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Contents

Session Five. Advancing the Cause of Integrated Bird Conservation

Opening Session.
Same Landscapes, New Horizons

Chair
Richard E. McCabe
Wildlife Management Institute
Washington, DC

Cochair
Terry R. Crawforth
International Association of Fish and Wildlife Agencies and Nevada Department of Wildlife
Reno

Opening Remarks of the 70th North American Wildlife and Natural Resources Conference

Richard E. McCabe
Wildlife Management Institute
Washington, DC

Good morning. Welcome to the 70th North American Wildlife and Natural Resources Conference (North American). Welcome also to Crystal City here in Arlington, Virginia.

This, I believe, is the most nontraditional North American Conference in the District's vicinity, at least since 1981. As most of you know, the North American rotates back to this area every 4 years, following each national U.S. election. The previous six postelection events were held at the Omni Shoreham, which no longer can accommodate the number of meetings and other functions of this international gathering. So, this year we aren't at the Omni Shoreham and we aren't in the District. Also, opening remarks for this plenary session traditionally are given by the Wildlife Management Institute (WMI) president. Those remarks invariably have provided perspective on natural resource management issues, on policies and programs, and on the prevailing tenor of the professional conservation community.

I am not the WMI president, and I plan to use my pinch-hit remarks to address the ongoing swirl of speculation about the status of WMI, despite last week's announcements, and also regarding the future of the North American.

It is a fact that WMI has experienced some difficulty the past year or so, mainly because of reduced levels of funding—something that everyone in our community has faced at some time. And if you haven't, you will. It cost us some very valuable staff members, restructured some of our administrative operations and caused WMI to withdraw from certain usual roles and involvements.

The reduced funding was primarily the result of a downswing in the fortunes of the industry that founded WMI in 1911 and that has been far and away its major source of support every year since. That industry, for those who don't know, is the Sporting Arms and Ammunition Manufacturers industry. These are the folks who gave WMI the charge 94 years ago—before conservation, as we know it today, was part of the national mindset or vocabulary—to do whatever it could to add the promise, reason and credibility of emerging science to help stem precipitous declines of game and other wildlife populations in North America.

These are the same folks who, in 1937, agreed to pony up excise taxes on their products to create the Federal Aid in Wildlife Restoration Program, better known as Pittman-Robertson. These are many of the same folks who have continued to contribute those excise dollars that are the backbone of state wildlife conservation programs.

As with any industry, the fortunes of the sporting arms and ammunition manufacturers have waxed and waned. For much of its history, WMI was shielded from the downturns. Within the past decade, however, that industry—our industry—was menaced by a series of lawsuits from certain major cities in the United States, hoping upon hope that the courts would find these companies somehow culpable and liable for gun-related crimes. In every instance, the lawsuits have been thrown out of court as baseless. In other words, industry ostensibly won. In fact, the litigation cost it tens of millions of dollars.

In absorbing the tremendous legal expense of defending itself, industry could have withdrawn entirely its support for WMI and, not insignificantly, its generous support for other conservation organizations and programs. It did neither. However, it was forced to cut back on its allowances, and WMI was significantly impacted by that necessity.

Sporting arms and ammunition industry companies still are WMI's most substantial backers. But they—through the WMI Board of Directors—have enjoined WMI to broaden its support base, so as not to be caught short and so programmatically vulnerable again. We have taken the directive very seriously and are responding earnestly.

The bottom line is that the WMI is very much alive and on the mend. Through the hard work and perseverance of a talented and highly dedicated staff, WMI has remained independent and professionally engaged. I would be remiss if I didn't note that WMI was made organizationally resolute before shortfall happened by the enlightened leadership of former WMI president Rollie Sparrowe. I would be equally remiss if I didn't tell you that WMI stayed on track these past months in large part because of the foresight and energy of WMI vice president Scot Williamson.

With continued support of industry and the stepping up of major conservation partners, WMI will get back fully to its traditional role and momentum in the business of conservation.

The North American Conference, administered by WMI since 1915, is scheduled and contracted through 2008, with 2009 in negotiation and 2010 in exploration. It, too, is not in jeopardy.

In 1946, Dr. Ira N. Gabrielson, the first director of the U.S. Fish and Wildlife Service, became the seventh president of WMI. Dr. Gabe provided opening remarks at this conference through 1970. In just a week or so, as most of you already know, Dr. Steven A. Williams, current director of the U.S. Fish and Wildlife Service, will become WMI's 11th president and will take the lead in charting WMI's new horizon. As a biologist, scientist and experienced administrator, Steve extends the tradition of top-shelf chief executive leadership at WMI. It is certain that he will provide more traditional opening comments for this plenary for many years to come.

Before relinquishing the microphone and balance of the morning's program to my session cochair, Terry Crawforth, President of the International Association of Fish and Wildlife Agencies and Administrator of the Nevada Wildlife Department, let me once again, on behalf of everyone at WMI, welcome you to the 70th North American Conference. Thank you.

Remarks of the Secretary of the U.S. Department of the Interior

Gale Norton
U.S. Department of the Interior
Washington, DC

Thank you. I am pleased to be with you, to be among you, to be counted as a steward and a conservationist.

