflict to Cooperation

Whitney Tilt
National Fish and Wildlife Foundation
Washington, D.C.

Introduction

The lie detector has been used in one form or another for thousands of years. In ancient Mesopotamia, suspected thieves entered a darkened shed where they were directed to grab the tail of a donkey, who, they were told, would bray if they were guilty. Those with nothing to hide grabbed the tail. Those who were not so pure of heart used the darkness to conceal their failure to touch the donkey's tail. Unbeknownst to the suspects, the donkey's tail was coated in lamp black. On exiting the shed, the innocent had dirty hands, while those with something to hide held out clean ones.

This ancient form of lie detection would fail today due to the speed of communications (not to mention protests from the animal rights folks about the abuse of donkeys). Society, however, still uses the clean and dirty hands metaphor when discussing personal responsibility. Direct involvement in a task often is referred to as "getting your hands dirty," while clean hands denote a remoteness from the task and lack of investment in the outcome. This clean (and guilty) hands versus dirty (and innocent) hands metaphor is a useful one for the following discussion on endangered species management. It also is an appropriate metaphor for the concept of "triage" and endangered species conservation priorities.

The Endangered Species Act (ESA), keystone of the nation's effort to conserve its biological diversity, is confronting an uncertain future as it faces reauthorization in 1995. Opponents of the ESA charge that the Act has a history of trampling private property rights and wreaking havoc on local economies in its pursuit to preserve obscure species like the Bruneau hot springsnail (*Pyrgulopsis bruneauensis*) or the Delhi Sands flower-loving fly (*Rhaphiomidas terminatus abdominalis*). Proponents of the ESA acknowledge that, for the first time, reauthorization of the Act faces a stiff challenge.

Unfortunately for the ESA and the U.S. Fish and Wildlife Service (FWS)—as lead responsible agency—the goal posts of public opinion are not crossed merely by accumulating listing (more than 830 animals) and recovery plan statistics (more than 500). What counts are results, or at least the perception of progress toward stated goals. This paper seeks to demonstrate that the ESA, while not fatally flawed, is a bio-political instrument in need of greater flexibility, less central command and control, and increased results and accountability. The ESA is a regulatory program in need of practitioners who have a greater sensitivity to the human element in all endangered species disputes. It is here that the concept of "triage" comes into play.

Triage and Endangered Species

Triage arose on the front lines of World War I where field hospitals queued casualties both by seriousness of the wounds and the chances for medical success.

Rather than commit limited resources in an attempt to save patients beyond their medical capabilities, triage directed front-line resources to those patients whose injuries were treatable. These decisions were not reached after a public hearing, draft rule-making, 90-day comment period or discussions with headquarters; they were made immediately.

Battlefield triage, as a concept for endangered species management, is not entirely practical. While the status of endangered species is dire, decisions about their treatment must respond to scientific and public process determinations. Still, like battlefield triage, endangered species recovery actions must take into account the realistic capabilities of any response, including available budget, staffing and executable techniques. In addition, prior to undertaking new recovery efforts, responsible agencies must be cognizant of the number of "patients" already under care along with the burden their "convalescence" places on available resources. A final aspect of triage useful in the endangered species context is the question of responsibility. In battlefield triage, the attending medical team is solely responsible for the patient. For endangered species, too often, treatment decisions are not made in the field but far removed in Washington, D.C. This paper will demonstrate that endangered species conservation is achieved best when the greatest amount of responsibility for that recovery is given to the field.

The Little Fish that Could

It is impossible to discuss perceptions of ESA without a look at *Percina tanasi*, the diminutive snail darter. In 1967, the Tennessee Valley Authority (TVA) began construction of the Tellico Dam on the Little Tennessee River which would dam the last significant free-flowing stretch of water in the region. Opposition to the dam was immediate, with opponents claiming loss of farmland, inundation of the Cherokee Indian Nation's most sacred religious site and loss of river recreational opportunities. The resulting tangle of lawsuits succeeded in delaying the project for years, but by 1973, the dam appeared destined to be built. The year also saw passage of the ESA, and discovery of the snail darter, thought only to reside within the area proposed to be inundated by Tellico. A number of Tennessee scientists, conservation groups and citizens petitioned to list the snail darter as an endangered species. Based on existing knowledge, as required by ESA, the species was listed as endangered in 1975 and critical habitat was designated (40 *Federal Register* 47506). FWS requested TVA halt construction and enter into interagency consultation to resolve the endangered species conflict. TVA responded that it would not discuss any option except completion of the dam.

Having lost on cultural and economic grounds, dam opponents now embraced the ESA and took TVA to court. The case found its way to the Supreme Court in 1977. Plater (1982) noted that the ESA "and its tiny protege [the snail darter] seemed to constitute a minor legal violation whimsically coincidental to the dam issue," but, since other more dam-related issues had failed to influence the TVA, the dam's opponents hoped that this little nondescript fish would give them the leverage to press the larger issues.

In *TVA v. Hill*, the Supreme Court found for the snail darter, even though the dam was 80-percent complete and more than $100 million already had been spent on its construction. The court made a number of findings, including that Congress intended endangered species to be afforded the highest of priorities, and that the ESA applied to all federal actions without exception, at whatever the cost (437 U.S. at 174). As a direct result of the court's decision, Congress amended the ESA in 1978, providing for the granting of exemptions to projects of regional or national significance where project benefits "clearly outweigh the benefits of alternative courses of action" (16 U.S.C. 1536, as amended). This review process was to be carried out by the Endangered Species Committee (ESC), a Cabinet-level committee nicknamed the "God Committee" because of its power over a species' existence. On January 23, 1979, the ESC unanimously denied an exemption for Tellico Dam on economic rather than ecological grounds. Concerning the ESC's decision, Chairman Cecil Andrus stated: "I hate to see the snail darter get the credit for stopping a project that was ill-conceived and uneconomic in the first place" (Plater 1982). Pork barrel politics in America, however, do not necessarily bend to the decisions of the Supreme Court and congressional-appointed ESCs. On June 18, 1979, a rider was attached to a public works appropriation bill which overrode all other decision and authorized the completion of Tellico Dam.

The snail darter continues to be an icon for endangered species management. Unfortunately, the actual events and outcomes of the case are poorly understood by environmentalists, policy makers and politicians alike. Too often, the case is viewed as one of a tiny, insignificant fish that threatened to stop a valuable public works project. In the course of the controversy, debate did not focus on the strong arguments against completion of the dam (i.e., TVA's own cost benefit analysis) or the loss of cultural and recreational benefits, but rather on the fish. Chairman Andrus' concern for the snail darter getting the credit for stopping what the *New York Times* (1980) termed a "costly boondoggle," was misplaced. The snail darter didn't get the credit, it got the blame.

This problem of perception not matching reality did not stop with the completion of Tellico Dam. It has been repeated consistently in other endangered species battles such as the northern spotted owl (*Strix occidentalis caurina*) in the Pacific Northwest and the golden-cheeked warbler (*Dendroica chrysoparia*) in Texas. Unfortunately, rather than recognizing the phenomenon and dealing with it, too many agency personnel have repeatedly ignored the snail darter's lessons and elected instead to stand fast by their data, deaf to public perception and politics. Such tenacity and dedication is, on one hand, admirable. On the other hand, an inflexible and rigid adherence to regulations promulgated under ESA can make enemies of potential allies, and cause ESA issues to become so polarized that resolution becomes impossible. When the "combat biologist" stands pat, in the name of conservation, on regulations that often are untested and inflexibly applied, that biologist is headed for a fall and, more importantly, so is the resource that the biologist is attempting to protect. A balance is needed. As one former FWS Deputy Regional Director often counseled, it is the job of the field offices to present the facts (as best they understand them) back to headquarters. The facts themselves should never get an employee in trouble. In return for this candor and competence, headquarters owes the field an explanation in those cases where the field office's recommendations are changed and/or overruled. Too often, this type of clear communication and management leadership is what is in danger of extinction.

Lessons from Wolves

After years of revising plans, seeking legislation, conducting environmental impact statements and responding to thousands of public comments, red wolves (*Canis rufus*) again roam North Carolina and the gray wolf (*Canis lupus*) has been released in Yellowstone National Park and central Idaho. For more than two decades, the main obstacles facing wolf recovery have been social and political, not biological.

Proponents often speak of endangered species conservation as being both legally required and ecologically desirable. But, as the wolf demonstrates, it is not sufficient merely to state legal and ecological mandates. There is the need to build a popular consensus that having wolves, even one a limited basis, is desirable. The people who live in the wolf recovery areas must be convinced that sharing the land with wolves need not result in socioeconomic loss. Nor is it sufficient merely to speak of "the national interest" or "existence value" (gaining satisfaction from merely knowing that the wolf exists in the wild, even if you never see one). National interest and intrinsic wildlife values are important, but to the rancher, farmer, outfitter, hunter and trapper in wolf recovery areas, these have become empty phrases.

While not comprehensive in their relief, three principles must be adhered to for successful wolf recovery specifically, and endangered species conservation as a whole. First, all parties must recognize that there will be times when individual wolves must be killed to protect lawfully present livestock and private property. The ESA allows the taking of individual animals where such an action supports the recovery of the overall population as often is the case with large predators (16 U.S.C. 1535, Section 10(a)(1)). Second, adequate funding is vital to endangered species recovery, regardless of species. The majority of state wildlife revenues come from hunting and fishing sales and the federal excise tax on firearms and ammunition. Traditionally, these monies have been used to support "game" animal programs. Endangered species, however, are not game species, and some states depend largely on federal assistance programs funded under the ESA. Unfortunately, the availability of funding for states has fallen far short of actual recovery needs. Finally, state officials have expressed concern that once recovery goals are met, the wolf will not be delisted. They feel that anti-hunting and other pro-animal advocates will foster a new set of criteria for delisting the species once it has reached the numerical goal established by the recovery plan. While the ESA does have a few success stories where geographical populations of species, like the alligator and brown pelican, have been delisted, the successes can not compete with a growing list of new candidates that number in the hundreds.

Efforts to recover the red wolf offer a number of insights for achieving cooperation rather than conflict for endangered species management. In the early 1980s, the red wolf was considered extinct in the wild—a victim of human persecution, habitat loss and hybridization with coyotes. The species was sustained by a captive population of some 70 animals awaiting identification of suitable release sites and establishment of sufficient public support. Early efforts to reintroduce the species into the Land-between-the-Lakes region of Tennessee and Kentucky failed when a lack of public education and the perception of "critical habitat" led to fears of a federal take-over. In November 1986, a much wiser FWS, after extensive public involvement and advance planning, began reintroduction of the red wolf on Alligator River National Wildlife Refuge in eastern North Carolina. The reintroduced wolves were listed as an "experimental, nonessential population" and the effort was carefully planned with the concerns of sportsmen, residents and conservationists incorporated. As of January 1995, a minimum of 41 wolves inhabit federal and private lands in eastern North Carolina (Morse 1995). A major reason for this success lies in the efforts of FWS personnel not only to be responsive to landowners' interests, but to take the time to meet with landowners one-on-one to discuss concerns and potential conflicts. Conscious efforts to be responsive and flexible have paid dividends with more than 186,000 acres in private lands voluntarily made available to the red wolf. One important element in this landowner cooperation is local accountability. Landowners have been willing to cooperate because the FWS has worked hard to demonstrate that the on-the-ground manager has the authority to respond on a local level (M. Phillips personal communication: 1994). Such faith would erode quickly if all decisions had to be sent to the Atlanta regional office or to Washington, D.C.

Analysis: Implications for Future Management

Through the years, much has been made in wildlife management circles of the need to base decisions on sound biological data. Unfortunately, sound science does not lead inexorably to sound public policy. FWS and other responsible parties in the ESA arena must recognize that years of hiding behind a process that is mystifying in its bureaucracy and maddening in its inflexibility have led to a total disconnect between the regulator and the regulated. Fortunately, there are numerous models of how the ESA can work to protect biodiversity in a responsive and flexible manner. The red wolf's access to 186,000 acres of private lands is just one example where a commitment to public involvement, direct contact with effected stakeholders and flexible application of the ESA has paid dividends.

Wolf recovery in the northern Rocky Mountains brings to the forefront another challenge that, if unmet, will destroy the credibility of the ESA. After millions of dollars of research and planning, restoration efforts are underway in Yellowstone and central Idaho. The two biggest questions that remain on the table are: (1) how will be ambitious recovery efforts be funded, and (2) will the environmental interests play by the rules or, once again, attempt to change them to their advantage? As one frustrated logger in the Pacific Northwest stated: "every time we get close to the goal line, they move the goal posts." This goal post issue is vital to the effectiveness of the ESA. Whether it involves wolves, snail darters, California gnatcatchers (*Polioptila californica*) or pigtoe mussels (*Pleutobema* spp.), effective conservation requires the commitment of the stakeholders, including private landowners and municipal governments. Such commitment will not be forthcoming if there is no assurance that the conservation interests will play by the negotiated rules. Currently, there are numerous efforts underway to force FWS to move the goal posts on listed species. In the majority of these efforts, the ESA is used as a surrogate for land-use planning where the real issues are concerns over such issues as wilderness protection, timber harvest, grazing allocations and mining operations, not endangered species. Conducting land-use planning through the narrow focus of the ESA allows the listed species to be blamed for any resulting economic hardship, but it should not be confused with sound land planning.

Current attempts to control the federal deficit will translate into lean years for the

ESA, regardless of how it is reauthorized in the 104th Congress. ESA currently has more patients in its intensive care ward than it can effectively manage and recover; and FWS and the National Marine Fisheries Service are under court-ordered mandates to list more and more species. Some issues, like Columbia River salmon (*Oncorhynchus* spp.) promise to be much more complex and bellicose than snail darters and wolves. The individual species-by-species approach that has driven endangered species management in the past slowly is being replaced by conservation planning based on the habitat. For example, in southern California there are an estimated 35 animals and 59 plant species dependent on coastal sage scrub habitat (California Department of Fish and Game personal communication: 1994). Instead of viewing them as 94 individual patients, budget and personnel constraints alone will force the FWS and other wildlife managers to view them collectively as a single patient through their common habitat.

In conclusion, we return to the clean (and guilty) hands versus dirty (and innocent) hands. As wildlife managers capable of learning from past mistakes, we must work to promote a flexible style of endangered species management that focuses on habitats rather than individual species, that promotes local delegation of authority to the greatest extent possible, and that is accountable not to mechanical adherence of the *Code of Federal Regulations*, but rather to achieving a workable solution, on-the-ground, that incorporates the interests of the human residents even as it strives to preserve scientific rigor. To the future, effective endangered species management will require more than scientific expertise and bureaucratic fortitude: it will require greater commitment to work with local landowners and governments to forge a common strategy that is achievable and realistic. It will require getting our hands dirty.

References

Morse, M. 1995. Activities of Reintroduction Project during January, 1995. Memorandum to interested agencies and individuals. U.S. Fish and Wildl. Serv., Manteo, NC. February 6.

New York Times. 1980. *"Minnows as weapons."* November 16, 1980.

Plater, Z. 1982. Reflected in a river: Agency accountability and the TVA Tellico Dam case. Tennessee L. Rev. 49(4): 769.

Special Symposium. *Visiting The Past: Wildlife and Environmental History*

Chair
ERIC G. BOLEN
Department of Biological Sciences
University of North Carolina
Wilmington, North Carolina

Cochair
Dan L. Flores
Department of History
University of Montana
Missoula, Montana

Animals and People in North American History

Dan L. Flores
University of Montana
Missoula

Eric G. Bolen
University of North Carolina
Wilmington

Pecked onto the slanting, nearly black surface of a lava boulder that commands a sweep of yellow grasslands east of the Rocky Mountains in New Mexico, there is a rock art panel done perhaps eight centuries ago. It merits mention here because of its silent testimony to the mystery and deep time of the human/animal interaction in America. Ten figures arranged in a deceptively simple design occupy this time-capsule message from the pre-Columbian continent (Figure 1). Seven evidently are indigenous Great Plains animals: a pronghorn, a deer, perhaps a coyote or wolf, a roadrunner, a jackrabbit, and two unidentifiable quadrupeds. The eighth figure—although it does not reside at center stage, it clearly was intended as the active agent in the scene—is a human figure in breechclout; a medicine bundle is affixed to the left leg and the upraised arms hold a halo, or maybe it's a circular rattle. Framing the scene are the remaining pair of glyphs, two carefully pecked circles that seem to symbolize the unity of the arrangement.

Extending human history back at least 300 years before Europeans colonized America, executed by a long-forgotten artist whose cultural affiliations are unknown, this single rock art panel cannot tell us now precisely what message it left the future. Is the human figure a shaman making hunting magic? Is this the recording of a vision quest and the helper animals of a long-ago dream? A panoply of animal deities whose personalities hold the secrets of the human condition? The straightforward answer is

Figure 1. People and animals interacting, as shown in a petroglyph etched on a lava boulder east of the Sangre de Cristo Mountains in New Mexico. *Photo courtesy of Katie Dowdy.*

that no one, not even the local New Mexico Indians, knows anymore. But the mutually affective power of the relationship between humans and animals is clear; it still resonates from this scene. And what it tells us is that we have been managing, learning from and intimately intertwined with the animals of this continent for thousands of years before Europeans arrived, scientific conservation emerged or ecosystem management was conceptualized.

The linkages between the fields of history and biology have been strengthening of late. ''Bridging the gulf'' between the two disciplines was the metaphor that inspired our opening presentation at a session similar to this three years ago, when we first assembled a group of environmental historians to present their work at the North American Wildlife and Natural Resources Conference in Charlotte. Now we want to continue that bridge-building with a new collection of research papers on issues of mutual concern to historians and wildlife ecologists: bison and their demise, wolves and their return, the function of cultures and commons in understanding how wildlife management evolved. But we also want to pay homage to the emerging new synthesis in ecology, which increasingly has shown how forcefully historical knowledge can reshape the basic premises under which wildlife ecology and conservation are practiced.

In a recent book, *Animals of the Soul*, religion scholar Joseph Epes Brown (1992) retrieved from several traditional Lakota elders, whom he interviewed in the 1930s, at least an echo of the kind of knowledge and logic that informed 11,000 years of Native American management strategies in North America. According to Brown, the Lakota perceived the essential nature of individual animal species less through observation than through dreams or visions. There was a certain ranking of animals in

Lakota taxonomy. Not surprisingly, the animals we now regard as "charismatic species"—grizzlies, bison, eagles—were accorded highest ranking, with bears ruling the underground, bison the surface and eagles the air (Rockwell 1991).

The Lakota also saw a perfectly logical connection, involving energy flow, between animals that the scientific worldview would not think to link together. What they called *Umi* or *Yum* was the power of the whirlwind, an uncontained residue of the energy of the four winds. Whirlwind power was much sought after by the Lakota, and only a small number of special animals—moths, dragonflies, spiders, bears, elk and bison—possessed its secrets. The periodic disappearances of bison, for example, appeared to the Lakota to be associated with seasonal winds from the north and south, and that linkage affirmed the Lakota belief that bison had their origins underground. Thus, Indians possessed a philosophy of interconnections or systems in their world, and when they sought to manage nature for their own ends, they did so within the context of their philosophies. Management based on population counts, gender harvests and ecological relationships such as we know them were entirely alien to Indian wildlife managers. When bison were disappearing on the 19th-century plains, Indians did not react by limiting harvest or protecting cows, but by appealing to the Master Bison Spirit to discharge more animals from beneath the ground (Flores 1991).