This is a bittersweet occasion since one of my favorite wildlife managers will soon be joining you. Steve Williams really reached out to hunters and anglers as Director of the U.S. Fish and Wildlife Service. I am sure he will serve the Wildlife Management Institute with the same excellence and spirit. Matt Hogan, who is currently the deputy director of the U.S. Fish and Wildlife Service, will be serving as acting director.

I would also like to provide a special thanks to Marshall Jones. He served as Acting Director of the U.S. Fish and Wildlife Service before Steve was sworn in, and he continues to provide sound advice and direction. In 2002, his management skills were properly rewarded with the Presidential Rank Award for meritorious service.

Over the past years, Steve and I have met with many of you and the leaders of your organizations. Today, we have gathered again with a passion for the environment and a purpose to improve it.

What you do is so important. Conservation of wildlife and the natural world may not dominate the newspaper headlines. But, it is a vital passion for countless North Americans.

Where does the desire to conserve come from? For me, it began in my home state of Colorado. I grew up there, I went to school there, and I am happiest when I'm somewhere high in the Rockies.

I would like to share with you a story from my home state that illustrates both environmental neglect and an emerging environmental success. I grew up about 5 miles (8 km) from a place called the Rocky Mountain Arsenal (Arsenal), in the suburbs of Denver. I have childhood memories of earthquakes along the Front Range. They knocked plates off the shelves and a local church off its foundation.

We eventually found out a nearly unbelievable fact—the earthquakes were stimulated by human activities. They were coming from the Arsenal, where the U.S. Army was disposing of chemical waste by injecting it deep in the earth.

The Arsenal was established as a chemical weapons plant during World War II, when our nation was facing a terrible challenge from tyranny. That mission continued as the Iron Curtain rose and as communism took the place of fascism. The weapons produced at the Arsenal were part of the vigilance necessary to protect liberty. But, there were unintended consequences. We did not fully appreciate the impact of chemicals on our environment. Nor did we understand how to dispose of them.

I remember, as a girl, being frightened of the specter of the Arsenal. We were told that a single drop of the chemical weapons would kill you. The Arsenal was widely known as the most polluted square mile on earth.

When I became Colorado Attorney General, state and federal governments were still battling about the clean-up. We took the litigation to federal court of appeals, and we won a ruling that the state had a real role in determining how the Arsenal should be cleaned up. When the state finally won a seat at the table, we were able to negotiate a clean-up plan.

Today, a decade later, the clean-up is moving ahead. About a year ago, I went back to Denver to celebrate the transfer of 5,000 acres (2,023 ha) from the U.S. Army to the U.S. Fish and Wildlife Service and to dedicate the Rocky Mountain Arsenal National Wildlife Refuge. The Arsenal is teeming with wildlife. Deer wander there; hawks soar above it.

Eventually 10,000 more acres (4,046 ha) will be transferred to complete the refuge. The refuge will be a place of wonder for generations to come, one of our largest urban refuges. It will be a living gift to the residents of Denver and the citizens of the United States. It will be a living reminder that the worst environmental excesses can be restored.

In a sense, the story of the Arsenal-turned-refuge is the story of conservation in the United States. Forty years ago, there were many areas of environmental devastation across the country; Love Canal brought toxic pollutants to the front pages and Ohio's Cuyahoga River caught on fire.

Fortunately, excesses on that scale are largely a thing of the past. But, there is still a great deal of work to do. Today, we realize how valuable our natural world is; we understand that we all have a role in its renewal.

Conservation is a high priority in this administration. President George W. Bush and I are committed to environmental stewardship. The President is a hunter and a fisherman. He has had hosted wildlife leaders at his ranch.

On many occasions, the President has told me and the other members of the Cabinet that we are not here to mark time. Waiting out the clock serves neither the cause of the nation nor the interests of conservation. We are here for action. We were reelected to achieve results, and we plan wide-sweeping improvements over the next 4 years. We have a vision of great results in conservation being achieved through cooperation.

I am passionate about partnerships. Perhaps I am too passionate. Last month, one organization accused the U.S. National Park Service of "promiscuous partnering." Yet, I truly believe that for conservation to be successful, the government must involve the people who live and work on the land. Millions of willing hands working together form the best foundation for results in conservation.

That is the reason that the cornerstone of the Administration's approach at U.S. Department of the Interior (Interior Department) has been the four Cs—communication, consultation and cooperation, all in the service of conservation. Last year, the President made this a governmentwide effort by issuing an executive order on cooperative conservation. President Bush has made significant investments in cooperative conservation programs because he believes in their power.

From 2002 through 2005, the Interior Department has provided $1.7 billion in grants to states, private landowners, hunting and fishing groups, and other conservation groups to preserve open space, to restore habitat and to conserve species. Many in this room have partnered with us.

Our budget for 2006 proposes $381 million in cooperative conservation programs, which is nearly triple what these programs received in 2000. We believe that the money is well-spent since it is being used to achieve remarkable results.

Partnerships have the power to literally improve the landscape. The partnerships between your organizations and the Interior Department are doing so, one project, one acre, one community at a time.

The meetings President Bush held with you in the White House and at Crawford, as well as the meetings Steve Williams and I held with you in Washington, DC and around the country, have made a difference. Together, we have improved access to public lands for sportsmen and sportswomen. Together, we have worked on a variety of policies, including those that affect refuge management, wetlands and energy policy.

Partners and their partnerships are making a measurable difference in conservation all across the country—from the grasslands of the Midwest to the Gulf of Mexico, from California to North Dakota.

For instance, 150 acres (60 ha) of wetlands will be restored, 100 acres (40 ha) of native grasses will be established and 35 miles (56 km) of riparian areas will be protected or enhanced at the French Creek Watershed in northern Pennsylvania. The project is happening through the cooperative efforts of several groups: Ducks Unlimited, Inc. Pheasants Forever, the Pennsylvania Game Commission and the U.S. Fish and Wildlife Service. Through challenge cost-share grants, the U.S. Fish and Wildlife Service has contributed about $275,000 to the project. Partners have leveraged that into more than $631,000.

Pheasants Forever is leading the Minnesota Habitat Corridors Partnership. The project restores the habitat corridors of fish and wildlife that run through private lands. Through this effort, one of the largest collaborations for conservation in the country, migration routes are being strengthened, flood and erosion control are being improved, and hunting and fishing recreational opportunities are being enhanced.

Nearly 1,500 acres (607 ha) of wetlands and coastal prairie were set aside for conservation in Galveston County, Texas, thanks to a multipartnered land acquisition effort. To make it happen, the U.S. Fish and Wildlife Service's Coastal Program worked very closely with several partners, including a variety of state agencies and Scenic Galveston, Inc., the local land trust. Thanks to those efforts, wading birds and wintering waterfowl will have important foraging areas, while mottled ducks will have nesting sites. Just as importantly, bird watchers and naturalists will have a wild area to enjoy, along with the residents of Galveston and the citizens of the nation.

The Rocky Mountain Elk Foundation, the National Wild Turkey Federation, the Arkansas Game and Fish Foundation, and the Arkansas Game and Fish Commission have partnered with the U.S. National Park Service to establish and restore elk habitat at Buffalo National River, Arkansas.

The list of projects could go on and on. Grasslands are being restored in Michigan's Lower Peninsula. Cutthroat trout passages are being repaired along the Thomas Fork River in Bear Lake County Idaho. Invasive plant species are being contained and controlled in the Flint Hills of Kansas.

The sage-grouse is one of our recent multistate successes. The sage-grouse was not placed on the endangered species list, thanks to an unprecedented, voluntary conservation effort that covered much of the West. The leaders of the 11 western states with sage-grouse populations came together with ranchers, farmers, and state and federal land managers. Tribes came together, as did power companies and even Canadian provinces. As a result, sage-grouse numbers have stabilized and could be on the rebound. Those cooperative efforts of conservation must continue.

The North American Wetlands Conservation Act (Act) and the North American Waterfowl Management Plan (Plan) continue to be one of our primary means for conserving wetlands and protecting waterfowl. Like the Act, the Plan is international in scope, reaching across the tripartite partnership of Canada, Mexico and the United States.

The two—the Act and the Plan---complement each other. They are models of vision and action. Together, the Act and the Plan have formed the basis for one of the most successful conservation efforts in the world.

Those who invest in the federal Duck Stamp Program are also partners in conservation. Since 1934, when the program was established, sales of duck stamps have raised more than $700 million to help conserve more than 5 million acres (2 million ha) of prime bird habitat in the National Wildlife Refuge System.

These programs are among the many ways we are doing more restoration work on wetlands. Three decades ago, wetlands were vanishing and waterfowl populations were plunging. From the mid-1950s to the mid-1970s, the United States lost more than 450,000 acres (182,108 ha) of wetlands each year. Last year, new figures released by the U.S. Department of Agriculture showed that the United States had reversed the annual net loss of wetlands on farms. I applaud our success. But, we will do even better.

In his Earth Day speech last year, President Bush committed the government to moving, "beyond the no net loss of wetlands in America to having an overall increase in American wetlands over the next five years" (Bush 2004).

Fulfilling the President's commitment will require the protection of at least 1 million acres (404, 685 ha) of wetlands, the improvement of at least 1 million acres (404, 685 ha) of wetlands, and the restoration and creation of at least 1 million acres (404, 685 ha) of wetlands.

We have already made significant progress toward meeting the President's mandate. Last year (2004), the U.S. Fish and Wildlife Service, in cooperation with partners like you, established, enhanced and protected a total of more than 440,000 acres (178,061 ha).

Reaching the President's ambitious goal will also require us to establish a reliable measure of the wetlands we have. So, we are going to improve on the ground data collection through better interagency coordination. We will also do a better job tracking the progress of wetland programs.

The U.S. Fish and Wildlife Service is preparing a nationwide analysis of wetlands status and trends. The analysis will provide an essential metric to the government—the baseline that we will use to measure our progress toward achieving, and perhaps even surpassing, the no-net-loss goal. Several federal agencies are cooperatively funding the study, which is expected to be completed by the end of this year.

As I mentioned earlier, the President signed an executive order on cooperative conservation last August. The order affirmed the Administration's ethos of conservation through cooperation, and it confirmed the Administration's dedication to advancing environmental protections through partnerships.

The order called for the White House conference on cooperative conservation within one year. It also directed federal agencies to ensure increased local participation in Federal decision making. The President wants tangible results from his executive order. We committed to delivering them.