What such information means, extrapolated backwards through 350 generations of human occupation, is that long before Gifford Pinchot or the Lacey Act, American Indians had been consciously altering, shaping and managing continental ecology and wildlife according to a system of logic all their own. In his 1992 article, "The Pristine Myth," geographer William Denevan asserts that, taken together, Indian alterations of the continent were so profound that it took the Europeans nearly three centuries to produce effects similar in scope (Denevan 1992). Along with the quite-recent discovery of the historic role of fire in continental ecology, this emerging knowledge about the past, specifically the range of Indian involvement in so-called "Virgin America," has recast modern ideas about wildlife restoration's goals. And it has done much to turn the concept of "American wilderness" into the cultural fantasy that it probably is. Indeed, it seems to us that when current managers seek to restore an "original ecology," as described by Euroamerican explorers, it ought to be acknowledged freely that what they are trying to recreate is not wilderness America but *Indian* America.

Then there is the big ecological picture and history's new role in it. Historians such as panelist Tom Dunlap are giving us ample evidence of the many ways that culture, itself a product of history, has shaped different wildlife management strategies across the globe. Recently, Daniel Botkin's (1990) widely read *Discordant Harmonies: A New Ecology for the Twenty-First Century*, has captured the late shift in ecological theory brought about by an acknowledgment of the historical force of time. Eugene Odum's (1969) ecosystem model of nature has dominated ecology and management since the late 1960s. But as Botkin's book shows, ecologists eventually have had to accept that a modeled ecosystem is a static picture, a snapshot in time. Reassembling its pieces is an algebraic exercise, with algebra's limits. The sum pays no attention to the arc and direction of *time*, and factoring the flow of time into an ecosystem model requires not just calculus, but a recognition of the forces of deep history. Hence, ecologists now speak the language of a dynamic nature, shifting mosaics, discordant harmonies and catastrophe theory—all because ecology finally has recognized how important evolving climate and life history, historical ecology in other words, are to its basic premises (see Worster 1993, Cronon 1993).

It is this importance—the linkage of historical knowledge with biological knowledge, if you will—that these papers seek to illuminate.

We hope that environmental history's perspectives—and stories—challenge you to look at wildlife management afresh. The range of papers presented here offers a sample menu of the kinds of topics and issues relevant to ecology that humanities scholars have been addressing for the past two decades. As these papers attest, time, cultural diversity and management precedents all are part of the mix. So, too, is philosophy—from the evolution of Aldo Leopold's land ethic to investigations of the historic applications of E. O. Wilson's biophilia hypothesis. While the manner in which humanities scholars couch their investigations into these matters might seem to exemplify, for scientists, the humanities' essential "fuzziness" and reliance on narration, rather than hard data, we hope you recognize that history *is* problem-oriented, offering hard data and resolution, as well as pathos. Environmental history's revisionist examination of the fate of the North American bison, seen in two papers here, is a prime example. We thus offer this modest proposal: in many instances, modern ecology's problems are resolvable only when they are correctly perceived as part of linkages with the past.

Environmental history could not exist without a significant reliance on the scientific method or on the sciences related to ecology. Of that, there can be no question. But we think history has something to offer scientists in return, and that among these benefits are context, precedents and continuum.

References

Botkin, D. 1990. Discordant harmonies: A new ecology for the twenty-first century. Cambridge Univ. Press, New York, NY.

Brown, J. E. 1992. Animals of the soul: Sacred animals of the Oglala Sioux. Element Press, Rockport, MA.

Cronon, W. 1993. Foreword. In M. McDonnell and S. Pickett, eds., Humans as components of ecosystems. Springer-Verlag, New York, NY.

Denevan, W. 1992. The pristine myth: The landscapes of the Americas in 1492. Annals Assoc. Amer. Geographers 82(September): 369–85.

Flores, D. 1991. Bison ecology and bison diplomacy: The Southern Plains from 1800 to 1850. J. Amer. Hist. 78(September): 465–85.

Odum, E. 1969. The strategy of ecosystem development. Science 164(April): 262–70.

Rockwell, D. 1991. Giving voice to bear: North American Indian rituals, myths, and images of the bear. Roberts Rinehart Publ., Niwot, CO.

Worster, D. 1993. The wealth of nature: Environmental history and the ecological imagination. Oxford, New York, NY.

Aldo Leopold, Wildlife and the Land Ethic

Thomas R. Dunlap
Department of History
Texas A&M University
College Station

People commonly see Aldo Leopold's land ethic as part of the stream of American nature writing that runs from Thoreau through Muir to the modern environmental movement. It is, for most readers of *A Sand County Almanac* (Leopold 1949), an intellectual touchstone by which to judge their actions and public policy. This view is not so much wrong as incomplete. Romantic nature appreciation shaped the land ethic, but a more powerful influence was the continuing interplay of knowledge and experience as Leopold tested his ideas against the world. He saw the land ethic as something each of us could use, but also as an institutional guide for his profession, a creed for game managers, who were to shape the society that they served. These often-neglected dimensions of Leopold's ideas are embedded in his professional life, and they appear well before the late 1930s, when the land ethic appeared explicitly in his essays.

Although Leopold had been interested in nature since he was a child, his intellectual journey properly begins with his experiences working for the USDA Forest Service. In New Mexico, between 1909 and 1924, he used the conservation creed he had learned in forestry school to enhance the hunting which had attracted him as a boy, and it was here that he began to see how inadequate his understanding (and everyone else's) was. Common sense and rules-of-thumb not only were the way to game abundance; they could produce disaster. Here, too, he came into contact with other perspectives on nature. Some were from the developing science of animal ecology, others from the American nature writers, still others from people who saw wildlife as more than game and nature as more than landscape for sport or pioneering play. By the time he was transferred to Madison, Wisconsin, he was drifting away from his old ideas and from forestry, and in 1928 he resigned from the Service to make his interest in wildlife his profession. He established the first department of game management, and tested his ideas in the field and around the state. Reclaiming his own farm in the ''sand counties,'' he experienced the problems of game and land restoration on a human scale. Field work led to new conclusions, and correspondence with ecologists helped him put those into a wider perspective. The essays from the late 1930s and early 1940s, the basis of his posthumous fame, grew out of this long process of learning. His ideas were not just those of a man who loved nature. They were the mature thought of a man deeply involved in practical problems and academic learning, who wanted not only to shape people's ideas but to inform professional practice (see Meine 1988, Flader 1976).

As a youth and a professional forester, Leopold took a utilitarian approach, and a narrow one at that, to wildlife. The only species he seriously considered were those that could be hunted; management's only goal was to produce as large a ''crop'' as possible; the only tools it needed were laws to limit the human kill and programs to ''wipe out'' the ''varmints'' that ''competed'' with human hunters. He thought, he wrote later, "that because fewer wolves meant more deer, then no wolves would mean hunters' paradise" (Leopold 1949: 138). He was hardly alone. This was the conventional wisdom of the sportsmen's program of game conservation, which states had begun to apply around 1900. They cut bag limits, shortened seasons, hired wardens and killed predators. Leopold had been in New Mexico for a decade, using and promoting these ideas, when events began to show the limits of this vision. The most dramatic case was on the Kaibab Plateau, on the North Rim of the Grand Canyon. Early in the century, the area had been set aside as a national forest and game preserve. Deer had been protected; wolves, bear, mountain lions, lynx and coyotes had been shot, trapped and poisoned. The deer herd had, gratifyingly, increased, but around 1919, forest rangers began reporting a new problem. There were too many deer. Killing some might save the forest, but sportsmen had come to see deer protection as essential to good hunting, and the National Park Service, on whose land the deer spent part of the year, wanted large herds as a tourist attraction. While federal and state authorities argued over the extent of the damage, who had responsibility and what should be done, nature applied its own remedies. In the winter of 1924–1925, deer began dying of disease and starvation. In the spring, carcasses littered the forest and the survivors were little more than skin and bones. Everything green had been eaten as high as a deer could reach. For the next decade, the USDA Forest Service, the National Park Service and the state of Arizona argued, and deer on the depleted range continued to die. For the next 30 years, the Kaibab was a classic conservation horror story, told and retold in nature and hunters' magazines, gaining force as other herds went through this cycle of growth, forest destruction and starvation (Dunlap 1988a).

Luckily for Leopold, he was transferred to Madison just as the storm burst. He could think without having to deal with state officials, angry hunters or the higher reaches of the Forest Service bureaucracy. He did not write about the Kaibab at the time, but it was the subtext of his 1944 essay, "Thinking Like a Mountain." There, after describing his early ideas, he went on to say that "I have lived to see state after state extirpate its wolves. I have watched the face of many a newly wolfless mountain, and seen the south-facing slopes wrinkly with a maze of new deer trails. . . . I now suspect that just as a deer herd lives in mortal fear of its wolves, so does a mountain live in mortal fear of its deer" (Leopold 1949: 139). His thinking, though, also ran in other channels. During his years in New Mexico, foresters had been independent agents. Few and scattered, out of easy communication with headquarters, in a country where national policies and industrial forestry were just coming into contact and conflict with established communal uses of the lands, they had the responsibility of translating scientific policy and economic measures of efficiency into action, and they could see the consequences. They dealt with people grazing their cattle on national forest land or hunting in traditional ways and at traditional times—now forbidden by new game laws. They had reconciled state demands with agency directives. Leopold approached the problems of deer management with the insights of science, and he contributed to that knowledge, but he also kept in mind that policies affected people's lives. When he pointed out, in "The Land Ethic," that farmers had done what they "conveniently could" to save the soil, but nothing more, he spoke from a knowledge of their lives and livelihoods (Leopold 1949: 245). What he saw in Wisconsin and put in his essays he had begun to learn in New Mexico.

In the Southwest, he had found knowledge as well as experience. Around 1917, he began submitting observations from his hunting trips to ornithological journals.

The ones he sent to *Condor* brought him into contact with Joseph Grinnell, director of the Museum of Vertebrate Zoology (MVZ) in Berkeley. This was a stroke of luck for Leopold. Grinnell had knowledge and a perspective Leopold needed. He had been raised in the West and had been an ardent naturalist from his teens. He had seen the land change, and as head of the MVZ from its founding in 1908, he was in an excellent position to chart those changes. The museum was doing the most extensive biological survey ever done in the region, which kept him in touch with field conditions. His graduate students were doing it, which kept him at the forefront of theory. He also had a very different standard for judging wildlife. While Leopold was thinking of game, he was arguing for preserving dead trees on the Berkeley campus. Leopold worried about the economic uses of the national forests; Grinnell observed with dismay the impact of sheep and cattle on the high mountain meadows. During the years Leopold was urging New Mexico sportsmen to get the last wolf in the state, Grinnell was preparing a case against the Bureau of Biological Survey's predator and rodent control program. Leopold got his notes published, but he also got a continuing education. Their correspondence only ended with Grinnell's death in 1939 (Dunlap 1988).

The timing of Leopold's transfer makes the land ethic appear the product of his Madison years, and Leopold lent some credence to the notion. In an unpublished Foreword to *A Sand County Almanac*, he attributed his essays to his job at the Forest Service's Forest Products Laboratory. The "industrial motif of this otherwise admirable organization," he said, "was so little to my liking that I was moved to set down my naturalistic philosophy" in essays. This is stretching it. As early as 1914, he had begun copying quotations about nature in a notebook. By 1920, he was writing papers (usually unpublished) about his ideas. "A Criticism of the Booster Spirit," delivered a year before he went to Madison, shows him already at odds with conventional notions of progress and even his own ideas a few years before (Leopold 1923). That piece also is noteworthy for showing one of Leopold's intellectual strengths—the ability to apply in one area concepts from another. He already had done this in his job. Campaigning within the Forest Service for wilderness areas and evaluating the agency's policy on vacation homes, he had argued for values beyond the merely economic. The Service, he said, should use its power to protect the romance of pioneer pack trips and the beauties of scenery. These, as well as lumber, could be forest resources (Leopold 1921). To hunting, a recreation, he had applied system and science. Basing land-use policies on ethical principles grounded in ecology would be a leap, but not a strange one.

In 1928, Leopold took a leap of a different kind. He resigned from the Forest Service to make game management his business and the field a professional discipline. The pace of his education quickened. A survey of game of the Upper Midwest, undertaken for the Sporting Arms and Ammunition Manufacturers' Institute, provided a crash course in the overlapping and conflicting interests pulling at game policy. Quail, the premier upland game bird over most of the region, were declining. Waterfowl were becoming scarcer, to the alarm of hunters and bird lovers. Farmers, meantime, were removing weeds from their fencerows, cutting down hedges, plowing up "waste" ground and draining swamps. This made them more efficient but their farms less attractive to game. He confronted the problems of game in an industrial society from an academic setting, but one he had, quite deliberately, shaped to keep him in touch with people and policy. The Department of Game Management, established in 1933, was in the University of Wisconsin's College of Agriculture, and Leopold planned to use the infrastructure of the college. Game managers, he thought, had to reach the people to be effective. This required either that they build an apparatus similar to agricultural extension "or else use the agricultural machinery already set up. Since game is largely an agricultural by-product, the latter course seems by far the best" (Leopold 1933: 406). He suggested demonstrations, farmers' short courses, lectures and portable exhibits for county fairs. Research followed the same pattern. It may have drawn on theory, but it aimed at results farmers and sportsmen could use. His model was Herbert Stoddard's study of Georgia quail, which he hailed as the first successful application of science to the improvement of game. This was a cooperative venture. A group of sportsmen, anxious to improve the shooting on their plantations, had made land available and paid for the research. The Bureau of Biological Survey picked Stoddard to oversee the project, made the results available to the landowners and then published them for everyone to use.

Stoddard was writing his report in 1929 when Leopold put his first graduate student, Paul Errington, to work duplicating the project at the other end of the bobwhite's range, in southcentral Wisconsin. The results were useful for management, but more for changing Leopold's thinking. The common wisdom, applied in the Southwest (and everywhere else) was that predation was the limiting factor on game populations. Stoddard had not found it so, and Errington provided quantitative evidence that, here at least, it was not. Through four winters he had tracked coveys in his study area and counted the birds in each one every week. He had made censuses of predators, tried to assess causes of mortality, and looked at cover, food, weather and anything else that might affect the birds. In the end, he cautiously concluded that neither the types nor numbers of native predators had any effect on overwintering survival (Errington 1933). In *Game Management*, Leopold used this study to sound a cautionary note. Predator control, he said, might be needed, but it had, in each case, to be shown to be needed. There was, he warned "only one completely futile attitude on predators: that the issue is merely one of courage to protect one's own interests, and that all doubters and protestants are merely chicken-hearted" (Leopold 1933: 252). He had come a long way from the ideas of his New Mexico days.

Leopold sought understanding as well as knowledge, and he saw his new profession taking an active role in finding it. On population cycles, a subject of interest to both scientists and game managers, he thought that game managers could not wait for scientists to provide answers. They had to act in the "here and now," but their action would serve a larger purpose. It is "unlikely that the game manager will find the explanation of cycles, but his field observations are the main reliance of the scientists who will" (Leopold 1933: 71). In 1930, at a conference on cycles, he met a man who could use those field observations, the English ecologist Charles Elton. He was, in some ways, Leopold's ideal collaborator. His textbook, *Animal Ecology* (Elton 1927: xi), had put forward a set of concepts—food chains, food cycles, trophic levels and niches—but called for testing them through field studies that would "revolve around censuses, the structure of the population by age and sex, the birth-rates and death rates, movements, as well as the influence on these outside changes and interrelations." Leopold became one of his most enthusiastic boosters, and the Oxford scientist would acknowledge, in turn "the great stimulus which American investigators such as Leopold, Stoddard, and Errington, have given me, both personally and from their writings" (Elton 1939: 332). The interplay of theory and experience that marked Leopold's life here was transferred to an interchange between disciplines, with important benefits to both sides.

Ecology not only provided concepts that Leopold could use, it helped justify the land ethic. It was one thing to speak of the "balance of nature," another to appeal to a quantitative body of research grounded in and testing theory. Part of the persuasive power of Leopold's ideas came from their reliance on the picture of nature constructed by people such as Elton, A. G. Tansley (who coined the word "ecosystem") and their counterparts in the United States. Science, though, did not restrain the land ethic. Leopold also depended on bold intuitive leaps. "A thing is right," he said, "when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold 1949: 262). This rests on science, but it is a moral declaration and an act of faith. So, too, were Leopold's forceful arguments, in "The Land Ethic," that there are no useless parts in nature, that nothing can be removed without changing the system and that diversity means stability. Indeed, 40 years later, R. W. May described the association of diversity with stability as part of the "folk wisdom of ecology" (Allen and Starr 1982: 188). But that kind of wisdom was necessary. The problems of land use and wildlife preservation were not only scientific, they involved the values people placed on nature. They were not just theoretical, they had to be addressed in the "here and now." Leopold was willing to move beyond what could be proven. He formulated the land ethic as a dynamic guide, subject to the correction of our increasing knowledge of what would "preserve the integrity, beauty, and stability of the biotic community." The openness to experience and commitment to action that produced the land ethic should be applied to its use.

Leopold's conception of the social role of game management also blended science and moral values. In *Game Management*, he acknowledged the practical element. The field was a "form of land-cropping . . . the art of making land produce sustained annual crops of wild game for recreational use." He insisted, though, that this practical, day-to-day activity serve a larger purpose. The manager really "labors to bring about a new attitude toward the land." Some people saw only economic value and thought the "food-factory" had "the right to be as ugly as need be, provided only it was efficient." Others thought of "economic productivity as an unpleasant necessity," and wanted it out of sight (here were the two poles of his early years, forestry's idea of conservation, based on economic efficiency, and the romantic tradition's emotional identification with nature). The game manager would be part of a third, much smaller group, which saw the ugliness of development as neither "the inevitable concomitant of progress" nor a "necessary compromise," but as "the clumsy result of poor technique, bunglingly applied by a human community which is morally and intellectually unequal to the consequences of its own success." The test of civilization was the capacity to live in high densities without destroying the environment, and the "practice of game management may be one of the means of developing a culture which will meet this test." It served "a motivation—the love of sport—narrow enough actually to get action from human beings as now constituted but nevertheless capable of expanding with time into that new social concept toward which conservation is groping" (Leopold 1933: 422–423).

This takes us into new areas. Textbooks of applied science normally preach instrumental values. They do not call for their discipline to be an agent of social change. Even this, though, is drawn from Leopold's life. He had been trained in forestry, at a time when Gifford Pinchot dominated the field and the Forest Service, and Pinchot had seen conservation as a crusade for democracy and opportunity and his forest rangers as agents of change. Leopold's cause was an extension of this. Modern society needed an attitude toward the land that would reconcile the contradictory demands of those ''who can live without wild things, and [those] who cannot'' (Leopold 1949: xvii). Game managers would help to bring about a ''culture that would meet this test'' of living at high densities without destroying the natural world, just as Pinchot's foresters had helped to make management of forest resources part of policy and an ideal of management part of the culture.