I am pleased to announce that we are changing the way we work with you. When making significant land-use decisions, federal agencies have not always consulted with state or local governments. We are reversing that. We are committing the Interior Department to cooperate more closely with you. We want to change the way we work under the National Environmental Policy Act (NEPA) by listening and working more closely with state and local governments.

The Interior Department is committed to reaching out to a variety of groups when making decisions that affect how our public lands are managed. Federal agencies should work to have state and local governments and tribes at the table as we prepare the land-use plans that will affect them.

We are making two specific changes that will improve how we cooperatively manage public lands. First, the U.S. Bureau of Land Management (BLM) will soon publish a final rule on cooperating agencies. That soon-to-be-published rule requires the BLM to proactively invite and encourage interested parties—state and local governments, tribes, and state fish and game agencies—to participate in writing our land-use plans. The change means that BLM will reach out to state game and fish agencies to be part of the decision-making process as we move forward on our planning. And it requires that they include willing local governments in this process.

Second, we will soon be publishing an amendment to our departmental manual that will require all the agencies in the Interior Department to follow similar procedures.

This cooperating agency status may not seem like a large change, but it should have a profound effect on the way the Interior Department operates. Cooperating agency status provides state and local government an opportunity to be at the table when the federal government makes decisions about land use.

Here is how it works. When federal agencies prepare an environmental impact statement—whether it is for a BLM land-use plan, a refuge management plan, or a U.S. National Park Service general management plan—they will notify states, tribes and county commissioners.

Then, they will welcome them to get involved in the decision-making process. State game and fish agencies should be sitting at the table with federal agencies and so should county commissioners.

Our cooperating agencies should not merely be members of the commenting public. Cooperating agencies should be a part of the process as we develop our range of alternatives, when we decide on a preferred alternative and when we make final decisions.

That input and involvement is important to this Administration. President Bush has called for increased local participation in federal decision making. This new BLM rule and departmental manual change will help institute his directive.

We need your active involvement. A long comment letter on a draft environmental impact statement is not as helpful to a land management agency as having an actual representative from the state game and fish agency sitting at the table, helping develop alternatives and decisions.

Unfortunately, that rarely happens now. Yet, great differences can be made at the local level, where there is a greater knowledge of conditions, a greater understanding of issues and a greater insight into solutions.

For those who are not government officials, there is still a chance to be a part of our planning—through state game and fish and through county commissioners—that rises above simply commenting or sending letters and e-mail. I hope you will take advantage of the opportunity offered through our proposed changes in cooperating agency status. I also hope that you will continue to work with us on our array of ambitious conservation initiatives.

There is so much that we can do as partners. Together, as friends and partners, we can achieve results in wildlife conservation that will return blessings to this nation for generations to come.

Thank you.

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Implementing Cooperative Conservation Partnerships in the U.S. Department of Defense

Alex A. Beehler
Environment, Safety and Occupational Health Office of the Undersecretary of Defense
Washington, DC

In short, the Environment, Safety and Occupational Health Office in the U.S. Department of Defense is looking at results over process. It's looking at how to make things better. It's looking at being proactive, at being innovative and at using research and common-sense approaches in cooperation and coordination with all aspects of the community to better our life environmentally in a conservation realm.

We have, in the conservation area, a sort of confluence of three trends that puts a premium on environmental improvement and on doing the right things to ensure and enhance conservation. Number one, there are military bases in the United States that are being called upon (because of our increased national security obligations) to do more testing and training, which by their very nature of these bases causes greater demand on the basic natural resources, both inside the fenceline and outside the fenceline. A point that I promote here is the military's sense of community. It's always been pretty strong inside the fenceline. It's often been totally oblivious outside the fenceline. That has changed with the military's individual services, and their look. But, transformation or sustainability, new strategies recognize head on that the community extends outside the fenceline. I'll elaborate a little bit more fully as I go through the other trends.

The first thing is that there is a premium on the space that the military has with which to achieve its national strategic purposes. This demand has been enhanced by the fact that the military is not going to expand its ownership of land; that's just a fact. If anything, the military is trying to reduce its overall footprint in order to reduce stovepipes among and between the services (so there can be more joint operations and more joint basing) and to make sure that, when it tests and trainis, it is less disruptive, both temporarily and permanently, to the natural surroundings.

The second thing that has happened is there has been a concentration of military activities on fewer bases. There has been development around these bases. Many of these bases were founded more than a hundred years ago, literally out in the boonies; an example of this is Luke Air Force Base. Fifty years ago, Phoenix was a relatively small town maybe 10 or 15 miles away. Now, Phoenix has grown up, and it completely surrounds Luke Air Force Base. This has been repeated, particularly in the South and West. For instance, Camp Pendleton, in Southern California, is now the only undeveloped area between the metropolitan areas of Los Angeles and San Diego. Even here, in the District of Columbia, Fort Mead is the biggest green space between Baltimore and Washington.

This urban development has occurred because the bases that are still prominent are magnets for jobs. They are magnets for retirees because the weather is pretty good. The military retirees are familiar with the base life. They see recreational opportunities. They have their health facilities there, and they also have their commissaries. The combination of these aspects means that, just across the fenceline, you have this development that is competing for many of the natural resources that the military is demanding. Because of the very sophistication of electronic gadgets that the military sets off during weapons practice, there have been reports of electronic garage doors in the neighborhoods going open and closed. So, you have many, many things in areas where the natural resources are in direct competition.