There is no need to rescue the land ethic from the philosophers and nature lovers—they have legitimate uses for it—but we need to examine all its implications. I have tried to suggest some. It is a call not just to individuals, but to the profession and, within the profession, it suggests a particular task for the individual—to seek a wider vision within daily practice, to make everyday matters serve higher goals. Wildlife managers are to build more than game populations and habitats. They must build ''receptivity into the still unlovely human mind'' (Leopold 1949: 295). It is a job that this Conference was created in part to do. To remind you is, perhaps, like preaching to the choir, but I prefer to think of it more as a Fourth of July oration. It reminds us of a common heritage and calls us to further efforts in the cause.

References

Allen, T. F. H. and T. B. Starr. 1982. Hierarchy: Perspectives for ecological complexity. Univ. Chicago Press, Chicago, IL. 310 pp.

Dunlap, T. R. 1988. Saving America's wildlife. Princeton Univ. Press, Princeton, NJ. 222 pp.

———. 1988a. That Kaibab myth. J. For. and Conserv. Hist. 32: 60–68.

Elton, C. On the Nature of Cover. J. Wildl. Manage. 3: 332–338.

Errington, P. Bobwhite winter survival in an area heavily populated with grey foxes. Iowa State Coll. J. of Sci. 8: 127–130.

Flader, S. 1976. Thinking like a mountain. Univ. Missouri Press, Columbia. 284 pp.

Leopold A. 1921. The Wilderness and Its Place in Forest Recreational Policy. Pages 78–81 *in* S. Flader and J. Baird Callicot, eds., The River of the Mother of God. Univ. Wisconsin Press, Madison. 389 pp.

———. 1923. A Criticism of the Booster spirit. Pages 98–105 *in* S. Flader and J. Baird Callicott, eds., The River of the Mother of God. Univ. Wisconsin Press, Madison. 389 pp.

———. 1933. Game Management. Scribner's, New York, NY. 481 pp.

———. 1949. A Sand County Almanac. Ballantine Books, New York, NY. 295 pp.

Meine, K. 1988. Aldo Leopold: His life and work. Univ. Wisconsin Press, Madison. 638 pp.

Shifting Ground: Indians, Conservationists and Wildlife in Glacier National Park, 1910–1960

Louis S. Warren
University of San Diego
San Diego, California

From the creation of Glacier National Park in 1910 until at least 1960, there was a persistent and occasionally bitter contest between park authorities and Blackfeet Indian hunters on the park's east side. Confrontation swirled around the elk (*Cervus elaphus*) that crossed from the park onto the Blackfeet Reservation each autumn. With the onset of heavy winters, elk herds moved from higher elevations within the park to the lower draws on the reservation. For most of this century, the Blackfeet tribe did not officially regulate hunting on the reservation. Park authorities and conservationists usually saw the reservation hunting of elk as a threat to the survival of elk within the park. Their attempts to stop it ranged from law enforcement campaigns and park expansion proposals to winter feeding regimes. Indian hunters, on the other hand, saw the park itself as the ''poacher'' of hunting lands guaranteed to them by treaty; they viewed their own taking of elk as the exercise of customary rights and a subsistence necessity.

This conflict was about divergent cultural systems that value elk differently, and about political struggle over land promised to Indians and claimed by a federal agency. But it was also a conflict in which nature played trickster, changing its shape and radically altering the terms of dispute between conservationists and Indians. Between 1910 and the 1950s, shifts in park ecology created a new world for conservationists and Indians, and for a brief time, brought park authorities to reconsider the meaning and importance of Indian hunting.

Glacier National Park is a wedge of land straddling the Rocky Mountains at their northernmost extension in the continental United States. Its defining features are steep mountains and deep valleys, many of them sheltering blue, glacial lakes. Heading east from the Continental Divide, the park mountains give way, briefly, to a series of low rolling hills and river valleys, with moderate tree cover. Ten miles beyond, the Great Plains begin. From the peaks of the mountains, on a clear day, a hiker can see 70 miles to the outline of the Sweet Grass Hills. Until the last quarter of the nineteenth century, these were the principal hunting grounds of the Blackfeet Indians, abundant with deer, elk, buffalo and other game. The Blackfeet, or Piegan, were Plains buffalo hunters. Through the 1860s, they were able to retain control over the plains from the mountains to the Sweet Grass Hills and beyond through a combination of armed resistance and diplomacy (Ewers 1958).

But between 1850 and 1890, the Blackfeet, like other Indians of the Great Plains, saw their buffalo hunting economy collapse before waves of white immigration. Armed resistance failed to halt the whites, and a series of unilateral and questionable declarations by the federal government left the Blackfeet with a fraction of their former lands. In 1886, the impoverished Indians agreed to sell all but the western end of their reservation, a parcel of 1.8 million acres stretching from the Continental Divide east to the mouth of Cut Bank Creek. The best hunting grounds, to the south and east, were gone. So was most of the game. Even in the Sweet Grass Hills, the elk and buffalo were gone. Usually, buffalo hunters could take hundreds of animals in a good year. The last buffalo hunt occurred in 1883, when a group of hunters returned from the Sweet Grass Hills having killed six buffalo and two antelope (Ewers 1958). The treaty of 1888 would go down in Blackfeet history as "when we sold the Sweet Grass Hills" (Ewers 1958).

One more final reduction of the Blackfeet homeland would have troublesome consequences for later relationships between the Indians and the Park Service. In the early 1890s, as a tide of white prospectors threatened to swamp the mountainous portion of the reservation, the federal government elected to buy these supposed mineral lands from the Indians. Negotiations were difficult. Ultimately, the Blackfeet faced a choice of selling the land or having it taken away. They agreed to sell in September 1895. For $1.5 million, the tribe relinquished ownership of a tract of land 10 miles wide and 60 miles long, extending from the peaks of the Continental Divide to the eastern foothills, and from the Canadian boundary to the southern edge of the Blackfeet Reservation. The holding became known as the "ceded strip."

Hard hit by decades of severe population decline and warfare with whites, the Blackfeet nevertheless secured special provisions in the 1895 agreement, guaranteeing customary hunting and woodcutting in the area. Little Plume observed at the negotiations, "All of the young men who have come here to this treaty were chopping wood in the mountains. . . . If we are hungry we go up to the mountains and get game" (Secretary of the Interior 1896). The Blackfeet made clear they would sell only if they retained rights to wood and game. White Calf, the leading chief of the Piegan, told the whites, "I want the timber because in the future my children will need it. . . . I would like to have the right to hunt game and fish in the mountains." Big Brave supported him, "I raise my hand to say that we want to hunt game, fish, and cut timer in these mountains" (Secretary of the Interior 1896).

Responding to Blackfeet demands, federal negotiations ensured the Indians the right to cut and remove wood from the strip, "to hunt upon said lands" and fish in the streams (Secretary of the Interior 1896). From the earliest days of the agreement, Blackfeet exercised their hunting prerogatives in the mountains. During the hottest parts of the summers, small groups took tipis to the cool slopes for hunting expeditions. Photographer Walter McClintock joined Blackfeet hunters on expeditions into the mountains the summer after Indians signed the mineral cession and, in 1901, George Bird Grinnell described the area: "everywhere . . . may be seen the sites of old Indian camps, with rotting lodgepoles, old fireplaces, and piles of bone and hair, showing where game has been cut up and hides dressed" (McClintock 1937, Grinnell 1901).

The government unilaterally terminated Blackfeet hunting and woodgathering rights in the mountains with the creation of Glacier National Park in 1910. The "ceded strip" was incorporated into the new park, and all hunting and woodgathering was officially banned as park officials set about preserving the landscape in a "state of nature," an idealized condition in which natural systems would operate without a human presence despite the long tenure of Indian hunters in the region (U.S. Statutes at Large). Blackfeet attempts to retain their customary use of the ceded strip occasioned numerous confrontations with park authorities after 1910. Many Indian hunters came from two reservation towns on the park's eastern border, St. Mary, where many Blackfeet lived, and Babb, home to both Blackfeet and Cree Indians. Park rangers routinely arrested Indians hunting in the ceded strip, and controlling the hunt just beyond the park boundary also preoccupied them. According to one superintendent in 1915, Blackfeet frequently chased animals out of the park and killed them on the reservation (Mather 1915).

Park Service efforts to separate Blackfeet from elk inside and outside the park took various forms in these years. In addition to law enforcement actions within the park, a succession of superintendents tried to reduce hunting all along the boundary by negotiating closed seasons and other game laws with the Blackfeet Tribal Council. To their dismay, the few game laws adopted by the tribe seldom were enforced to the satisfaction of the park. Conservationists frequently were infuriated by their impotence in stopping Indian hunters. A 1918 letter from the Secretary of the Interior was typical: "There is not much use in our spending thousands of dollars to protect the wild animals in Glacier National Park during the summer only to have them killed as soon as storms drive them over into the Indian reservation" (Secretary of the Interior no date, Warren 1993).

In a persistent effort to remove the Indians, park authorities sought to expand the park eastward, securing the reservation draws for a winter elk refuge. One park engineer proposed an extension of the park to the road connecting the two towns, the Blackfeet Highway, 6 miles east of the park boundary (Goodwin 1917). Superintendent Eakin continued to warn anyone who would listen, including the Director of the Park Service in late 1929, "we shall never have much wild life on the east side of the park until the park is extended to include the Blackfeet Highway" (Eakin 1929). Although park officials did not say as much, such an extension would have incorporated Babb and St. Mary within the park.

Indian resistance to the park was not limited to hunting within its boundaries. Blackfeet leaders like Peter Oscar Little Chief circulated petitions demanding restitution of hunting rights in the park in the mid-1920s. The petitions vanished in Washington, but in 1932, Little Chief sent a letter to the park Superintendent demanding restitution of Indian hunting, fishing and timber rights in the ceded strip (Scoyen 1932). In 1925, the Blackfeet tribe filed a law suit alleging that they had been deprived of treaty guarantees without compensation. It would take a decade for the U.S. Court of Claims to render a decision, and, when it came, it did not favor the Indians. Despite widespread evidence of Indian hunting in the park, the court found that the Indians "did not exercise to any appreciable extent the rights reserved" in the 1895 treaty and, therefore, "such rights were authoritatively terminated by the limitations of the act" creating the park in 1910 (Warren 1993, U.S. Court of Claims 1935).

Denying Indian claims in court was one thing, but park authorities could not keep elk from Indian hunters. More and more, rangers and superintendents warned of environmental catastrophe if hunting on the reservation did not end. The park Superintendent intoned in his 1923 report, "the big game is gradually being exterminated on the east side of the park, as deer and elk are driven out on[to] the Reservation by heavy snows, and the Indians may kill at any time" (Eakin 1923). Particularly bad was the winter of 1930, when the approximately 125 elk of St. Mary Valley endured a thaw followed by a rapid freeze, which "coated the snow with a crust sufficiently think to withstand the weight of a full-grown bull elk." Unable to dig through the crust for food, the animals moved out to the reservation, "where they were recklessly slaughtered by the Indians, so that perhaps only 20% survived the winter" (Eakin 1930).

In the latter 1920s, park officials began resorting to winter feeding to prevent elk "from seeking winter pasture outside the park." By 1935, elk were receiving upwards of 30 tons of hay in their winter yards on the park's east side (Eakin 1927, 1929; Scoyen 1933, 1934, 1935).

Worry about the viability of elk on the east side would diminish rapidly with the ecological changes which followed the introduction of winter feeding. In 1938, in the southern end of the park, Superintendent Scoyen was sounding a new and strange warning: "The consistent increase of elk in the park is rapidly resulting in an acute winter range problem in the Double Mountain area" (Scoyen 1938). To park biologists, it soon became clear that the surge in elk populations at Double Mountain was only part of a park-wide phenomenon. By 1942, reports of over-population were making their way into park discussions of big game. Estimates of elk population, which had been as low as 337 in 1930, now ran to more than 3,300 (Libby 1942, Eakin 1930).

Exactly what was causing the growth of elk herds is difficult to say, but it no doubt had something to do with better-than-adequate food and cover. Winter feeding of elk can allow elk herds to survive at given levels or to increase when poor winter range otherwise would cause some animals to starve and lower the birth rate for the herd (Nelson 1982, Nelson and Leege, 1982). In the various elk ranges of the park, and especially in St. Mary and Red Eagle Valleys where park officials provided tons of timothy hay every winter, the growing elk population was a positive response to administrative shaping of the ecosystem.

The surge in elk populations, however, did not stop. Once the herds reached several thousand, they continued to grow, as did their demands on limited park ranges. Only a few years before, administrative attempts to control the land were directed toward producing more elk. Suddenly, a scramble was on to find ways of reducing the number of animals. Park biologists were especially concerned about the southern end of the park. Just south of the park was the Lewis and Clark National Forest, a favorite hunting grounds for many Montanans and tourist hunters. Where once the park superintendent had longed to expand the park southward to protect elk, park officials negotiated in 1943 with state game authorities to allow an extended elk hunting season in the forest. The hope was that an extended hunt would reduce park elk herds. Because the winter was mild, relatively few elk left the park, and the attempt was judged a failure (Hodgson 1944).

By the mid-1940s, Glacier Park was one of several national parks which were reporting damage and game starvation from over-populated herds of elk and other game (Folson 1944). In 1944, the park superintendent would complain that Glacier's popular pack horse activities were threatened, as "Several sections of park trails have become impassable by pack stock due to heavy usage by elk going to and coming from the natural licks" (Libby 1944).

Mounting concerns about elk over-population in the park's southern districts caused a complete reversal in the park's appreciation of the "Blackfeet problem" on the eastern side. Once, Blackfeet hunters had represented the greatest threat to elk survival—or, at least, the Park Service thought they did. Now, in 1944, the park superintendent wrote, "The migrating of elk upon the Blackfeet Indian Reservation and the usual take has served to keep the herds east of the [C]ontinental [D]ivide within reasonable and desirable limits." A park press release concurred in 1947, "Elk on the east side of the park which drift out on to the Blackfeet Indian Reservation are legitimate game for the Blackfeet Indians who are permitted to hunt all year round. Usually surplus game on the east side are kept to more or less normal numbers by the take on the reservation'' (Libby 1944, Glacier National Park 1947). Even as elk on the east side of the park continued to increase, park authorities remained optimistic. In 1950, park observers noted ''Part of the St. Mary herd moved through Babb during the winter and the Indians reduced them by about 85 head.'' The report concluded, ''With a combination of the management program being carried on and the winter loss, the elk situation in Glacier appears to be improving and approaching to normal'' (Glacier National Park 1950). Once instigators of an environmental crisis, Indians now had become an unintentional bulwark of ecosystem management.

This optimism vanished by 1953. In that year, the park wildlife census reported that the elk count for the park as a whole had increased by more than 800 in two years. The winter ranges again were showing over-grazing. ''The St. Mary herd . . . shows a decided increase which will require management measures'' (Glacier National Park 1953). Soon, park biologists were warning that the St. Mary elk herd—which now numbered almost 1,000 animals—would have to be reduced by two-thirds to prevent severe damage to the range in St. Mary Valley. Park rangers would make every effort to move the elk to the park boundary by ''hazing'' the herds from behind and baiting the boundary with hay (Glacier National Park 1953a). Hopefully, enough of the animals would cross the park boundary and be killed by waiting Indian hunters to reduce the herd substantially.

In a remarkable reversal of position from only a generation before, Indian hunters now were an integral part of the official elk management plan. And, after decades of warning that the Indians killed too many elk, park authorities now worried that the Indians were not killing enough. Superintendent J. W. Emmert (1953) warned his superiors in 1953: ''In the past two years, the increase of elk has been greater at St. Mary than any other place in the Park. Unless a heavy movement of elk from Park to Reservation occurs, we are faced with serious range damage at St. Mary in the coming year.'' Concerns about the uneven harvest of elk to the east brought park officials to try killing animals within the park. The park service now hoped that by shooting a small number of elk, they would move more animals out to areas where hunters could get them (Emmert 1953).

The park began attempts to reduce the St. Mary elk herd during the winter of 1953–54. Aiming to reduce the St. Mary herd from 900 to 350 animals, rangers harassed the elk continually for two months, from January 11 to March 18. Rangers launched flares and grenades in an effort to startle elk into crossing the park line, and shot more than two dozen animals to control the movement of the herd. The herd dispersed, and ''small bunches left the Park during the night and drifted onto the Reservation where the Indians made an impressive reduction.''

Despite this, the hazing nearly was a fiasco. Many elk, startled at the noise of fireworks, turned around and headed for cover back up the St. Mary Valley instead of moving onto the reservation. The park superintendent estimated that the herd was reduced to 400 animals, but that even this population ''is greater than the range will support. Damage to vegetation during the late winter and early spring showed over-utilization and damage to forage crops as well as cottonwood and conifers'' (Glacier National Park 1954).

The hazing efforts continued through the mid-1950s, with park authorities worried that the elk population would surge again if they let up for even a year. In the summer of 1955, park authorities counted 270 elk in the St. Mary Valley, concluded that "the constant harassing did some good" and that it "should be an annual occurrence in order to keep this herd at a low level so as to be compatible with the range" (Emmert 1955). By 1963, step five of the program for "long range management" of Glacier Park's east side wildlife was to "encourage migration of elk herds to the Blackfeet Indian Reservation from specific drainages where animal overpopulation exist[s]" (Glacier National Park 1963).

By the 1950s, park goals for managing the St. Mary herd had become a through-the-looking-glass version of park goals in the 1920s. "It is hoped that, eventually, these elk will develop a migratory habit and leave the St. Mary valley when winter snow conditions and constant harassing are combined to make foraging difficult" (Glacier National Park 1955). But even the new outlook of park authorities could not end the decades-long contest between Indians and the park for control over game. Indians continued to resist park authority, even as park rangers tried to herd elk across the park line into the sights of waiting Indian hunters. At the park's eastern boundary, it was not enough for park authorities that Indians were willing to kill elk. Indeed, the goal of reducing elk numbers was strictly short term. The long-term goal was to *control* the elk population. In the official lexicon, the herd needed "managing." Managing the elk required controlling how much food they had, where they spent their winters, and collecting accurate data on as many aspects of elk life and death as was possible. In the national forests on the park's southern boundary, cooperative arrangements between the state of Montana and the National Park Service resulted in the creation of a unified elk management program extending across park boundaries. There, the state of Montana provided numbers of elk killed each season. Although these numbers were not necessarily accurate, they provided park officials with data, from which to make calculations of herd size, breeding potential and likely reduction needs in the following year.

Park authorities hoped for a similar arrangement on the park's east side. Ideally, Indians would establish their own conservation regime on the reservation, compiling records of hunting licenses sold and elk taken, and creating a bureaucratic agency which would cooperate with the Park Service in setting bag limits and season lengths on the reservation. Indians provided no such data and, as well as park officials could tell, their hunting was uneven. At times, hunters in Babb and St. Mary took enough elk to meet park management goals; at other times, the elk stayed within the park and returned to it constantly until the ranger at St. Mary reported in frustration "Indian hunters have not killed more than 10 elk all winter" (Barium 1957).

Park authorities repeatedly encouraged the Blackfeet to implement their own conservation program. In 1954, at the height of the elk reduction program in St. Mary, park officials still were hoping for "regulation of shooting seasons by the Blackfeet Indians on their reservation" as part of the greater elk management program for the park's east side (Glacier National Park 1954). But Indians expressed their hostility to the park by adamantly opposing closed seasons or other game management programs beyond the park line. One frustrated federal conservationist, surveying Blackfeet opinion on wildlife conservation in the early 1940s, estimated that "the principle of wildlife conservation is opposed by about 95 percent of the Indian population" (Adams 1942).

Indian resistance to park authority was such a dominant characteristic of local living that it came to characterize the oral history of these years as well. Local Indians do not recall the park ever trying to chase elk out of the park. As they remember, park rangers shot rockets and bullets at the animals to chase them back in (Fisher 1992). In part, this popular memory probably stems from eye-witness accounts of the elk hazing program. When the rangers launched rockets at the elk herd, they turned and ran back up the St. Mary Valley. No matter what rangers and other park officials might have said they were doing, Indians knew from experience that the park authorities would deny them game at every opportunity. When they saw rockets exploding and elk running deeper into the park, they interpreted it as a new twist on an old pattern of park attempts to keep elk off the reservation.

Indian resistance to being "managed" illustrated their continuing resistance to federal ownership of lands promised to them at the 1895 negotiations and the treaty which followed. Such resistance remained a defining feature of life at Babb and St. Mary. To be a local on the east side, although it required a large degree of dependence on the national park, also meant defying the national park. This would be true in other communities around the park as well, but at Babb and St. Mary it was strengthened by Indian experience, especially Blackfeet experience, of federal power. In the eyes of the Indians, the 1896 treaty gave them the right to hunt in the park's east side. The hunting rights provisions of the 1896 agreement remained a flashpoint for park/Indian conflicts throughout the twentieth century. Mushrooming elk populations in the St. Mary Valley at mid-century could change park perspectives on reservation hunting, but they could not subdue Indian challenges to park ownership of "the ceded strip."The irruption of elk at St. Mary created a strange new world on the park's eastern side. After decades of trying to keep elk in the park and away from Indians, rangers now tried to chase them out of the park and to the Indians. Indians, witness to the spectacle and still suspicious, took large numbers of elk and refused to abide by park service recommendations to "regulate" the hunt. It was a grudging arrangement, but it seemed at least somewhat effective for controlling elk herds.

The contest between local community and national authority had long revealed underlying differences in the ways people understood elk. To the park, they were a tourist attraction and part of the park's "natural" landscape. To the people of Babb and St. Mary, they were food, hides, clothing and cash. They were also a prize to be claimed in the on-going struggle over land use at the park's eastern border.

And, yet, they were more. Elk were as vital a part of local environments as people, and almost as unpredictable. Park authorities reported in the middle 1950s that hundreds of elk moved across the boundary into the reservation, and hundreds fell before Indian guns there as rangers fired rockets at the retreating herds. After decades of park attempts to separate animals from Indians, this was a peculiar spectacle. Stranger still was a note which found its way into a park report on elk hazing at St. Mary in 1954. The herd at St. Mary was much reduced, owing to the large number of elk which had left the park and vanished into the reservation. Rangers had assumed that Indians would kill any elk which stayed there for long. But apparently, one herd survived a migration across the entire length of the Blackfeet Reservation. They must have moved at night and escaped hunters by hiding in river valleys far out on the reservation where no one would be looking for them. They reappeared on the other side of the reservation to the east. At Cut Bank, 45 miles from the park, locals reported a stunning event. For the first time in more than half a century, elk had returned to the Sweet Grass Hills (Joseph 1955).

References

Adams. L. 1942. Report on the wildlife of the Blackfeet Indian Reservation. Record Group 75, Bur. Indian Affairs, Blackfeet Indian Ag., Decimal Correspondence 020–034, Box 7, Folder 031.0, Fed. Archives and Record Ctr., Seattle, WA.

Barnum. 1957. Memorandum to chief ranger. Folder 201-2, Ruhle Library Archives, Glacier Nat. Park, MT.

Eakin, J. R. 1923. Superintendent's annual report. Ruhle Library, Glacier Nat. Park, MT.

———. 1927. Superintendent's annual report. Ruhle Library, Glacier Nat. Park, MT.

———. 1929. December 14 letter to Director. Box 225, Ruhle Library Archives, Glacier nat. Park, MT.

———. 1930. Superintendent's annual report. Ruhle Library, Glacier Nat. Park, MT.

Emmert, J. W. 1953. April 3 memorandum to regional director. Folder 201-1 Ruhle Library Archives, Glacier Nat. Park, MT.

———. 1955. August 1 memorandum to regional director folder. Folder 201-1, Ruhle Library Archives, Glacier Nat. park, MT.

Ewers, J. C. 1958. The Blackfeet: Raiders on the northwestern plains. Univ. Oklahoma Press, Norman.

Fisher, J. 1992. Interview in possession of the author.

Folson, H. A. 1944. February memorandum for regional directors. Folder 200-11, Ruhle Library Archives, Glacier Nat. Park, MT.

Glacier National Park. 1947. Press release 47-11-13 (No. 19). Folder 200-12, Ruhle Library Archives, Glacier Nat. Park, MT.

———. 1950. Glacier National Park 1950 annual wildlife report. Folder 200-14, Ruhle Library Archives, Glacier Nat. Park, MT.

———. 1953. Glacier National Park 1953 annual wildlife report. Folder 201-1, Ruhle Library Archives, Glacier Nat. Park, MT.

———. 1953a. St. Mary elk herd reduction plan. Folder 201-1, Ruhle Library Archives, Glacier Nat. Park, MT.

———. 1954. 1954–55 St. Mary elk herd management plan. Folder 201-1, Ruhle Library Archives, Glacier Nat. Park, MT.

———. 1955. Annual animal census report for Glacier National Park, Sept. 20, 1953–Sept. 20, 1955. Folder 201-1, Ruhle Library Archives, Glacier Nat. Park, MT.

———. 1963. Long range management plan for eastern Glacier wildlife and range. Folder 201-4, Ruhle Library Archives, Glacier Nat. Park, MT.

Goodwin, G. E. 1917. Superintendent's annual report. Ruhle Library Archives, Glacier Nat. Park, MT.

Grinnell, G. B. 1901. The crown of the continent. Century Mag. vol. 62.

Hodgson, F. B. 1944. January 1 memorandum for the chief ranger. Folder 200-11, Ruhle Library Archives, Glacier Nat. Park, MT.

Joseph. 1955. February 16 memorandum to regional director. Folder 201-1, Ruhle Library Archives, Glacier Nat. Park, MT.

Libby, D. S. 1942. Superintendent's annual report. Ruhle Library, Glacier Nat. Park, MT.

———. 1944. August 3 letter to Chairman A. Willis Robertson. Folder 200-11, Ruhle Library Archives, Glacier Nat. Park, MT.

McClintock, W. 1937. Hunting and winter customs of the Blackfoot. Ser. II, No. 21, Walter McClintock Papers. Beinecke Library, Yale Univ., New Haven, CT.

Mather, D. 1915. September 4 letter to solicitor. Record Group 79, General Records, Central Files 1907–1939, Box 23, Folder "Game Protection."

Nelson, J. R. 1982. Relationships of elk and other large herbivores. Pages 415–441 *in* J. W. Thomas and D. E. Toiweill, eds., Elk of North America: Ecology and management, Stackpole Books, Harrisburg, PA. 698 pp.

Nelson, J. R. and T. A. Leege. 1982. Nutritional requirements and food habits. Pages 323–367 *in* J. W. Thomas and D. E. Toweill, eds., Elk of North America: Ecology and Management, Stackpole Books, Harrisburg, PA. 698 pp.

Scoyen, E. T. 1932. April 22 letter to director. Folder 196-2, Ruhle Library Archives, Glacier Nat. Park, MT.

———. 1933. Superintendent's annual report. Ruhle Library, Glacier Nat. Park, MT.

———. 1934. Superintendent's annual report. Ruhle Library, Glacier Nat. Park, MT.

———. 1935. Superintendent's annual report. Ruhle Library, Glacier Nat. Park, MT.
———. 1938. Superintendent's annual report. Ruhle Library, Glacier Nat. Park, MT.
Secretary of the Interior. Letter from the Secretary of the Interior transmitting and agreement made and concluded September 26, 1895, with the Indians of the Blackfeet Reservation. Senate Doc. No. 118, 54th Cong., 1st Sess.
———. No. date. Letter to Cato Sells. Record Group 79, General Records, Central Files 1907–1939, Box 23, Folder "Game Protection."
U.S. Court of Claims. 1935. Blackfeet Et. Al. Nations v. U.S. Court of Claims Reports.
U.S. Statutes at Large. S. 2777. Sixty-first Congress, Sess. II, Ch. 226, 354.
Warren, L. 1993. The hunter's game: Poachers, conservationists and twentieth-century America. Ph.D. diss., Yale Univ., New Haven, CT.

The Buffalo Robe Trade and the Displacement of the Canadian Bison

William A. Dobak
University of Kansas
Lawrence

The story of the near-extermination of the bison in the United States is a familiar one. About 1870, a new tanning technique made possible the use of buffalo hides as industrial leather (as drive-belts on factory machinery, for instance). At the same time, extension of railroads into the grassland offered a way to get the raw hides to market. The towns of Hays and Dodge City, on the Kansas Pacific and Santa Fe lines, became major shipping points for hides in the early 1870s, until the herds were virtually exterminated in that region. When the tracks of the Northern Pacific railroad reached Miles City, Montana, in November 1881, the stage was set for an assault on the northern herd. The last carload of hides was shipped in 1884 (White 1994: 247–248).

New technology—the tanning process and the railroad—was the cause of the bison's destruction in the United States. Yet, the bison had almost disappeared from the Canadian grassland by 1880, several years before a railroad entered the region, and the figure of the white hide-hunter does not appear in the environmental history of Canada (Hornaday 1887: 511, 513). The bison moved south from Canada gradually, because of decades-long over-hunting by Native peoples. The overhunting was a response to the demand for buffalo robes at American trading posts along the Missouri River, and the Hudson's Bay Company's demand for pemmican to feed the boatmen who brought trading goods to its inland posts and returned to York Factory on the bay with furs for shipment to England. That Native peoples, using traditional hunting methods, could affect such a drastic change in the environment—the displacement of an entire species—suggests that the ecological balance of the North American grassland was and is more precarious than generally is acknowledged; certainly more than was recognized in the nineteenth century.

Let us look first at the international commercial rivalry that caused Native peoples to overhunt the bison herds, nudging them westward from the country between Red River and the Missouri, and finally south, out of the Canadian grassland altogether. Later, we will consider the traditional hunting methods that, along with increased demand induced by trade, were sufficient to displace the bison. As the American fur trader Edwin Denig wrote in the 1850s, "They are a shy animal and will not remain where they are much troubled" (Denig 1930: 461).

In the late 1820s, John Jacob Astor's American Fur Company (AFC) established trading posts along the Missouri River. The Hudson's Bay Company's (HBC) trader at Brandon House, in southwestern Manitoba, reported in 1829 that Indians told him that "Americans . . . held out great encouragement to them, to go thither to trade. . . . They also affirm that if the Company does not establish a post nearer to them than this . . . that all the Indians in that quarter will . . . be induced to become Yankies" (Brandon House 1829). That same year, the AFC's Kenneth McKenzie founded Fort Union, at the confluence of the Missouri and the Yellowstone, to tap the trade of the

Blackfeet. In 1831, the AFC began steam navigation on the Upper Missouri, and the next year, the steamer *Yellow Stone* reached Fort Union and returned to St. Louis with a cargo of buffalo robes. "The Leviathan company of the North," as Kenneth McKenzie (1834) called the HBC, responded to the challenge.

Hudson's Bay Company senior officials plotted strategy at an annual meeting, held in the summer at a convenient place in the interior—Norway House, at the north end of Lake Winnipeg, or the Red River Settlement at the south end of the lake—or at York Factory on the bay itself. HBC trading posts received their annual "outfits" (trade goods from England) and shipped out their "returns" (furs, robes and pemmican) in York boats, rowed by French Canadians, Red River Metis or Scots recruited in the Orkney Islands. Because of high transportation costs, the HBC needed high-value, low-bulk cargoes—beaver and "fine furs" like marten. Pemmican (a compact, high-calorie meat-and-tallow mixture) was necessary to feed the boatmen. Since the Plains Indians and Red River Metis were its sources of pemmican, the HBC obliged them by trading some high-bulk, low-value buffalo robes. The Council showed the slight importance it attached to the robe trade in 1823 when it instructed the trader at Upper Red River to "procure 500 Buffaloe Robes if not too dear" (York Factory 1831).

The American Fur Company's challenge to the Hudson's Bay Company's hegemony brought a slow response. In 1830, when HBC posts traded only 1,049 robes, the Council "directed" traders "to use their utmost endeavors to collect large quantities" of robes. Two years later, when only 1,008 robes were traded, Council minutes noted the "recent defection of the Piegan tribe" to AFC posts, and urged "increasing the Returns in the article of Buffalo Robes in order to withdraw the Plains tribes from the American Establishments on the Missouri. . . ." In 1836, when HBC returns included 4,626 robes, the Council recommended "greater encouragement . . . for the trade in Buffalo Robes, which from the want of such encouragement falls into the hands of the American Traders on the Missouri." In 1839, the number of robes and "dressed skins" (tanned leather like that used for tipi covers) traded at HBC posts passed the 10,000 mark and stayed above, with a few temporary dips, until 1879, the last year of the trade (York Factory 1830, 1846, 1892).

The American Fur Company, for its part, was ready to meet competition from the north. "I have encountered various opposition traders & it has always been to their cost," Kenneth McKenzie wrote in 1835, a year when the AFC's Upper Missouri Outfit (roughly speaking, the posts above present-day Bismarck, North Dakota) shipped 23,640 robes to St. Louis, nearly eight times the number gathered at all Hudson's Bay Company posts from Red River to the Rocky Mountains (McKenzie 1835, York Factory 1846). Steam navigation on the Missouri River made the difference. In the 1820s, when the AFC brought its robes down the river in keelboats, the number shipped east to New York City each year was about 14,000. In 1833, the year after the *Yellow Stone's* first trip, the robes that reached New York numbered 31,000 (Swagerty 1991 [12]: 225, 227; [14]: 16; [15]: 857–858, 1,077; [21]: 115–116).

Although statistics for the fur trade in the United States are not nearly as complete as those kept by the Hudson's Bay Company, they permit a few comparisons. In 1854, when the Upper Missouri Outfit returned 29,251 robes, the HBC's total was 11,496, or 39 percent of the American's take. And the Upper Missouri Outfit represented only part of the AFC's operations. In 1853, 93,371 robes passed through St. Louis; the HBC traded just more than 13,000 (Swagerty 1991 [32]: 493, 731; [33]: 72–75; York Factory 1875). (By this time, the AFC had acquired a new post at Fort

Laramie, on the North Platte River, where the Western Sioux furnished thousands of robes each year; while this does not bear directly on the question of Canadian bison, it does illustrate the market's expansion into new regions and its ability to include a people, the Sioux, who themselves were expanding.) The number of robes traded north of the 49th parallel continued to be just a fraction of the number traded in the United States. The Hudson's Bay Company's customers, after all, were exploiting the resources of only the northern margin of the grassland.

What were the means Native peoples used to hunt the bison? The chase on horseback is the method probably most familiar to the general public. (The Montana artist Charles M. Russell painted the subject more than 45 times.) Usually depicted as a headlong free-for-all, both tribal and Metis hunts were, in fact, strictly regulated. In order to assure all families of an opportunity to get meat, the hunters moved on the herd at a given signal. Overeager hunters who stampeded the buffalo faced penalties of flogging and destruction of their property (Ewers 1955: 163–164, Hind 1860 [2]: 111, Ross 1957: 249). The chase was used both by the Red River Metis in their semi-annual hunts and the Plains tribes: the Assiniboines, Crees, and the three groups that made up the Blackfeet confederation: the Pikuni (Piegans), Kainah (Bloods) and Siksika (Blackfeet).

The Metis—an ethnic group descended from European and Canadian traders and Native women—had developed the two-wheeled Red River cart, made entirely of wood and rawhide. When drawn by an ox, one of the carts could haul a 900-pound load. Alexander Ross, a retired fur trader living in the Red River Settlement, estimated that the hunters brought in 545 tons of meat in 1840. Under optimum conditions, with an average cow yielding 300 pounds of meat, 545 tons would have represented the meat of 3,600 cows (Edmonton House 1855, 1860, 1869, 1870). Yet, Ross wrote "that not less than 2,500 animals had been killed" on the first day of the hunt alone, and that the Metis had managed to save, at most, 29 tons of pemmican and dried meat. Even allowing for weight-loss in drying, and what the hunters needed to eat, the amount of meat saved represented perhaps 10 percent of what was killed. A pack of more than 500 dogs accompanied the hunt, and wolves scavenged whatever carcasses had not been butchered by nightfall. It also is likely that rain ruined meat while it was being dried. Ross wrote that "a thunder-storm, in one hour, will render the meat useless," and travelers' journals often mention afternoon thunderstorms. Whatever the unavoidable waste associated with outdoor butchering may have amounted to, if 2,500 bison yielded 29 tons of pemmican and dried meat, a total of 545 tons would have required the slaughter of about 47,000 animals. This, for a population that in 1840 numbered 4,073 men, women and children (Ross 1957: 246, 264, 272).

If the Metis were loading their carts with provisions, as Alexander Ross stated, they did not have much room left for robes. Their communal hunts began in 1820; the District Fur Returns of the Hudson's Bay Company show that the Red River posts did not trade more than 1,000 robes in any year until 1849. Robes were coming from farther west, in the Swan River and Saskatchewan districts. In 1840, posts in the Saskatchewan District traded 3,844 robes, and those in the Swan River District 3,390, a total of 7,234 (York Factory 1846). But that was just a few years after a smallpox epidemic devastated much of the Plains population. The Crees did not suffer much, because the HBC had a supply of vaccine on hand, but as many as two-thirds of the Assiniboines and Blackfeet may have died (Milloy 1988: 71, Peers 1994:

141–142). Let us look instead at the year 1854, when the population had recovered somewhat. It is a year for which we have an accurate count of the returns of the AFC's Upper Missouri Outfit, as well as those of the HBC, and the year after a representative of the United States government's northern railroad survey made an estimate of the Blackfeet population. We will try to estimate the total Plains population for the early 1850s and, based on that figure, calculate how many buffalo might be needed for subsistence. What the Plains tribes killed beyond that—the 37,536 robes and dressed skins that were traded in 1854 at posts along the Saskatchewan, Swan River and the Upper Missouri—represents the extent of overkill that eventually would drive the buffalo out of Canada.