The third is really a function of the first two; it is the incredible influx of endangered, threatened and critically exposed species that are migrating into military installations from surrounding areas for the sole reason that military bases' land is much, much less disturbed than the surrounding expanse of development. Right now on military installations, there are over 320 endangered species and over 550 of those are in a critical category. If you combine the two, that's close to 900 species that the military has to ensure appropriate habitat approaches for, in order to make sure that these species are resuscitated, restored or (at least) not in further jeopardy.

All of these three developments are competing for the same, diminishing natural resources. What has to be done and what is determined to be done with the U.S. Department of Defense is absolutely critical for the long-term conservation and the wise use of these natural resources. The bottom line is the U.S. Department of Defense and the military services have just as much at stake, if not more, than any of you who are involved in wildlife management.

The conclusion is that we're natural partners, and there are many opportunities that have been and are being developed to encourage this partnership.

Let me mention a variety of them. First, the military is now accounting for and surveying the nature, quality and extent of natural resources on their facilities. The military roughly covers 29 million acres. They have discovered the importance that this administration places on wetlands preservation, restoration and enhancement. The military has discovered that they have about 1.2 million acres of wetlands on their facilities. This has been an incredibly well kept secret, which needs not to be kept a secret anymore. It needs to be factored into our overall national protection of wetlands. By and large, the military has done a very good job of protecting wetlands just because wetlands really mean swamps in a lot of occasions. The Army and the Marines, in particular, need swamps to do effective training. Therefore, they are very much concerned about making sure that that they have good swamps. Not just a few good swamps, but many good swamps.

On top of this, you have determinations—by such groups as The Nature Conservancy—that Egland Air Force Base, in the panhandle of Florida right off the Gulf Coast, is the number one biodiversity priority east of the Mississippi River.

So, you have these developments where the military is going to have a better handle on exactly what natural resources it has and how to effectively make sure that it has the capacity from these natural resources to carry out its very important national security mission. The second thing that the military is looking at is endangered species management and resuscitation, through some of the recently enacted legislation that now allows the military a more holistic approach. I would like to describe a watershed approach to habitat management through the creation of integrated natural resource management plans known as inramps, which are developed, improved and implemented very closely in coordination with the U.S. Fish and Wildlife Service. The military now has over 500 of these plans at a facility-level basis in which they are engaged in the resuscitation and preservation of endangered and threatened species. I'm proud to say that, of the 15 species that have come off the U.S. Department of Interior's Endangered Species List, the military has been responsible for 6 of those. Forty percent is not bad.

Finally, the military is engaged in partnerships at the facility level, as well as through my office at a national level with state and local governments, conservation groups, local community leaders and interested private property owners to insure sustainable growth in the neighborhood to use shared resources responsibly.

Let me give you some examples of what we're doing, both at the national level and the local level. Again, I mention my office, but—while we can be the cheerleader, the promoter and the pusher, and while we do have some funding and programs through our Legacy Program—the lion's share of the action is at the local level in conjunction with the communities and the state and local governments.

The total expenditure of the military for this fiscal year is over $200 million in conservation. Frankly, it's a lot more than that because there are a lot of actions—particularly people's time and effort—that do not really get accounted for in that particular number. That is a significant number in which many good programs, many effective conservation efforts, can be had. Through the Legacy Program, which Peter Boyce has been key in helping to develop, we have over 60 programs we've funded over the past 8 years, dealing with migratory birds. Once again, this does not include programs funded by the military installations themselves. We have, for example, the Navy who is responsible for funding 70 percent of this nation's research in marine mammals. We have an integrated pest management board, which has the top Web-based library that people around the world use to figure out how they should handle certain types of disease or pest related issues. We do extensive work on invasive species through our various research organizations that also engage in long-term ecosystem management, once again going back to merely the training and testing concerns as well as our responsibilities for preservation and resuscitation of endangered species. It's paramount in dealing with invasive species at the installation level.

I think it is really important to look at things holistically on an integrative basis. The military, for instance, has been involved in producing over 50 percent of the vaccines that are currently in use worldwide. I think this is important to keep in mind because, if you have healthier people throughout the world, they will be able to devote more productive attention to wildlife management and to conservation issues in their surrounding community. In that same vein, all but two of the drugs used to treat malaria were developed by Army research.

We operate not only at a national level and a local level but also at a regional level. We have the Chesapeake Bay Program, which is involved in regional ecological management. And, we've launched innovative programs toward developing oyster reefs that are vital to the recovery health of the Chesapeake Bay. For instance, at one time the oyster population was so plentiful that it could naturally filter every drop of water in the Chesapeake Bay within a 3-day period. We didn't have to worry about the effects of phosphorous and nitrogen runoff then. Now, the population of the oysters is about one 1 millionth of what it was at that time; we have lost that natural filtration process and are now battling increases in nitrogen and phosphorous. Anything that can be done to rehabilitate the oyster population is a win on so many different levels. The military installations (of which there are 66 in the Chesapeake Bay watershed) have played a hand in that.

Fifty miles out is San Clemente Island, a Navy-owned island. The Navy has launched an extraordinary effort to restore an endangered bird—the shrike. They're doing this while using this island for principle bombing areas. Yet, they have increased the population of that endangered species bird by ten times.

The Marines control pickle-weed and mangrove, which are in Hawaii. They monitor and manage coral reefs using set guidelines. Most significantly, we have launched, at both the national and local level, a conservation buffer zone program, which directly ties into my earlier remarks about going beyond the fenceline in our community. This is a program that, for the first time this fiscal year, Congress has given specific appropriation for funding the purchase of easements or adjacent lands to conserve and to help with sustainable development around military bases. Currently, we have $12.5 million. The military installations, such as Fort Bragg, Fort Carson and Egland Air Force Base, have used a combination of funding of this in the past to help develop conservation areas.

Fort Bragg, in North Carolina, had a scenario on the east side of the base, wall-to-wall tract housing that was built right up to the line of the base. They were proposing to do the same thing on the west side. There was concern for the red culcated woodpecker, which is an endangered species. Fort Bragg, 5 years ago, launched an effort to fund and to work with the state and the local government and with The Nature Conservancy and with other private interests. They were able to make sure that the development on the west side did not happen in the same way that it happened on the east side. It was a winning situation for the training, for the red culcated woodpecker and for responsible sustainable growth within that area. Toward this vein, I have to applaud the work of the state governments in 15 states who have passed legislation saying that military bases have to be, at a minimum, notified and, more likely, actually brought into the process that determines what and how development will occur regarding any significant development that is going to occur within a certain proximity of bases.

Finally, I'll just briefly cite how we're involved in many of the six special sessions, which you will be having throughout the course of this gathering. First, regarding the sage-grouse dilemma session, we have inramp projects at both Mount Home Air Force Base, in Idaho, and Yuccamon training center that have helped to develop collaborative management strategies for the sage grouse. Regarding the conservation across borders session, we are party of the Southwest strategy, which has a variety of task forces in Arizona and New Mexico where we have a large presence to help on ecosystem health fire task team, the border land management task and the water task for wise use of a very scarce resource there. In addressing current and future wildlife health issues, we have funded research on diseases affecting gopher tortoises. In fact, I once saw, in an Army PowerPoint presentation, a new tank. And, (I believe this was unintentional) they also had a tortoise there. I was looking at that, and I thought, you know, the tank and the tortoise actually look and operate similarly in a lot of different areas. I've already mentioned how many programs we have. But, the U.S. Department of Defense is in the avian productivity and survivorship system; 20 percent of the sites that are used to monitor are on U.S. Department of Defense facilities. We actually engage some of our facilities with the National Audubon Society and their various bird counts that go on. Regarding stemming the tide of nonnative, invasive plants, we help to fund noxious, nuisance plant management. It's sort of a developing information system that helps in the training of personnel, so they can better identify and tackle this issue. We have programs on yellow star thistle and on cheat grass, which are very important. I know that they are a widely spread invasive species, and we're trying to fight them as well.

The bottom line is we're doing a lot. We're going to be doing more. We are looking for opportunities at the national level and at the local installation level to work with you and your organizations so that, as we attempt to do more, we do it the best we can for the community and for conservation.

Thank you very much.

Celebrating the U.S. Forest Service's Past and Looking to Its Future

Sally Collins
U.S. Department of Agriculture, Forest Service
Washington, DC

Well, good morning. I stand between you and lunch, and I hope for not too long because of that.

It's really a pleasure to be here. I think, for many of us in the U.S. Forest Service, this conference is really a highlight. Because we see so many people, it's a bit of a reunion for us. We see so many people we know. Really, I'm very grateful to be in front of you today and to have the opportunity to share the perspectives going on in the U.S. Forest Service today.

This year the U.S. Forest Service turns 100. In January, hundreds of people came from all over the United States, from Puerto Rico, from Canada and even from parts of Europe to help us celebrate. We had delegates from all over the country, speakers from universities, and speakers from other agencies. We actually only had one current employee who was a speaker for the U.S. Forest Service the entire time, and he was a young, new employee from the South.

I know some of you attended because I've seen some of your faces. It really was a great occasion for celebrating our past and for looking at our conservation roots but also for looking at the challenges that are facing us in the future.

The participants, and maybe some of you are among them, met in small groups. They came back at the end of the conference with some recommendations. I'm going to share those with you as we set out because it will sort of set the tone for the rest of what I'm going to say.

The first one had to do with the way people appreciate and value the ecosystem services provided by forests. The participants told us that, on the national forests, on the 192 million acres we manage, they want to see us provide clean air and clean water, abundant wildlife for fisheries and wildlife, and opportunities for them to enjoy them.

The participants told us, and we concur with this, that national forests provide some special and unique ecosystem services found only on national forests. There are very few other places in the United States or in the world. That's like providing niche-specialized habitat for rare species.

It includes the opportunity to recover and conserve wildlife and fish species that have limited protections elsewhere, like on private land. A great example of that is species dependent upon late successional ecosystems.

We're also really uniquely positioned to provide remote recreation experiences, like primitive hunting and camping and fishing.