James Doty, of the northern railroad survey, was responsible for finding camps of the Blackfeet in 1853 and inviting them to a treaty conference. He estimated their number at 9,170, a figure close to the U.S. Indian agent's estimate of 9,400 in 1858 (U.S. Congress 1854 [1]: 443, 1858: 432). The American Fur Company trader Edwin Denig estimated an Assiniboine population between 3,400 and 3,700. In 1858, the Canadian explorer Henry Hind gave their number as 3,200 (Denig 1930: 397, 431, Hind 1860 [2]: 152). The British explorer John Palliser, who crossed the country between Red River and the Saskatchewan repeatedly in the years from 1857 to 1860, estimated the number of Crees at slightly less than 12,000 (Ray 1974: 185). Together, the three groups, which included nearly all of the people who were hunting buffalo in the lands between the Missouri and the Saskatchewan, numbered about 25,000.

Estimates of the number of women among the Plains tribes are hard to find, but they are important, for women skinned and butchered the buffalo, dried the meat and tanned the skins. The U.S. Indian agent for the Blackfeet in 1858 estimated 3,100 women, or nearly 32 percent, in a population of 9,400 (U.S. Congress 1858: 432). Censuses of the Cheyennes in 1860 and 1877 show that women constituted about 34 percent of the population (Berthrong 1963: 155, 1976: 17). If women made up roughly one-third of the entire Assiniboine, Blackfeet and Cree population of 25,000, there would have been about 8,000 of them. If each woman was able to tan 20 hides a year—not a remarkably high figure—it would have represented a kill of 160,000 animals (Denig 1930: 541). Allowing each person one skin per year as a lodgeskin, either as part of a new tipi cover or to repair an old one; two skins for garments; and two for use as robes, for sleeping and for outerwear, gives an annual requirement of 125,000 buffalo. (Admittedly, children would not need as many skins for clothing.) Adding to the 125,000 skins necessary for the people's own use the 37,000 robes they traded in 1854 yields a total of about 162,000 skins, or roughly the production one would expect, given the figures quoted above. Thus, the robe trade required the slaughter of nearly 30 percent more buffalo than the people's minimum needs.

Besides hunting buffalo on horseback, Native peoples sometimes drove or lured them into pens, called "pounds" in contemporary documents. The Canadian geologist Henry Hind, exploring the valley of the Saskatchewan River in 1858, described a buffalo pound built by the Crees: a circular fence about 120 feet in diameter "constructed of the trunks of trees . . . and braced by outside supports." Two converging lines of bushes, spaced about 50 feet apart, stretched about 2 miles out from an opening in the fence and made a funnel-like entrance. The buffalo were headed into the funnel by mounted men; those that tried to break out from between the lines of bushes were frightened by men on foot, waving robes, and headed toward the pound. Once inside, every animal was killed. The method was rather hit-or-miss. During the first attempt to use this pound, according to

Hind, one buffalo had broken through the wall and most of the herd followed him through the gap. On their second try, the Crees killed 240 buffalo (Hind 1860 [1]: 355–359, Larpenteur 1989: 340–342, Kurz 1937: 145–146).

The use of a buffalo pound required skill and patience. In 1862, for instance, the Hudson's Bay Company's chief factor at Edmonton House recorded that the Crees "are not hunting, as they wish to let the Buffalo draw in nearer, before they make the Po[u]nds" (Edmonton House 1862). Even so, sometimes the buffalo could not be enticed; near Fort Pelly in 1854, Indians complained that they "could not get the Buffalo in their pounds" (Fort Pelly 1854). Pounds, of course, required timber for construction, so this method of hunting was possible only on the margins of the grassland. During relatively warm winters, when the grass was not covered with frozen snow, the herds tended to stay in open country. At Carlton House, on the North Saskatchewan River, the chief trader noted in 1827 that "as the winter [h]as proven uncommonly Mild with little snow the Buffalo never advanced towards the Woods" (Carlton House 1827). Cold weather and lack of forage would bring buffalo toward the shelter of the parkland belt, where pounds could be constructed (Christie 1867). In any case, pounds were not the best way to secure robes. The American Fur Company trader Charles Larpenteur wrote in his journal that "the robes from the penned cattle are not considered as good as those which are not fenced up for they are very often injured by tramping over each other which very often takes the hairs off of the skin which does a great injury to the robes" (Larpenteur 1835). Pounds were more efficient as a source of meat than of robes. Since most HBC posts were located in the parkland belt, close to the habitat of fur-bearing woodland animals, and since the timber used in building pounds was close at hand, pounds often were an important source of provisions.

In this brief discussion, I have not meant to imply profligacy on the part of Native peoples. A certain amount of waste was to be expected in the course of outdoor butchering and tanning. Anyone who has lived in the grassland, or even traveled through it, knows how uncertain the weather is. Nor have I meant to imply that the commerce "corrupted" the Plains culture. Trade goods often were used as gifts, by which the donors demonstrated their generosity and enhanced their prestige in the community, and generosity always has been highly esteemed among Native peoples. But since contemporary documents contain no suggestion of epidemic disease among the buffalo (Roe 1934: 2–10), or of a general failure of pasturage, I submit that the extra pressure put on the herds in order to supply the robe and provision trade was sufficient to cause them to move south out of the Canadian grassland by the end of the 1870s. That this displacement could have been effected using traditional methods of hunting and tanning illustrates the precarious ecological balance of the grassland.

Acknowledgment

A grant from the Friends of Fort Union Trading Post funded much of the research for this paper. Material from the Hudson's Bay Company Archives is quoted by permission.

References

Berthrong, D. J. 1963. The Southern Cheyennes. Univ. Oklahoma, Norman.

———. 1976. The Cheyenne and Arapaho ordeal: Reservation and agency life in the Indian Territory, 1875–1907. Univ. Oklahoma, Norman.

Brandon House. 1829. Post journal entry, 10 March, B.22/a/22, Hudson's Bay Company Archives (HBCA).
Carlton House. 1827. District report, 1826–1827, B.27/e/4 HBCA.
Christie, W. J. 1867. Letter to J. Hackland, 9 December 1867, Edmonton House correspondence book, 1864–1868, B.60/b/2 HBCA.
Denig, E. T. 1930. Indian tribes of the Upper Missouri. Pages 375-654 *in* Annual report of the Bureau of American Ethnology. Washington, D.C.
Edmonton House. 1855. Post journal entry, 31 January, B.60/a/29a HBCA.
———. 1860. Post journal entry, 17 March, B.60/a/31 HBCA.
———. 1862. Post journal entry, 24 December, B.60/a/33 HBCA.
———. 1869. Post journal entries, 6 February and 29 December, B.60/a/37 HBCA.
———. 1870. Post journal entries, 27 January and 16 February, B.60/a/37 HBCA.
Ewers, J. C. 1955. The horse in Blackfoot Indian culture. Bur. Amer. Ethnology Bull. 159, Washington, D.C.
Fort Pelly. 1854. Post journal entry, 9 April, B.159/a/18 HBCA.
Hind, H. Y. 1860. Narrative of the . . . Saskatchewan exploring expedition. 2 v., London: Longman, Green.
Hornaday, W. T. 1887. The extermination of the American bison. Pages 367–548 *in* Smithsonian Institution Annual Report. Washington, D.C.
Kurtz, R. F. 1937. The journal of Rudolph Friederich Kurz. Bur. Amer. Ethnology Bull. 115, Washington, D.C.
Larpenteur, C. 1835. Journal entry, 9 October. Microfilm copy at Fort Union Trading Post Nat. Historic Site.
———. 1989. Forty years a fur trader on the Upper Missouri. Univ. Nebraska, Lincoln.
McKenzie, K. 1834. Letter to D. D. Mitchell, 21 January. Excerpts from the Manuscript Collections of the Missouri Historic. Soc. microfilm at Fort Union Trading Post NHS.
———. 1835. Letters to M. Bellehumeure, 24 November, and R. Crooks, 10 December, *ibid.*
Milloy, J. S. 1988. The Plains Cree: Trade, diplomacy and war, 1790 to 1870. Univ. Manitoba, Winnipeg.
Peers, L. L. 1994. The Ojibwa of western Canada, 1780 to 1870. Univ. Manitoba, Winnipeg.
Ray, A. J. 1974. Indians in the fur trade: Their role as trappers, hunters, and middlemen in the lands southwest of Hudson Bay, 1660–1870. Univ. Toronto, Toronto.
Roe, F. G. 1934. The extermination of the buffalo in western Canada. Can. Historic. Rev. 15: 1–23.
Ross, A. 1957. The Red River settlement. Ross and Haines, Minneapolis, MN.
Swagerty, W. R., ed. 1991. Papers of the St. Louis fur trade. Part I: The Chouteau Collection, 1752–1925. Univ. Publ. of Amer., Bethesda, MD.
U.S. Congress. 1854. 33rd Congress, 2nd session, S.Ex.Doc. 78, Reports of explorations and surveys. . . .
———. 1858. 35th Congress, 2nd session, H.Ex.Doc. 2, Report of the Secretary of the Interior.
White, R. 1994. Animals and enterprise. Pages 237–273 *in* C. A. Milner II et al., eds., The Oxford history of the American West. Oxford Univ., New York, NY.
York Factory. 1830. Minutes of council, 1821–1831, B.239/k/1 HBCA.
———. 1846. District fur returns, 1821–1846, B.239/h/4 HBCA.
———. 1850. Minutes of council, 1832–1850, B.239/k/2 HBCA.
———. 1875. District fur returns, 1846-1875, B.239/h/5 HBCA.
———. 1892. District fur returns, 1875–1892, B.239/h/6 HBCA.

Speaking of Wolves: A Call to Biophilia

Tommy Youngblood-Petersen
Montana Field Representative
The Wolf Education and Research Center
Ketchum, Idaho

The organization I work with, The Wolf Education and Research Center in Ketchum, Idaho, is examining wolf vocalization identification through spectrograph analysis with a captive wolf pack. We are working on vocal recording and analysis to determine whether individual wolves can be identified through their voice prints. This information will be tested and sample sizes increased with other captive packs and wild wolves. It may be possible to identify wild packs through vocal information, instead of telemetry, when biologists survey wild populations.

This is exciting research, and I will get back to it shortly. For I also want to talk about how we speak, to challenge you and I to communicate our research more personally. I believe the public needs to hear about science through story; they need to know *how* scientists learn as well as *what* they learn. Louis Warren stated in the 1992 symposium on environmental history: ''Historians are inevitably story tellers, whose task is to make sense of the past by telling factual stories about it. Environmental historians consider connections between human beings and the natural world, and how they change over time'' (Warren 1992). I am not a historian, nor an environmental historian, but I am a storyteller, intrigued by the connections between the human and natural worlds. I am here to tell stories, to blend the factual and the hypothetical, to blend science and dreams.

It is half-time at the Orange Bowl, Nebraska and Miami. I am watching the game on television with Evan, my 10-year-old, while folding clothes. Suddenly, the announcer exclaims, ''Ladies and Gentlemen, Federal Express is proud to sponsor the 1995 Orange Bowl, and bring you this exciting half-time show: a live circus featuring a man shot out of a cannon, exotic and rare tigers, aerial stunts and more.''

Unimpressed, Evan and I look at each other and shrug our shoulders. We see three large cats being driven into a circular cage with their ''trainer.'' One of them is creamy white with dark, lightening-striped patterns across its back and stomach, another is night black and the third a huge African lion with full mane. The trainer cracks the whip in their faces and the cats—fur rippling as their thick wild muscles innately react to the trainer and his whip—bare their teeth, hesitate and then acquiesce, jumping up on small pedestals for display to the Orange Bowl crowd. But the creamy white cat with black stripes refuses to jump and nervously paces back and forth in front of the trainer. He snaps his whip again and this time the white cat jumps, but not onto the pedestal. It turns its head towards the trainer's knee and lunges for him, snarling, white teeth flashing. Evan and I are motionless.

The camera moves quickly, and Evan and I barely have time to let out our cheers for the cat. For 20 dancers are on the screen now, men and women dressed in pale blue silkish costumes, the women with low V-cuts. The women are slinking into the men's arms and we hear them purring, ''we are the other felines under the big top tonight,'' and the women dreamily eye the men, running their hands seductively over the men's faces.

A quick camera pan again. We see an enormous grizzly bear with a thick, glistening auburn coat. It is beautiful. It is muzzled and on a long leash. The griz, a red derby banded to its head and frilled matching skirt attached to its waist, is led to the steering wheel of a small convertible car. The griz barely fits behind the wheel, its large stomach squeezed tightly against it, and there is laughter at the contrast of sizes, 800-pound grizzly and diminutive car. The grizzly grabs the wheel and begins rocking it back and forth, "steering," and Evan and I see *Ursus horribilis* rip the wheel right off the steering column. This evidently was supposed to happen, for the bear trainers are holding their stomachs, feigning laughter and amusement.

The camera quickly switches back to the twenty dancing blue ladies and this time they are all holding small brown teddy bears as they dance. We hear them sing-song in unison: "The bear is a squeal/he rips off the wheel/his middle is extreme/if you know what I mean." And the women dancers coyly poke the teddy bears in the stomach with their manicured fingers.

After calling Federal Express to voice my anger toward their corporate support and, therefore, tacit approval of the half-time show, I realized that part of what disturbed me about the Orange Bowl half-time circus is that 2 million people saw this blatant humiliation of animals—both four-legged and two-legged—and might not have thought twice about it; in fact, probably enjoyed the show. I was under the illusion that my views of treating animals with respect were held by most people. I was wrong. I think the majority of Americans view their relationship with animals, and their relationship to the natural world, with indifference, or even worse, with domination and control. And that is disturbing. That is very disturbing.

I want to talk about "biophilia," defined by E. O. Wilson in *The Biophilia Hypothesis*, as ". . . the innately emotional affiliation of human beings to other living organisms" (Wilson 1993). Wilson (1984) also noted that "to the degree that we come to understand other organisms, we will place greater value on them, and on ourselves." Stephen Kellert (1993) further clarified Wilson's concept by saying that biophilia "might be an expression of biological need, one that is integral to the human species' developmental process and essential in physical and mental growth."

And I want to speak of wolves and how attitudes toward this species in the Northern Rockies may be a litmus test for feelings of biophilia—or biophobia—toward the natural world as a whole. But as educators and researchers, you and I first have to feel that connection; we have to become biophiliacs, and then learn how to communicate our biophilia to others. Because of the potential for biophobia in our culture, those of us here might have an especially large responsibility to speak of wolves and other species in ways that communicate our "emotional affiliation to other living organisms."

In February 1995, I skied three miles from the outskirts of Stanley, Idaho, to the 20-acre enclosure that is home to the Sawtooth Wolf Pack, a group of eight wolves that were born and raised in captivity for a film project. This pack soon will be moved to another 20-acre enclosure on the Nez Perce Reservation, where the Nez Perce and the Wolf Education and Research Center are building an environmental education and research facility. Unable ever to be released in the wild, the Sawtooth Pack will become an ambassador pack for wild wolves, as the public will be given the unique opportunity to directly experience the simple awe and respect that *canis lupus* evokes.

The pack's current home hugs the base of the jagged Sawtooth Mountains in southcentral Idaho. It is here that biologist Megan Parker is conducting spectrograph analysis, attempting to identify individual wolves through voice prints.

The sun had just fallen behind the 10,000- and 11,000-foot peaks of the Sawtooths, and Megan asked if I could ski away from the site about a quarter mile and howl, and see if the wolves would "answer." She would be inside the enclosure to record some of the individual wolves' howls.

Parker explained her reasoning. "If I howl, trying to elicit their response while I'm in with the pack, they just look at me like, 'what are you doing that for?' They don't respond. But if you can get a little distance away, and they don't see you, then we might be able to get them to howl back, at least for a little while."

Parker assembled her digital DAT recorder and uni-directional microphone. She explained that the $1,200 Sonnheizer microphone, if held near a particular wolf while howling, was able to pick up just that individual wolf; all other howls would be recorded as background. Parker went on to explain that when wolves howl, a fundamental tone is produced by each individual on top of which other tones are sung. Parker's research is attempting to individualize these tones, to identify particular wolves with specific howls. Dr. Erick Greene, at the University of Montana, has generously offered his assistance and laboratory to analyze the recordings. Parker and Greene are talking about the possibilities of identifying wild packs through vocal information perhaps, instead of telemetry, when biologists survey wild populations.

I started skiing, heading for a stand of lodgepole pines where I would be out of sight of the wolves, while Parker went inside the enclosure. After reaching the stand, I stopped, checked my watch for the coordinated time and waited a few minutes. Other than an occasional raven's caw, it was still, clear, windless.

I put down my ski poles, cupped my gloved hands around my mouth, raised my neck up and let loose with the best howl I could muster.

Moments later, I heard the response. Echoing off the Sawtooth granite was a chorus of enthusiastic howls from the pack: yaps, moans and single notes dropping and raising in haunting musical intervals. Because wolves layer their notes in harmonies rather than singing in unison, it sounded like 15 wolves, not 8, and after I howled once more, the chorus intensified and sang out, a question, a statement? I don't know what they were saying, but it was indeed some sort of answer to my call. I started laughing to myself and broke into a very unscientific but incredulous wide-mouthed grin.

After my third howl got a half-hearted response, I stopped, figuring that the pack was tired of this game. The woods were completely quiet again, and I remembered that music also is the absence of sound.

It was a biophiliac connection, not a totally unusual connection, as we know that wolves respond to human howls, but a connection and response that was very different than, say, asking your dog to "speak." It was a specific response, a dialogue, a conversation if you will. The tongue was foreign, the exact words mysterious, but their intent was not.

That we need to take a hard look at biophilia is best said by Scott McVay (1993): "Our persistence as a species will depend upon cognition of ourselves as part of nature and recognition of our new duty to see how much of creation can be sustained." All that I read and understand about Wilson's work on biophilia, and much of what I see around me, leads me to believe that a segment of our Euro-American culture is drawing away from, not toward, the natural world. Witnessing the Orange Bowl half-time certainly verifies this in my mind.

Here is the essence of the biophilia hypothesis: according to Wilson and Kellert, we don't only need to be connected to the earth, we have to be connected (Wilson 1993). It is a necessity, a biological survival tool. This connection is not a matter of choice, but an essential ingredient of our biological makeup. It is mandatory to realize that our very lives, the heart and soul of our lives, depends on the rest of creation. After we realize our dependency, the biophilia hypothesis goes, we see the way in which biodiversity is threatened, the way in which species are going extinct at astounding rates. The result of species extinction, then, is the draining of our lifeblood, with the human species in need of a transfusion to keep us alive.

How do we get that transfusion? What is the way that new blood could course the veins of the 2 million Orange Bowl viewers? Of course, direct experience, like hearing the Sawtooth Pack, is best. But I suggest that new blood can also move through story, allowing our culture to feel through the power of language, a ski trip to the Sawtooths, the awe of a wolf's response, the stillness of a forest.

Some say that modern societies' penchant for zoos, pets and indoor apartment plants—an apparent new blood of contemporary feelings toward nature—is ersatz lifeblood. We are moving from experiencing the real wild to experiencing a very flaccid imitation that we *believe* is the real thing. But we are being fooled.

We are fragmented and less whole without the wild, and the substitutes—circuses, domesticated animals—are weak substitutes at best. At worst, they do irreparable harm to our psyches by fooling us into thinking and feeling that they, these substitutes, *are* the connection we need to wildness.

But a real wild animal, the gray wolf, is slowly recovering in the Northern Rockies. Through natural recovery and reintroduction, almost 100 wolves are loping through the wilds of Montana, Idaho and Wyoming. We might experience a biophilia connection with wolves through howling, but biophobia also is alive and well in the West.

More than 60 years ago, in 1933, the bounty law in Montana finally was repealed, after 80,000 wolves were killed and bountied (Lopez 1978). But the Associated Press reported in *The Missoulian* on January 20, 1995, that the House Agriculture Committee of the Wyoming state legislature passed eight to one, a bill which puts a $1,000 bounty on wolves that wander outside the Yellowstone Park boundary. The sponsor of the bill, Republican state Representative Roger Huckfeldt—pictured with a wolf pelt draped on his chair—said, matter-of-factly, that the bill probably violates federal law and encourages wolf killing.

Wyoming Governor Jim Geringer did veto the bill, although solely on the grounds that it was unconstitutional. Geringer told the committee that he appreciated the sentiment behind the wolf bounty, and believes it sends a message about how Wyoming feels about wolves in Yellowstone. Hunter Bill Yanacone of Cheyenne, it was reported, said maybe Wyoming should just forget the bill and take the matter into their own hands. Speaking in reference to three radio-collared wolves that were killed recently in Minnesota, Yanacone said, "In Minnesota, they have the three 'S's—shoot, shovel, and shut-up—and maybe that's what we'll do."

Montana state Representative Marian Hanson, a republican rancher from Ashland, Montana, and speaker *pro tem* of the Montana House, also has sponsored anti-wolf legislation. House Joint Resolution #8 urges Congress to reintroduce wolves into other states besides the three selected in the Northern Rockies: Montana, Wyoming and Idaho. She suggests putting wolves "into every other ecosystem and region of the United States, including Central Park in New York City, the Presidio in San Francisco, and Washington, D.C.'' Hanson asks, ''Why pick on three states? Why don't they pick on Texas or Tennessee?'' (*The Missoulian*, January 16, 1995).

And U.S. Representative from Idaho Helen Chenoweth is pushing Congress and Secretary Babbitt to allow hunting of wolves and other predators within the boundaries of Yellowstone National Park.

Is this the raucous voice of a few radical conservatives? Possibly. Is it ludicrous, preposterous, media-grabbing legislation, proposed to make a statement? Definitely. But a statement that I suggest represents the veiled sentiments of wolf opponents across the Inland West.

The House Joint resolution #8 by Marion Hanson to urge wolf reintroduction in Washington, D.C. did receive a hearing from the Montana House Fish and Game Committee. No executive action has been scheduled to date.

And so biophobia seems alive and well.

''Don't talk to me about living with wolves and grizzlies,'' the bearded, bespectacled man sitting across from me at the table growled. ''I lived in Alaska for thirteen years and had to stand on my front porch with my rifle to protect my kids from bears and wolves while my kids played in the front yard.'' He paused, and then extended his neck and head inches away from my face. ''There are some animals we just can't live with,'' he said with certainty, got up, and walked away.

I had never met this man before. He had seen me writing, asked what I was writing about and offered his opinion without solicitation.

Wolves aren't the only species that is struggling to hang on in the Northern Rockies. Four grizzly bears were mysteriously killed in the North Fork drainage just west of Glacier Park in Montana. The bears' radio-collars were found in ditches, their carcasses found rotting, half-hidden nearby (*The Missoulian*, November 13, 1994). Salmon are declining at an alarming rate, too, being killed in everything from silted river-beds to power turbines. They are too expensive to save, say some.

''The issue is not wolves,'' says Karen Henry, fifth-generation cattle rancher and president of the Wyoming Farm Bureau. ''The issue is control of the land. This is part of a bigger agenda from the Interior Department to control the West. If they control the land and if they control the water, then they control the people'' (*The Missoulian*, January 8, 1995).

I think she is exactly right. Control. And this is part of my point: the issue is about a strong human desire to have control over, but not co-exist with, the natural world. According to Roderick Nash (1967) in *Wilderness and the American Mind*, Euro-Americans have a history of controlling and dominating wild places and wild animals, and it is difficult to wrest this control from their hands. Where is our ''emotional affiliation to other living organisms?''

Joseph Bruchac (1993) wrote:

If we pretend
that we are at the center,
that moles and kingfishers,
eels and coyotes
are at the edge of grace,
then we circle, dead moons
about a cold sun

If you and I feel that a return to the wolf bounties of the early 1900s is not what we see as progressive wildlife management; if we feel that wolves and salmon can indeed coexist with humans; if we feel that grizzlies on leashes in the Orange Bowl half-time might not represent a wild grizzly's best interest, then it is our responsibility to become biophiliacs and communicate our "emotional affiliation" to others.

Why does a scientist need to be a biophiliac? Because science is well-respected in our contemporary world, and rightly so: science and reason have expanded our capacity for understanding the natural world. People pay attention when you are identified as a scientist or a doctor, and, for the most part, they treat the scientific community with admiration.

Because of this respect, the scientific community carries a deep responsibility to respond fully to human needs. Responding fully means speaking with reverence as well as reason, with feeling as well as fact. Be aware that people listen when you speak, and that your words and writings directly mirror the feeling, or lack of feeling, you carry for the natural world. Your biophilia, if you choose to express it, can be contagious. Dig deeply, reflect and speak from your heart. Our culture needs you.

How do we speak? Research is important, certainly. But you and I know that even the best research often is overshadowed and ignored by culture. For example, research in Montana and Minnesota tells us that wolf depredations on livestock are less than 1 percent (Ream et al 1986, Mech 1970). But wolf opponents ironically borrow a *canis lupus* metaphor and cry wolf about the possibility of high livestock depredations. The Farm Bureau, in its injunction against wolf reintroduction in the Northern Rockies, told stories about devastating wolf kills on livestock from the 1910s and '20s. The Wyoming judge who denied their injunction scolded them: this is the 1990s, he said, and contemporary depredation research does not show the "irreparable harm" that the Bureau claimed (*The Missoulian*, January 4, 1995). Yet, those stories by grandfathers and great grandfathers of mass livestock kills by wolves continue to capture our consciousness. Why? Because they are stories, and they are stories with feeling.

If we desire to be both credible and memorable, we must speak not only factually, but also with feeling. One way to do this is to speak of wolves and other species by naming them.

The Wolf Education and Research Center has initiated the "Track a Wolf Project" in the Idaho school system. The radio collars that were put on the 15 wolves reintroduced to central Idaho first were given to school children, mainly in rural Idaho schools near wolf recovery areas. These kids decorated the collars with bright colors and etched names on the collars: "Akiata," "Moon Star Shadow" and "Chat Chaaht," translated as "Older Brother" in the Nez Perce tongue. As the reintroduced wolves are tracked by biologists, with kills noted, habitat used and direction traveled, the school children become partners in learning as they receive this information about "their" wolf from the biologists. The "Track a Wolf" project allows the children to learn directly from the wolf, gain ownership of an historic event occurring in their own backyards and hopefully pass on their enthusiasm and learning to their parents.

But it is the names of these wolves that have stuck in peoples' minds and hearts. As you probably are aware, the media coverage of wolf reintroduction in Central Idaho and Yellowstone was intense. And part of what the media focused on were these collars and these names. One news update on the reintroduced wolves told us this: that "Chat Chaat," the wolf named by Nez Perce schoolchildren, ironically had traveled near Chief Joseph Pass, and, during one monitoring overflight, "Akiata" was seen lying on her back, paws in the air. Biologists later learned Akiata had stuffed herself on a whitetail deer and was basking, belly-up, in the sun. Names help us move toward that "emotional affiliation."

Diane Boyd is a wolf biologist, and worked for the Wolf Ecology Project out of the University of Montana for 14 years. The Wolf Ecology Project and Boyd were instrumental in tracking the first wolf known to den in the Western United States in a half-century. It was a creamy-white wolf that came down from Canada and denned in Glacier Park in 1986.

"This white wolf became Alpha female," Boyd told me, "and her pups formed what we called the Magic Pack. We named the wolf 'Phyllis,' but of course for scientific purposes she was 8550: '85' for the year she was collared, the '50's, assigned to females." Boyd paused thoughtfully for a moment, and then continued, "You know, we assigned the numbers to avoid accusations of being unprofessional, for giving names and not numbers to our research wolves. But it's funny, it was always the names, like 'Phyllis,' that agency people and the public remembered."

Finally, I want to speak about dreams, about the effects that animals have on our deepest selves. As scientists, you often must mask those effects. But as humans—as speakers and educators—I think it's imperative that we speak our dreams aloud.

Diane Boyd and I were traveling in her cinnamon-red pickup up into Canada to track and trap wolves in the Alberta bush. We went in search of Phyllis'—the white wolf—offspring. We were driving along the northeastern side of Glacier National Park in a heavy, wet mid-winter snow and ice storm. The road is a ribbon of curves and we heard the tires crunch coldly as Boyd slowed the truck through the ice.

"You know I never trapped Phyllis," Boyd was telling me, her voice raised over the noisy ice, "but I've trapped quite a few other wolves, and a kind of strange thing always happens before I go out to check the traps."

"I have these dreams the night before I go out to trap," Boyd continued. "I dream that I trap a wolf, and sometimes I dream everything—the color and sex of the wolf, the situation and habitat—and the next day I check the traps and I find the wolf I've dreamt about. Now there are nights before when I don't dream, and we get a wolf. But every time I do dream, a wolf is there. It's like I'm living out the dreams."

Boyd pulled the truck over and shut it off. We got out and tried to stretch the road miles off. We saw last light illumine Chief Mountain on the northeastern edge of the park. The flat-topped mountain has, for centuries, been an important vision quest site for the Blackfeet and other tribes. It continues to be a sacred site, and as we watched the scarlet light steal from the uppermost points of this revered mountain, silence fell, ringing with Boyd's dream and those vision ghosts.

References

Bruchac, J. 1993. Prayer. Page 3 *in* S. Kellert and E. O. Wilson, eds., The biophilia hypothesis. Island Press, Washington, D.C.

Kellert, S. 1993. Introduction. Page 20 *in* S. Kellert and E. O. Wilson, eds., The biophilia hypothesis. Island Press, Washington, D.C.

Lopez, B. 1978. Of wolves and men. Charles Scribner's Sons, New York, NY.

McVay, S. 1993. Prelude: A Siamese connexion with a pluarality of other mortals. Page 16 *in* S. Kellert and E. O. Wilson, eds., The biophilia hypothesis. Island Press, Washington, D.C.

Mech, L. D. 1970. The wolf: The ecology and behavior of an endangered species. The Natur. Hist. Press, New York, NY.

Nash, R. 1967. Wilderness and the American mind. Yale Univ. Press, New Haven, CT. and London.

Ream, R. R., M. W. Fairchild and D. Boyd. 1986. Wolf Ecology Project progress report. School of Forest., Univ. Montana, Missoula.

Warren, L. 1992. Poachers, conservationists and ecosystems: Local struggles over American wildlife. Trans. No. Amer. Wildl. and Natur. Resour. Conf. 57: 711–716.

Wilson, E. O. 1993. Biophilia and the conservation ethic. Page 31 *in* S. Kellert and E. O. Wilson, eds., The biophilia hypothesis. Island Press, Washington, D.C.

———. 1984. Biophilia. Harvard Univ. Press, Cambridge, MA.

Conservation and Equality: The Bison as a Natural Resource

Andrew C. Isenberg
Brown University
Providence, Rhode Island

In 1870, John Cook signed on as a skinner in a bison-hunting outfit operating out of Dodge City, Kansas. Like thousands of other hide hunters and skinners in the 1870s, Cook soon found himself camped south of the Arkansas River. The presence of white bison hunters south of the Arkansas raised difficult questions about the disposition of hunting rights between the Plains Indians and Euroamericans, because, the United States' government had reserved this territory by treaty to the Comanches, Kiowas, Southern Arapahos and Southern Cheyennes. The Indians maintained that, at the time of the treaty negotiations in October of 1867, the United States had promised to forbid white hide hunters from the territory south of the Arkansas (Gard 1959).

The white hide hunters were extraordinarily destructive of the bison herds, the plains nomads' most important natural resource. In six weeks, Cook's outfit stacked up more than 2,000 hides. To amass so many hides was quite a feat, given the wastefulness of the white hunters. Poor hunters wounded two or three animals for every one they killed; the crippled bison wandered away only to fall later to wolves. Inexperienced skinners, such as Cook, often ruined hides as they flayed them, or failed to stretch and stake them to dry properly. Altogether, in the early 1870s, every hide shipped to market probably represented three to five dead bison. In 1873, an Army officer stationed on the Arkansas testified to the devastation of the hide hunters: "where there were [once] myriads of buffalo," he wrote, "there were now myriads of carcasses . . . [and] the vast plain . . . was a dead solitary desert." (Dodge [1873] 1989). The profligate slaughter of the bison in the southern nomads' hunting territory gave Cook a moment's pause. "What would you do, John. R. Cook," he asked himself, "if you had been a child of this wonderfully prolific game region . . .? What would you do if some outside interloper should come in and start a ruthless slaughter upon the very soil you had grown from childhood upon . . .? But there are two sides to the question," he reasoned, "It is simply a case of survival of the fittest. Too late to stop and moralize now." (Cook [1907] 1989).

The slaughter of the herds in the 1870s and early 1880s was the final phase of the dynamic relationship between economic culture and the natural environment in the nineteenth-century plains. Over the course of the century, the continuing interaction among indigenous and Euroamerican economies, cultures and ecologies drove the bison to near extinction. The destruction began in the second third of the nineteenth century, as the nomads were increasingly integrated into the Euroamerican market economy. They killed vast numbers of bison as they competed in the effort to provide robes to Euroamerican traders. The commercial exploitation of the bison culminated in the final third of the nineteenth century, as Euroamerican hunters such as John Cook pressed the herds to the brink of extinction. The final slaughter was guided not only by the desire to profit from the herds but by a competitive, Darwinian worldview that regarded the extinction of the bison and the subjugation of the nomads as the just desserts of the biologically and socially unfit (Isenberg 1993). As Cook mused, "It is simply a case of survival of the fittest." Cook's unselfconscious rationalization revealed the symbiotic relationship between unequal and competitive economic cultures and the destruction of wildlife. The mid-century trade in bison robes prospered only insofar as the Indians' social orders became increasingly characterized by competition and inequality. In the final third of the century, competition and the destruction of wildlife reached their apogee together, as white hunters delivered the coup de grace to the herds in part to deny their use to the nomads.

The destruction of the bison had its roots in the European ecological conquest of North America (Crosby 1986). In the eighteenth century, Native Americans on the fringes of the plains and in the Missouri River valley adapted to the arrival of the horse from the Old World to become nomadic equestrian bison hunters (Holder 1970). In order to exploit the herds, the Indians adjusted their social organization to the habits of the 25 million or so plains bison who wandered throughout the grasslands in groups as small as 5 or as large as 100. Groups of bison joined together in large herds only during the summer, when the western plains shortgrasses were at their thickest and most nutritious. Reliance on the bison meant constant movement and the dispersal of tribes into bands of a few hundred or a few dozen during most of the year (Oliver 1962). The constant movements and divisions of the nomads on the high plains helped to insulate them from the deadly Euroamerican crowd diseases that nearly destroyed many village tribes of the Missouri River and its tributaries between 1780 and 1782 (Ewers 1973, White 1978). The creation of the equestrian plains nomadic societies, thus, largely was a reaction to the European ecological conquest of North America.

Equestrian bison hunting necessitated a dependence on intertribal trade. The nomads often found it difficult to supply their horses with sufficient water and winter forage (Osborn 1983). Thus, the nomads acquired horses and corn at the Indian villages of the Upper Missouri or the Rio Grande in exchange for robes and dried bison meat (Wood 1980). Eighteenth-century Euroamerican fur traders grafted their commerce onto the existing intertribal trade network. Among groups already leveled by seasonal dispersal, Euroamerican commerce spread rapidly. Once the plains nomads had become decentralized bands of economic specialists who produced a surplus for the purpose of intertribal exchange—all elements of the protohistoric transition to equestrian nomadism—it was a comparatively small step to commercial exchange with Euroamerican fur traders.

Yet, until the second third of the nineteenth century, the nomads' consumption of Euroamerican goods was minimal. A French fur trader noted in the first few years of the century that the Crows and the Teton Sioux "have not yet used intoxicating liquors enough so that they have a passion for them" (Tabeau [1803–05] 1939). An American fur trader complained that when the Assiniboines first came to the Missouri to trade in the early nineteenth century, "they were the poorest of all Indians, and used knives made of the hump rib of a Buffalo, hatchets of flint stone, cooking utensils of clay or skin, awls and other tools made of bone, and arrow points or spear heads of stone" (Denig [1854] 1961). Not until the 1830s, after the process of steamboats up the Missouri River to the mouth of the Yellowstone and the liberalization of laws regulating commerce with Indians, did the market in bison robes oversweep the plains.

During the acceleration of the fur trade in the 1830s, commerce began to characterize the social relations of the plains nomadic societies. Debt dictated social status among the Comanches (Plummer [1836] 1973); the Crows and Blackfeet used wealth acquired in the fur trade to attain greater prestige (Nabokov 1967, Lewis 1942). When the forty-niner William Kelly encountered the Sioux on the Overland Trail, he wrote that they "displayed a quickness of discernment, and adroitness of dealing, that would have done credit to a Cheapside apprentice" (Kelly 1851).

One of the first and most noticeable effects of the commercialization of the nomadic societies was the erosion of women's status. By the 1830s, a traveler in the plains described Indian marriage as a "business transaction," in which a suitor purchased a woman from her father (Farnham [1843] 1904). Hunters primarily acquired women to process bison robes for the fur trade. A Euroamerican captive of the Comanches reported in 1836 that her Indian master set her to work dressing buffalo robes; indeed, he required her to dress a certain number of robes each month (Plummer [1836] 1973). As the demands of the fur trade rose, husbands and fathers in kinship groups pressed more women into service to dress robes for trade. "Amongst those tribes who trade with the Fur Companies," wrote the artist and ethnographer George Catlin in 1832, "the women are kept for the better part of the year, dressing buffalo robes and other skins for the market; and the brave or chief, who has the greatest number of wives, is considered the most affluent and envied man in the tribe" (Catlin [1832–39] 1913). Polygyny increased markedly among the nomadic tribes in the mid-nineteenth century. Moreover, women entered into marriage at ever-younger ages (Lewis 1942). The rise of polygyny and the fall in the age of women at first marriage was one of the insidious effects of market relations upon the nomadic societies. When Euroamerican traders brought wealth and prestige to hunters in exchange for bison robes, they encouraged the creation of inequitable gender relations in order to accumulate robes.