Now, that's on the public land side. On the private land side, the participants encouraged us to look for ways to attach market value to the ecosystem services that are provided on those private lands as a way to help private lands stay forested into the future. To add a bigger economic engine to conservation. These services have traditionally been provided for free, including carbon sequestration, soil and water protection, biological diversity, and outdoor recreation.

A second major recommendation had to do with better engaging the public in conservation and really emphasized conservation education as an important thing that we need to be involved with in the future.

A third major recommendation involved improving the opportunities for partnership and collaboration, which I'll talk about some more in a minute.

All of the issues in one way or another focused on partnership. On this notion of facilitating a collective commitment to conservation, I will come back to that in a minute.

Because this is our 100-year anniversary and you can be tolerant for a minute, I'm going to give you a quick synopsis of this 100-year history. I think it does put in context some of what I'm going to say. It's also an opportunity for letting me give you a plug to go see *The Greatest Good* tomorrow, which is an award-winning movie. You're going to see only 30 minutes of it. It's a two-hour movie that showed this weekend at the Environmental Film Festival, in Washington, DC. It is a really great movie, and it shares some of what I'll talk about in a minute.

In the past century, in a nutshell, we've been through three very different phases in our history of conservation in the U.S. Forest Service. We're well into a fourth right now.

The first one started a century ago when we, as a nation at the turn of the century, faced a crisis in natural resource management. Conservation and the whole conservation movement grew out of that crisis. National systems of reserves were created in the late 1800s. Then in 1905, we were given the responsibility to manage these reserves. That's the system we basically manage today. For the first time, we put uses like grazing and timber under careful management. We also got on top of protecting game species and started to get fires under control.

The next era came with the great depression in the 1930s. We strengthened our commitment to social responsibility. The Civilian Conservation Corps (CCC) built most of our infrastructure that we see today and gave jobs to thousands of unemployed U.S. citizens. Really, what you use today was much of what was built at that time.

So, from the turn of the century to the 1950s was a period of basic custodial management. By the 1950s, we saw a really big transition into what we call the timber era. A lot of this was because the private land supplies were depleted during the World War II effort.

From the 1960s to the 1980s, every administration, with bipartisan congressional support, called for more timber from the national forests. In those 30 years, we went from producing very little timber to making a large share of this nation's need for wood. We helped millions build homes. During the same period, the courts became much more active in determining forest policy, due to many of the conflicts among these various uses. When you think about our multiple-use mission in the U.S. Forest Service, know that we protected and delivered a lot of values during this time: lots of goods and services, range for wildlife, water, fish and wildlife habitat, protection for wilderness, and outdoor recreation opportunities.

But, by the 1990s, under the combined pressures of delivering all that and from delivering a very high timber program, our ability to meet public expectations was overwhelmed. So, for the past decade, timber production on national forests has been a relatively small program, and most of you know that. Where we once met 25 percent of this nation's supply for wood (which was, at its peak over 12 billion board feet) it's less than 2 billion board feet today, which is less than 5 percent of this nation's supply of timber. Most of what we produce is a byproduct from projects for other purposes, like reducing fire hazards or habitat improvement. Today, we decommission 12 miles of road for every mile we construct, and timber is no longer the reason why we construct most of the roads. It's recreation.

Our main focus today is on ecological restoration and outdoor recreation. These shifts in what we're doing on the land today really reflect a whole new set of challenges facing us in the 21st century. I want you to consider just a few things. The other speakers have addressed them as well.

In the last 4 years, we've had our worst fire seasons in 50 years. Five states have had their biggest fires in their history. We've lost dozens of lives and thousands of homes. And, we've had record fire fighting costs.

Nationwide, invasive species have cost our citizens billions of dollars and have contributed to the decline of up to half of our imperiled species. The rate of new introductions is growing steeply.

We're fragmenting our forests and losing open space. Every minute, our citizens lose more than 4 acres (1.6 ha) of open space to development. Again, the rate of loss is growing.

Recreational uses have been rising so fast that we haven't been able to keep up. In particular, we're seeing unacceptable levels of off-highway vehicle use where it's not being managed well.

So, those are the four threats we've been talking about in the U.S. Forest Service a lot. All of those are important, but the other threat that's facing us is climate change. And, at various scales it's undeniable. U.S. Forest Service researchers for the last three decades have been looking at climate change. I think if you even look at the most optimistic projections in some of their scenarios, you'll see significant ecological changes ahead in the United States. Tomorrow some of those researchers will be speaking to the changes in sagebrush ecosystems as a result of climate change. I encourage you to look at that.

These are enormous and growing challenges, yet we still are often caught up in debates of the past. Getting people to focus on the important issues of the future is one of the main challenges we face today.

As we in the U.S. Forest Service are turning our attention to the larger threats of our natural resources, we've been struck by a couple of things. The largest is the extent to which these national issues have become global issues. Everything from species protection with the migratory bird program to invasive species management with a never-ending introduction of exotics from ever-expanding global trade to international ecotourism to global markets for forest products.

Our chess game of resource management has become more and more multidimensional. Let me talk for just a minute about this last issue—this global markets for forest products issue—because I think this has a huge impact on our efforts to provide good conservation in the United States.