In pursuit of robes, Indian hunters were tremendously destructive. Catlin, writing in the 1830s, estimated that the nomads traded 150,000 to 200,000 robes each year. William S. Hatton, an Indian agent, conducted a thorough survey of the Missouri River trade between St. Louis and the mouth of the Yellowstone in the summer of 1849, and concluded that the nomads sold 110,000 robes each year to the traders. Moreover, that number reflected not "the great abundance of the buffalo, but the unusual diligence and industry of the Indians hunting them" (Hatton 1849). According to Catlin and the fur trader Edwin Denig, at the mouth of the Teton River in 1832, a large herd of bison appeared across the river from a Sioux encampment. Five hundred or six hundred Sioux hunters forded the river at noon, spent the afternoon slaughtering bison, forded the river again at sundown, and, in exchange for trade goods, presented the resident traders with 1,400 fresh bison tongues.

Ecological pressures conspired with the nomads to reduce the herds. Beginning in 1846 and continuing for the next decade, rainfall in the plains was below average (Lawson 1974). The extended drought reduced the carrying capacity of the plains at a time when the bison were under extraordinary pressure from Indian hunters. Also in the 1840s, caravans of European emigrants began traversing the plains; the emigrants' livestock overgrazed the grasses along the Platte River road, effectively destroying the region for bison. Above all, the steady pressure of Indian commercial predation caused greater and more erratic migrations of the bison, interrupting the animals' search for forage and the congregation of the herds in the rutting season (Bamforth 1987). Drought and habitat degradation combined with Indian commercial hunters to eliminate millions of bison before the arrival of the first white hide hunters in the plains.

The hide hunters stormed into the plains in the 1870s, armed not only with powerful, accurate rifles, but with a Darwinian worldview that sanctioned the destruction of useless species, the subjugation of inferior races and the impoverishment of the shiftless (Isenberg 1992). The work of European and American naturalists exemplified the late nineteenth-century worldview. Natural scientists such as Charles Darwin, Alfred Russel Wallace and Asa Gray saw in nature turbulence, competition and change (Worster 1985). Darwin maintained that "under nature during the constant Struggle for Existence, we see a powerful and ever-acting form of Selection. A grain in the balance may determine which individuals shall live and which shall die" (Darwin [1859] 1962). In Darwin's nature, the extinction of species such as the bison was not a loss but a triumph. According to Darwin's tautology, an extinct or even rare species was by definition unfit. Whether extinction was the result of competition in the non-human natural world or collision with humans—the most favored species of all—was irrelevant.

Likewise, in the mid-nineteenth century, most white Americans assumed that the expansion of the United States at the expense of Native Americans was a process of natural selection (Horsman 1981). Darwin's colleague Alfred Russel Wallace (1870) was blunt: "the red Indian[s] . . . die out, not from any one special cause, but from the inevitable effects of an unequal mental and physical struggle . . . just as the better adapted increase at the expense of the less adapted varieties in the animal and vegetable kingdoms." The expansion of Europeans at the expense of non-Europeans, Wallace argued, was a natural improvement of humanity.

Just as scientists believed that biological and racial competition improved nature and humanity, political economists in the middle of the nineteenth century believed that economic competition ensured the growth and betterment of American society. Just as nature selected the fittest for survival, the operations of the market selected that efficient and productive for prosperity. Indians, in particular, were destined for poverty: "Such are their apathy and improvidence," wrote one political economist, "that they often suffer extreme want" (Bowen 1870). Where the law of nature decreed the extinction of unfit species, the law of economy ordained the impoverishment of the unindustrious. Nature and economy, argued the mid-century worldview, assured the dominance of the strong and the extinction of the unfit. To resist the process of weeding out unfit species—be they animal, vegetable or racial—was not only pointless, but contrary to the design of nature.

The late-century creed of natural, racial and economic competition provided the blueprint for the near extermination of the bison between 1870 and 1883. Bison-hunting outfits scoured the southern plains in the early 1870s. With roughly 1,000 hunters aiming for a regular quota of 25 hides a day, the hide hunters quickly extirpated most of the several million bison remaining in the plains (Mayer and Roth 1958, Strickland 1949). Colonel Richard Irving Dodge estimated that, in just three years, railroads in the southern plains shipped more than 3 million hides east. He reckoned that the figure probably was a mere indication of the actual number of bison killed, given the wastefulness of the hunters and the shoddiness of railroad records (Dodge [1873] 1989).

Euroamerican policy makers in Washington and in the plains were sanguine about the extermination of the bison. Columbus Delano, the Secretary of the Interior, wrote in 1872, "The rapid disappearance of game from the former hunting-grounds must operate largely in favor of our efforts to confine the Indians to smaller areas, and compel them to abandon their nomadic customs" (Delano 1872). In the plains, military officials encouraged the activities of bison hunters. Colonel Dodge invited both commercial and sport hunters to kill bison inside and outside the Indians' hunting reserves (Butler 1913, Mooar 1933). Frank Mayer claimed that he, like other bison hunters, received thousands of rounds of free ammunition at military posts. John Cook believed that the hunters' destruction of the herds had the blessings of the Army. He maintained—probably apocryphally—that General Phil Sheridan reportedly told the Texas state legislature in 1872 that the hide hunters "have done more in the last two years, and will do more in the next year, to settle the vexed Indian question than the entire regular army has done in the last thirty years. . . . Send them powder and lead, if you will, but for the sake of lasting peace, let them kill, skin, and sell until the buffaloes are exterminated" (Cook [1907] 1989).

Congressional bills in 1874 and 1876 that reserved use of the bison to the Indians of the plains never became law, just as Euroamericans ignored the treaties of 1868 reserving certain territories to the nomads for bison hunting. Indian policy, in effect, was to allow the market in hides to proceed unfettered. The effect was predictable. After clearing the southern plains of bison by the late 1870s, the hide hunters moved north, where they finished their work by 1883. When the naturalist William Hornaday surveyed the bison population of the plains in January 1889, he discovered fewer than 300 remaining in the United States.

Even the preservation of the bison in the early twentieth century was riddled with social and economic inequity. Ranchers profited handsomely from the bison they sold to government preserves. The Northern Pacific Railroad—whose line ran near Yellowstone Park—promoted the government herd at Yellowstone as a tourist attraction. When Hornaday's American Bison Society created national bison preserves in Oklahoma and Montana, it was on lands alienated from the Kiowa-Comanche and Flathead reservations. The preservation of the bison thus came to resemble its near extermination: it benefited ranchers and railroads at the expense of Indians (Isenberg 1995).

At the root of the failure to regulate bison hunting was the economic culture of competitive destruction. By the 1830s, everyone, Indians and whites included, was engaged in a race to exploit the bison for individual gain. To reserve wildlife for anybody's use violated the competitive ideal; to reserve them for social outcasts such as Indians was still more unthinkable. Yet, the peculiar tragedy of the destruction of the bison was that United States' authorities had the opportunity to regulate hide hunters and declined to do so. The opportunity to prevent the slaughter of the bison—like most questions about whether or how to conserve nature—essentially was a question about the distribution of wealth (Stretton 1976). Who should use a resource, this generation or the next, the rich or the poor, Indians or whites, or both, or neither? The federal government's permission for hide hunters' near extermination of the bison, thus, was in part a question of distributive justice. The ultimate failure of the law to prevent the slaughter revealed the difficulty of achieving an equitable and sustainable relationship with non-human nature in a society blinded by racism, committed to economic competition and tolerant of poverty.

Indeed, the unsustainable exploitation of the bison proceeded directly from economic competition, social prejudice and inequality. For the plains nomads, economic inequity—the competition for prestige, the subjugation of women—was the engine that drove destructive commercial hunting. To a Euroamerican commercial hunter in the late nineteenth century, to leave a bison behind was to leave it for a competing hunter, or worse yet, for an Indian. The Indians and Euroamericans who slaughtered the bison not only denied resources to their competitors but to succeeding generations. In contrast, a sustainable relationship with non-human nature begins with an equitable management of nature and extends the sharing of resources from this generation to the next. The question of economic equity is crucial to the development of a sustainable relationship with nature. Only when users put the economic interests of the community—both the human and the ecological community—before the pursuit of individual wealth is a sustainable relationship with nature possible.

References

Bamforth, D. B. 1987. Historical documents and bison ecology in the Great Plains. Plains Anthropologist 32: 1–16.

Bowen, F. 1870. American political economy. Scribner, New York, NY.

Butler, W. 1913. Sir William Butler: An autobiography. Scribner, New York, NY.

Catlin, G. [1832–39] 1913. North American Indians: Being letters and notes on their manners, customs, and conditions. 2 vols. Leary, Stuart, Philadelphia, PA.

Cook, J. R. [1907] 1989. The border and the buffalo: An untold story of the southwest plains. State House Press, Austin, TX.

Crosby, A. W. 1986. Ecological imperialism: The biological expansion of Europe, 900–1900. Cambridge Univ. Press, New York, NY.

Darwin, D. [1859] 1962. The origin of species by means of natural selection, edited by L. Engel. Anchor, Garden City, NY.

Delano, C. 1872. Annual report of the Secretary of the Interior. 42nd Cong., 1st Sess., H. exdoc. 1.

Denig, E. T. [1854] 1961. Five Indian tribes of the Upper Missouri: Sioux, Arikaras, Assiniboines, Crees, Crows, edited by J. C. Ewers. Univ. Oklahoma Press, Norman.

Dodge, R. I. [1873] 1989. The plains of North America and their inhabitants. Univ. Delaware Press, Newark.

Ewers, J. C. 1973. The influence of epidemics on the Indian populations and cultures of Texas. Plains Anthropologist 18: 104–115.

Farnham, T. J. [1843] 1904. Travels in the great western prairie. *In* R. G. Thwaites, ed., Vol. 28 of Early western travels. Clark, Cleveland, OH.

Gard, W. 1959. The great buffalo hunt. Univ. Nebraska Press, Lincoln.

Hatton, W. S. 1849. Annual report of the Office of Indian Affairs. 31st Cong., 1st Sess., S. exdoc. 1.

Holder, P. 1970. The hoe and the horse on the plains: A study of cultural development among North American Indians. Univ. Nebraska Press, Lincoln.

Hornaday, W. T. 1887. The extermination of the American bison, with a sketch of its discovery and life history. Gov. Print. Off., Washington, D.C.

Horsman, R. 1981. Race and manifest destiny: The origins of American racial Anglo-Saxonism. Harvard Univ. Press, Cambridge, MA.

Isenberg, A. C. 1992. Toward a policy of destruction: Buffaloes, law, and the market, 1803–1883. Great Plains Quarterly 12: 227–41.

———. 1993. Indians, whites, and the buffalo: An ecological history of the Great Plains, 1750–1900. Ph.D. diss., Northwestern Univ., Evanston, IL.

———. 1995. Progressivism and the preservation of the bison. Paper read at 8th biennial conference of the American Society for Environmental History, 8–11 March, Las Vegas, Nevada.

Kelly, W. 1851. An excursion to California over the prairie. Chapman and Hall, London.

Lawson, M. P. 1974. The climate of the Great American Desert: Reconstruction of the climate of the western interior United States, 1800–1850. Univ. Nebraska Studies, New Ser. no. 46. Univ. Nebraska Press, Lincoln.

Lewis, O. 1942. The effects of white contact on Blackfoot culture with special reference to the role of the fur trade. Mono. Amer. Ethnological Soc., vol. 6. Augustin, New York, NY.

Mayer, F. H. and C. B. Roth. 1958. The buffalo harvest. Swallow, Denver, CO.

Mooar, J. W. 1933. Buffalo days. Holland's 52: 10, 44.

Nabokov, P., ed. 1967. Two Leggings: The making of a Crow warrior. Crowell, New York, NY.

Oliver, S. C. 1962. Ecology and cultural continuity as contributing factors in the social organization of the Plains Indians. Univ. California Press, Berkeley.

Osborn, A. J. 1983. Ecological aspects of equestrian adaptations in aboriginal North America. American Anthropologist 85: 563–591.

Plummer, R. [1836] 1973. A narrative of the capture and subsequent sufferings of Mrs. Rachel Plummer, written by herself. *In* R. VanDerBeets, ed., Held captive by Indians: Selected narratives, 1642–1836. Univ. Tennessee Press, Knoxville.

Stretton, H. 1976. Capitalism, socialism, and the environment. Cambridge Univ. Press, New York, NY.

Strickland, R. W., ed. 1949. The recollections of W. S. Glenn, buffalo hunter. Panhandle-Plains Hist. Rev. 22: 21–64.

Tabeau, P. [1803–05] 1939. Narrative of Loisel's expedition to the Upper Missouri, edited by A. H. Abel. Univ. Oklahoma Press, Norman.

Wallace, A. R. 1870. The development of human races under the law of natural selection. Contributions to the theory of natural selection: A series of essays. London.

White, R. 1978. The winning of the West: The expansion of the Western Sioux in the eighteenth and nineteenth centuries. J. Amer. Hist. 65: 319–43.

Wood, W. R. 1980. Plains trade in prehistoric and protohistoric intertribal relations. *In* W. R. Wood and M. Liberty, eds., Anthropology of the Great Plains, Univ. Nebraska Press, Lincoln.

Worster, D. 1985. Nature's economy: A history of ecological ideas. Cambridge Univ. Press, New York, NY.

Registered Attendance

ALABAMA
Lynn Boykin, Bill Garland, Billy Goodson, David C. Hayden

ALASKA
David B. Allen, Gene Augustine, Ellen Campbell, Artina Cunning, Laura Greffonius, Joe Meehan, Wayne L. Regelin, Allen P. Richmond, John Sandor, Chantal Sauve, Robin L. West, Robert W. Williams

ARIZONA
Robert X. Barry, Bruce Eilerts, Lawrence D. Garrett, Bill Grossi, Junior D. Kerns, Paul R. Krausman, Valerie Morrill, Ronald L. Pearce, Ronald Popowski, Charles Pregler, Darcy Shaw, William W. Shaw, Duane L. Schroufe, Linda Schroufe, H. Sheridan Stone, Bruce D. Taubert

ARKANSAS
Don Akers, Charles Becker, Hugh Durham, Larry D. Hedrick, Marcus Kilburn, Tony Melchiors, Steve N. Wilson

CALIFORNIA
Stephen Ahmann, Veronique Anderson, Nancy H. Bennett, Timothy A. Burr, John B. Carlson, Liz Reese Clark, John Colberg, William K. Collins, Anne De Bevec, Wanda Deal, Wade L. Eakle, Myra Fraser, Rick Griffiths, Chris Grunewald, Mark Hagan, John G. Kie, Kristine Komar, Gary W. Kramer, Terry M. Mansfield, Michael Mantell, David Morgan, Linda Parker, Jack Payne, John Phillips, Nancy Read, Frederic A. Reid, Bruce Reinhardt, John Schmidt, Tamara Shepherd, Kent Smith, G. Lynn Sprague, Ron Stromstad, Scott A. Sysum, Richard L. Vaughn, Barbara Wilson, Peter Wixted, Sandra Wolfe, Tommy Wright, Carlos Yep

COLORADO
Arthur W. Allen, Sally Angus, Mike Babler, Chris Bandy, Roland Lee Barkow, Gary Belew, Jacqueline A. Boss, Theodore R. Boss, Clait E. Braun, Casey R. Buechler, Richard L. Bunn, Len H. Carpenter, Alan P. Covich, Dick Curnow, Wayne O. Deason, Eugene Decker, Betty Enderson, James H. Enderson, Elizabeth Estill, Alan R. Fisher, Rebecca Frank, Joan Friedlander, Mark Gershman, Jeff Green, Lynn Haines, Robert Hays, Bob Hembrode, Don E. Huff, Michael Kirby, David M. Knotts, Carol A. Lively, Mike Lucero, Clinton K. Miller, Michael W. Monahan, Ralph O. Morgenweck, Mark Morse, Thomas E. Nicholls, Perry D. Olson, Jim Ringelman, Duncan Rollo, Randall D. Rowland, Michael Sanders, R. B. Shaw, Gary Skiba, Noeleen A. Tillman, Lee Upham, Bruce Van Havern, Tom Warren, Gary C. White, Craig Whittekiend

CONNECTICUT
Robert Delfay

DELAWARE
Lloyd Alexander, Rodney L. Harmic, Lynn Herman, Andrew T. Manus, Bill Wagner

DISTRICT OF COLUMBIA
Bobby R. Acord, Kirk Andries, Daniel Ashe, Don Barry, Bruce Beard, Molie Beattie, Michael Berger, Bruce Blanchard, Tom Browning, John D. Buffington, Dan Burns, Chris Chesak, Jamie Rappaport Clark, Richard C. Curry, Tom Darden, Bob Davison, Barbara Dean, David Dexter, Jodi A. DiCamillo, Mike Dombeck, Naomi Edelson, Chip Elkins, Dennis B. Fenn, Robert Ferris, Harv Forsgren, Rebecca Francis, Evelyn Herbst, Robert L. Herbst, Christine Jauhola, Joseph J. Kraavenbrink, George Lapointe, Charles Leitschuh, Don MacLauchlan, Sherry MacLauchlan, Daniel C. McCluskey, Robert Meltz, James E. Miller, Phil Million, Bob Nelson, Ira F. Palmer, Beth Giron Pendleton, R. Max Peterson, Mark J. Reeff, O. J. Reichman, John G. Rogers, Eric Schenck, JoAnn Schneider, Max Schnepf, Randall Snodgrass, Donald F. Stahler, Robert G. Streeter, Glenn Sugamelli, Scott Sutherland, James M. Sweeney, Gary J. Taylor, Jack Ward Thomas, Whitney Tilt, Christopher E. Williams, Jim Wyerman

FLORIDA
Michael D. Adams, Michael L. Avery, Allan L. Egbert, Gene R. Hickman, Ronald F. Labisky, Rich McWhite, Brian Millsap, Bob Progulske, Steve Shea, David Sumpter, Diana Swan, Richard H. Tobin, Shelley Urbinek, Pat Walsh

GEORGIA
Tim Beaty, Harold W. Benson, Bert Bivings, Timothy A. Bottomley, Jimmy Bullock, Noreen K. Clough, Nancy Cotner, Bobby G. Ellis, Richard Haeuber, Dennis Krusac, Gloria Manning, Joe McGlincy, Victor F. Nettles, Charlotte Quint, Steve Rickerson, Tom Sinclair, Eric Spadgenske, Linton Swindell, David Waller

HAWAII
Mark Kaminski, Timothy Sutterfield, Karen A. Verkennes

IDAHO
Bill Burnham, S. Kent Carnie, C. D. Chaffin, Jerry M. Conley, Charles Harris, Jonathan B. Haufler, Tom Hemker, Mark A. Hilliard, William A. Kennedy, Lyle Lewis, Mike Mathiot, Marjorie L. McHenry, Steve Mealey, Carolyn Mehl, Wayne Melquist, M. Scout Monroe, Frank Nesmith, Ken Norrie, Robert L. Parenti, John Ratti, Gary J. Roloff, William A. Wall

ILLINOIS
Randy J. Berry, Patrick W. Brown, Connie Carroll, John A. Clemetsen, Mary Garrison Harper, Linda Hawkins, R. E. Hawkins, G. Brent Manning, Raymond W. Marshalla, Romy Myszka, Gene M. Nelson, Harvey K. Nelson, Perry C. Reynolds, Clifford G. Rice, Kathleen Rude, William F. Sembold, Rick Sharp, Robert Sisler, Mike Spanel, Richard E. Sparks, Ruth Sparks, Robert D. Speaker, John Tranquilli, Jeff Ver Steeg, David Tazik, John D. Thompson, Ann-Marie Trame, Steve Widowski, Alan Woolf

INDIANA
David Case, Gary D. Doxtater, Hannah Kirchner, Kenneth Nettles, Domingo C. Riego, George Seketa, Phil. T. Seng, Mary Ellen Sullivan

IOWA
Katherine L. Anderson, Judy Bishop, Richard A. Bishop, William R. Clark, Richard A. Clewell, Allen L. Farris, Ruthie Farris, Joe Haffner, Tamara Haffner, Rolf Kofard, Bruce Menzel, James Pease, Anjeanette L. Perkins, Nancy Riley, Terry Z. Riley, Larry Stone, Larry J. Wilson

KANSAS
Robert Barbee, George C. Halazon, Kathryn R. Halazon, Jeff Keating, Joe Kramer, Charles Lee, Rob Manes

KENTUCKY
Tom Bennett, Lynn Garrison, Len G. Polasek, Donald W. Sheroan, Roger Thacker, Tom Young

LOUISIANA
John M. "Frosty" Anderson, Nancy J. Anderson, Pamela R. Garrettson, Joe L. Herring, Greg Linscombe, Dave Morrison, Robert E. Stalart, Johnnie W. Tarver, William Thomas

MAINE
Ray B. Owen, Jr.

MARYLAND
Robert A. Backman, Scott Balfit, L. Peter Boice, Jeffrey C. Bossart, Betty Boyland, Paul Brouha, David Dolton, Thomas M. Franklin, W. Reid Goforth, Bette S. Gutierrez, Paul W. Hansen, Joe Hautzenroder, Harry E. Hodgdon, Mary S. Hodgdon, Fred Johnson, Daniel L. Leedy, Virginia Leedy, Doug Lister, Tessa E. Martin, Dick Masse, Duncan MacDonald, Laury Marshall, Richard E. McCabe, Ginger Merchant, Betty Olivolo, Paul I. Padding, Daniel A. Poole, Dorothy Poole, Kyle Rambo, Tim Richardson, Steven W. Sekscienski, Jerome R. Serie, Graham W. Smith, William Spicer, Molly R. Whitworth, Lonnie L. Williamson, Paul Wilson

MASSACHUSETTS
Willaim C. Ashe, Jack Buckley, Daane A. Crook, Cick Dyer, Ronald E. Lambertson, Wayne MacCallum, Tom Poole, Gina Rossi

MICHIGAN
David R. Branson, George E. Burgoyne, Keith J. Charters, Joe Christiansen, Larry DeVuyst, Tracy Dobson, Jim Ekdahl, Richard C. Elden, Jennifer Filipiak, Laura Grantham, Roland Harmes, Brian J. Kernohan, Mark Ledebuhr, Donna L. Minnis, Scot Nauertz, Brett D. Nelson, Matthew Oke, R. Ben Peyton, Rodney Robson, Vanetta Truan, Ann M. Wilson

MINNESOTA
Ira Adelman, Nancy Albrecht, Joel Anderson, Bruce Arnold, Jack Arnold, David Augustine, Rich Baker, Robert Barta, Tim Bartish, Fred Bengtson, Alfred Berner, Mike Biltonen, Janet Boe, Ed Boggess, Ken Bonnema, Rob Bouta, Timothy Bremicker, Jeremy B. Cable, Lee Carlson, Jerry Christopherson, Ken Cole, Donna Compton, Tom Conroy, Lucinda Corcoran, Pamela Coy, Francie Cuthbert, Craig D. Daeda, Robert Dana, Glenn D. DelGuidice, Randall D. Devendorf, Dan Dietrich, Albert Dietz, Alan R. Ek, Bonita Eliason, Bonnie Brooks Erpelding, Richard Erpelding, Peter Fasbender, Michael Faw, Patricia Freeman, Michael Furtman, Mike Gabriel, Jim Gallagher, Nancy Gibson, David M. Gilbraith, Larry Gillette, Doughlas H. Grann, Janet C. Green, Joan Guilfoyle, Dewey Hanson, Mark A. Hanson, Kurt Haroldson, William Hartwig, Susan D. Haseltine, Richard Hassinger, Katherine Haws, Carrol Henderson, Jeni Henrickson, Michael Hestick, Ross H. Hier, Jeanne I. Holler, Roger Holmes, Mark Hove, William Hutchinson, Tom Isley, David P. Iverson, James Jack, Stan Jackowicz, Fred Jannett, Roger N. Johnson, Peter Jordan, Blair Joselyn, Rick Julian, Tom Keefe, Sean Kelly, Dick Kimmel, Steve Kittelson, Lloyd W. Knudson, Scott Krych, Lance Kuester, John J. Kvasnicka, Mark Labarbara, Roger E. Lake, Bob Lange, Gret Larson, Mike Larson, Thomas J. Larson, Jeff Lawrence, Jim Leach, L. Lewis, Dan Licht, Beaulin Liddell, Judy Liddell, Madeleine Linck, Kevin Lines, Andrea Lueders, Bryan K. Lueth, Tom Magnuson, Mark Martell, Steve Masten, Mike Maurer, Stephen J. Maxson, Jay McAninch, Walter Medwid, Cheryl Miller, Martha Minchak, John Mooty, John Moriarty, Marvin Moriarty, Lisa C. Mueller, Donald Nelson, Larry Nelson, Gerda Nordquist, Ray Norrgard, Doug Norris, Jane Choromanski Norris, Jan Orr, Cynthia Osmundson, Paul Pajak, Barbara Pardo, Jon M. Parker, Dean Paron, David C. Pauly, Roger L. Pederson, Vanessa E. Pepi, Eric M. Peterson, Mary Peterson, David P. Rave, Fabian F. Romero, R. Nicholas Rowse, Kurt A. Rusterholz, Teri A. Sardinas, Dave Schad, Ron Schara, John Schladweiler, Don Schultz, Joan Scott, Ogbazghi Sium, Martin Skoglund, David Soehren, Mark Spoden, Bill Stevens, Andrea Stoffregen, Charles P. Stone, Danielle Stone, W. Daniel Svedarsky, Frank Taylor, John Tester, David Trauba, Jim Truax, Neil Vanderbosch, Ken Varland, Rod Vetipak, Robin Vora, Jeanine Vorland, Tim Wallace, John M. Ward, Paul Webster,

Richard Weisbrod, Bob Welsh, Lauren Wemmer, Julie Wermerskirchen, Jane Noll West, JoAnne Wetherell, Richard S. Wetzel, Steve Wilds, Jack Wingate, Art Wirtz, Michael C. Zicus

MISSISSIPPI

Kenneth M. Babcock, Charles Baxter, Richard A. Fischer, Robert Glasgow, Robert Griffin, Gerald Inman, Kent C. Jensen, Charles Lorsch, Ron Lukens, Seth E. Mott, Randy Robinette, Margaret Sartor, Donald W. Thompson, Michael R. Waring, David E. Wesley, Gary Yeck

MISSOURI

Donna K. Brandt, Terry Wayne Cloutier, Ray Evans, James P. Fry, Kenneth E. Gamble, Thomas F. Glueck, Robert R. Harms, Donald E. Meuschke, Jerome M. Organ, Sara Parker, Jerry J. Presley, Mark R. Ryan, Ollie Torgerson, James H. Wilson

MONTANA

Maryanne Bach, Dale M. Becker, Jodi Bishop, John Boehmke, Perry J. Brown, Michael Butler, Don Childress, Seth Diamond, Kay Ellerhoff, Brian Gilbert, Patrick J. Graham, William H. Greer, Judy Hinz, Tom Hinz, Kirk M. Horn, Larry L. Irwin, David F. Jolly, Kevin Lackey, Ron Marcoux, Robert Martinka, Robert W. Munson, Daniel H. Pletscher, Thomas Puchlerz, Ralph Rogers, Hal Salwasser, Fred B. Samson, Greg Schildwachter, William Schneider, Chris Servheen, James W. Stutzman, Gary L. Sullivan, Gregory B. Watson

NEBRASKA

Thomas B. Bragg, Kevin Church, Mary Clausen, Jim Douglas, Keith W. Harmon, Gary L. Hergenrader, Scott Hygnstrom, Gene D. Mack, Mike McCabe, Wes Sheets, Greg Wingfield

NEVADA

William A. Molini, James M. Ranakka, Norman Saake

NEW HAMPSHIRE

Susan Buckley, Wallace Elton, William W. Mautz, Scot J. Williamson

NEW JERSEY

Robert Itchmoney, John Joyce, Robert McDowell

NEW MEXICO

Steve Fettig, Leon Fisher, David A. Holdermann, Jim Lloyd, A. Stevan Logsdon, Susan Lowrey, Jerry Maracchini, Julie Moore, Harold F. Olson, Hildy Reiser, S. D. Schemnitz, Thomas E. Smith, Lynn B. Starnes, Dan Sutcliffe, Daisan E. Taylor, Bruce Thompson, Phil Zwank

NEW YORK

James A. Beemer, Tommy L. Brown, Daniel Decker, Herbert E. Doig, Susan B. Doig, Jody Enck, James R. Hessil, Rich LeClerc, Cynthia Loker, Gary Parsons, Carl Schwartz, Roland Shanks, Michael D. Zagata

NORTH CAROLINA

Richard O. Bierregaard, Eric G. Bolen, Phil Doerr, Daniel W. Frisk, Harry Hottell, William Michael Hunnicut, Robert L. Montgomery, Richard L. Noble, David Patrick, William H. Robers, D. Alan Schultz, Scott B. Smith, Evelyn Johnson Watkins, Randall C. Wilson, Edward J. Zakraisek

NORTH DAKOTA

Bruce Barbour, Steve Blomeke, Paul Bultsma, Walt Fairbanks, Todd S. Grant, Ellen Heilhecker, David Herr, Scott Hettinger, Greg Hiemenz, Douglas H. Johnson, Mike Johnson, Lloyd Jones, Dona J. Kirby, Ronald E. Kirby, Jean K. Kotchman, Michael W. Kotchman, Steve Kresl, Dan Limmer, Michael G. McKenna, Bob Meeks, Ellie Meeks, Robert K. Murphy, Theresa Olson, Pamela J. Pietz, Randy W. Renner, Ron Reynolds, Ken R. Sambor, Michael J. Schneider, Tom Sklebar, Marsha Sovada, Delbert Tibke, Keith Trego, Rich Warhurst, Alicia L. Waters

OHIO

Theodore A. Bookhout, Mike Cornelius, Steven A. Gray, Jeffrey J. Herrick, Roy W. Kroll, Stephen W. Madewell, Tony J. Peterle, Richard B. Pierce, Dave Risley, Patrick M. Ruble, Rob Sexton, Thomas E. Wasson

OKLAHOMA

Nancy Haxton Davis, Greg D. Duffy, Jim Gallagher, Richard T. Hatcher, Toni M. Hodgkins, Chip Leslie, Ernest M. Steinauer, Gene Stout, Glen Wampler

OREGON

Robert Anthony, Bradley Bales, James C. Bartonek, Hugh Black, Brad Bortner, Erik K. Fritzell, Monte Garrett, Jim Greer, Gordon Haugen, Jerry P. McIlwain, E. Charles Meslow, Ross Mickey, Guido Rahr, Richard S. Rodgers, Rudy Rosen, Phil Schneider, Mike Spear, Sara Vickerman

PENNSYLVANIA

Betty Bowers, Glenn L. Bowers, Robert C. Boyd, Calvin DuBrock, Dennis R. Fredericks, Donald C. Madl, Larry A. Nielsen, James W. Rainey, Gerald L. Storm, W. Ned Weston, Steve Williams

RHODE ISLAND

Janet L. Wallace, Mark C. Wallace

SOUTH CAROLINA
Ron Brenneman, Brock Conrad, Mark Addison Dutton, John Edwards, Rodney Fleming, Drenia Frampton, John E. Frampton, David H. Gordon, David Guynn, Frank Kartch, Rob Keck, James Earl Kennamer, Terrence C. Larimer, Chris Muckenfuss, Ed Muckenfuss, Carlton Owen, Kathleen Stiles, Gary Tanner, T. Bently Wigley

SOUTH DAKOTA
Paul Coughlin, Doug Hansen, Kenneth F. Higgins, Dan Hubbard, Jonathan A. Jenks, Fred Kinard, Emily Kleve, Christine Lousias, Steven P. Riley, Rod Sather, Charles G. Scalet, Spencer J. Vaa, George Vandel

TENNESSEE
Bruce Batt, Jim Byford, Alton Dunaway, Mickey E. Heitmeyer, Bob Hoffman, Joe F. Hopper, James R. Jordan, Gary Larson, Gregory W. Lee, Chester A. McConnell, Ross Melinchuk, Gary Myers, Jeff Nelson, Shanen M. Onken, Cynthia Ragland, Traci Michelle Sanders, Ed Warr, Jan Wentz, W. Alan Wentz, Gene A. Zirkle

TEXAS
Clark E. Adams, Leslie A. Baker, Terry L. Bashore, Vernon Bevill, Kirby Brown, Robert D. Brown, Patricia A. Chamberlain, Robert L. Cook, Jerry Cooke, Rafael D. Corral, Rolly Correa, Thomas R. Dunlap, Ronnie George, Gary Graham, Richard W. Hansen, Dennis M. Herbert, Joyce Johnson, Carl Lahser, Richard K. Lawrence, Brian A. Locke, Blake Morris, David M. Palmer, James Ray, Calvin Richardson, Nova Silvy, Bradley Simpson, Doug Slack, Loren M. Smith, Darryl Stanley, Don Steinbach, Dennis Tates, James G. Teer, Ray C. Telfair, Michael Warnock, Roy Willis, Clayton Wright

UTAH
William Alan Adair, R. Craig Altop, John A. Bissonette, Mary Elizabeth Bissonette, Dale Bosworth, Bill Burbridge, Joseph A. Chapman, Jim Cole, Michael Conover, Jay Gore, Suzanne Hoover, Stephanie Hussey, Kimberly K. Kessler, Kristen P. LaVine, Jackie Love, Terry A. Messmer, Mat Millenbach, Randy L. Quarnberg, Heidi Thurgood, R. G. Valentine, Joan Valentine, Frederic H. Wagner

VERMONT
David E. Capen, Allen A. Elser, George W. LaBar, Mary Jeanne Packer, Byron K. Williams

VIRGINIA
Robert Anderson, Keith A. Argow, James M. Beers, Jack H. Berryman, Bob Blohm, L. Peter Boice, Jim H. Brabston, Bud Bristow, Columbus H. Brown, Gregory N. Brown, Jan Brown, Richard D. Brown, Robert L. Byrne, Steve Capel, Nance Ceccarelli, William M. Conlin, Pamela J. Couch, Gerald Cross, Alan Dyck, Gary Edwards, Bob Ellis, Ron Escano, Jim Fenwood, Steve Gottshall, Carola A. Haas, Donald W. Hawthorne, Gene Hester, Brian K. Hoppy, E. Brian Hostetter, Jacquelyn M. Howard, Laurence R. Jahn, Sharon L. Jones, Gary S. Kania, Kerrie Kirkpatrick, Erika Kroetch, Matthew A. LaCroix, Susan R. Lamson, Jennifer L. Lawson, Mike Lennartz, Kelley S. Lipphard, J. Larry Ludke, Donald F. McKenzie, Brian R. Murphy, Tom Parsons, Patricia A. Peacock, Carol J. Peddicord, Phillip C. Pierce, Norville Prosser, Steve Rafe, Kathy Rafe, Dan Reinke, Terry R. Sanders, Paul Schmidt, John D. Schroer, Merrily M. Severance, Mark L. Shaffer, David A. Smith, Rob Southwick, Bettina Sparrowe, Rollin D. Sparrowe, Robert T. Stamps, David M. Sutherland, Thomas W. Taylor, Kelly G. Wadsworth, Jeff Waldon, Geoffrey Walsh, David K. Whitehurst, James R. Wise, James R. Woehr, Thomas Wray, Kira Young, Catherine M. Zielske

WASHINGTON
Robert J. Anderson, Ron Bockelman, Larry L. Caldwell, Crystal Driver, Becky Groves, Lorin L. Hicks, Louis D. Jurs, Chris Loggers, Jim MacCracken, Wayne R. Marion, John H. Munn, Cavin Richie, James A. Rochelle, Dean C. Smith, Sandra Staples-Bortner, Loren Stern, R. Neal Wilkins

WEST VIRGINIA
Bernard F. Dowler, Glenn Gravatt, Scott Hartman, Paul Johansen, Rick Lemon, Gordon C. Robertson, Michael Tome

WISCONSIN
Ann Addis, James T. Addis, LaVerne Ausman, Al Boss, Mark Boyce, Mark Elizabeth Braun, Geoff Chandler, Ralph E. Christensen, John Cole, Scott Craven, Dan Dessecker, Kevin Furlong, Robert F. Gaugush, Deb Gavnitz, Daniel Gonnering, Steph Griphe, David A. Halfmann, Lynn E. Hanson, Jerry Hartigan, Thomas M. Hauge, Raymond Hubley, Jeff Janvrin, Barry Johnson, Paul Keenlance, Marcy Kirsch, Laurie Larson, Carole Lee, Harry Libby, Diane Lueck, Cy Lyle, John Maestrelli, Butch Marita, Jim B. Marks, Kim Mello, Steven S. Merchant, Evelyn Merrill, George Meyer, Teresa J. Naimo, Thomas J. Niebauer, Dave Neuendorf, Joseph Osteryich, Neil F. Payne, Dennis Presser, Doug Rhend, Bill Richardson, Tony M. Rinaldi, Robert N. Rosenfield, Robert Ruff, Don Rusch, Sherri L. Schulz, Mark Smith, Janet Snedeker, Christine L. Thomas, Wendy Thomford, Tony Thompson, Jack G. Troyer, Bobbi Webber, Norman L. Weiland, John F. Wetzel, Tim Wilder, Robert G. Wright, Gary Zimmer

WYOMING
Stanley H. Anderson, Robert H. Hanson, John G. Kremer, Jay Lawson, Art Reese, Thomas Smith, John Talbott

CANADA
Diane Anderson, Eric Anderson, Karl Anderson, Michael G. Anderson, R. C. Anderson, Rick Bates, Rick Baydack, Pat Caldwell, Bob Carles, Dale Caswell, Steven Curtis, Patricia M. Dyer, Ian W. Dyson, George Finney, Rod Fowler, Richard C. Goulden, Doug Hagan, Lorraine Henley, Thomas Henley, Geoff Holroyd, Joan Jaffit, Robert

E. Jones, M. W. Lankester, Brian Mackie, Gerald McKeating, Terry G. Neraasen, Paul H. Patrick, Douglas K. Pollock, Merlin Shoesmith, Tim Sopuck, Shawn Wasel

GUAM
Heidi Hirsh, Leslie Sweeney Morton

INDIA
Satish Kumar

PANAMA
Tara Wiskowski

VIRGIN ISLANDS
David Nellis