Let me tell you a story. When I was forest supervisor of the Dechutes National Forest in central Oregon, I noticed that mills were closing all over in the Northwest. Yeah, it had a lot to do with declining timber availability because of the whole spotted owl crisis that happened in the 1980s and early 1990s. But, more and more during that time, prices for timber were being set globally. The U.S. timber industry now is not fairing well in this global market at all. More and more timber producers are investing overseas, where labor and production costs are lower. So, 10 years ago, one of our local mill owners in central Oregon bought a mill in Lithuania for export of material to the United States. At the time, I wondered how could this be possible? How could this be economical when you think about the transportation costs and all the associated development costs in an underdeveloped country?

This became even more confusing and confounding to me when I went to South Africa in 2002. I was one of those people who attended a world summit on sustainable development. Before going to the conference, I visited three mills owned by a U.S. company near a town called Sabe in northern South Africa. The mills had equipment that was a decade old, and it was pretty inefficient. I think we must have given them the equipment or sold it to them. In addition, they were required by postapartheid law to bring management under black leadership by a certain deadline—one that was fast approaching. They were funding this huge training program, and the workforce wasn't stable. Thirty percent was HIV positive, and the death rate was just about as high because they didn't have the drugs available and their living conditions were extremely poor for the workers.

In this context, the company played an important social role providing medical care and family and personal counseling. You can imagine all the costs and difficulties associated with this. But, these mills were exporting Forest-Stewardship-Council-certified (FSC-certified) wood to the United States, and they expected to be producing a profit within 3 years.

So, in the United States with all the advantages we have in terms of equipment and infrastructure and social conditions and proximity to markets, there are very few mills left in some parts of the country. I think about southern California where we had those big fires a couple of years ago, and lots of wood to process. Now it's tough to get the wood out of the woods, something we have to do to reduce fire hazards, to provide habitat for species and to restore fire-adaptive ecosystems, systems that we all know are significantly out of whack in this country.

From this trip, I finally began to see how global trends are affecting forestry. The trends caught up with forestry here. We're so challenged in the United States—with this whole range of social, economic, environmental and other issues—it can actually be cheaper to operate overseas and import wood than it is to operate in the United States and sell on our own markets.

When our citizens buy softwood timber, when you go to Home Depot today, 4 boards in 10 come from other countries. This has huge implications at home and abroad. The biggest one relates to something I think all the speakers this morning have said. If forest owners in the United States can't make it pay to manage their forests sustainably, then they tend to stop trying. If it pays more to sell their land to developers—and it often pays much, much more—then that's what they often do.

The southern United States is still the biggest wood-producing region in the world. But, states like Florida and North Carolina are actually seeing net forest losses to urban and suburban development. As that happens, we're losing forest values and benefits we desperately need, like habitat for native wildlife that we're all committed to protecting.

This also has implications abroad. Public forests in the United States enjoy some of the greatest protections in the world. At the same time, we are, by far, the largest consumer of wood products in the world. Our per capita wood consumption is three times the world average. Our consumption of softwood timber has set new records in 6 of the last 8 years.

That raises a really important question. As we import more and more wood from overseas, some of it coming from places with relatively few environmental protections, what are we doing? Are we fueling unsustainable forestry practices in those countries, such as deforestation in Brazil and illegal logging? What does that do to biological diversity?

I believe that we have to understand the global context we live in, no matter what our jobs are. For the U.S. Forest Service, I think it means paying attention to the signals coming from all around us, and today they're coming from all around the world. If we find ourselves focusing on the past and on the debates that mattered yesterday, we'll miss the signals we're getting today.

At the U.S. Forest Service, we're trying some things in response to the challenges we face. I'm going to share just a few of those. I want to assure you that we don't have all the answers. We're trying out a lot of things, and we're adjusting our methods. I want to say one thing; we can't do this alone. We can't do this without active participation from partners. Partnerships are key in all of this.

Many of you know that, as I reflect on this 100-year history, Gifford Pinchot was one of the first people to talk about our traditions of accomplishing our mission through partnerships. But, the way we work with people has changed over time. When I first started working for the U.S. Forest Service, a lot of us believed that we professionals in the forestry field had all the expertise needed to make all the right choices for the land. Public involvement was largely limited to explaining our decisions, and our partnerships were largely limited to helping us carry them out.

That's changed as well. Again, a global trend is involved, and one that I think is very interesting to look at. Eighty percent of the world's poor depend on forest resources. More than 1 billion poor people live in the world's 19 biologically diverse hot spots.

What we're learning from our international partnerships—from organizations like The Nature Conservancy, the World Wildlife Fund, Conservation International Forest Trends and lots of others—is that if we want to protect biological diversity worldwide, then we have to give local communities a stake in the land. What these partnerships are showing internationally is that, for people to work for conservation, conservation has to work for people. More and more governments are engaging communities and are managing their local forests because they see that the best caretakers are those that know and depend on the land the most. We're seeing this global trend to community-based forestry everywhere, with Mexico being one of the best at it.

Something similar is going on in the United States. In many of our rural counties, residents just eke out a living on the margins of some of our richest forests, which are often on public land. Our local communities know forest conditions better than most of us and they have strong traditions of caring for the land, so long as they have a stake in the outcome. Our response to this trend of community-based forestry has been the evolution of a new tool called stewardship contracting. I'm just going to give you three of our reactions to some of these issues that are really facing us globally, and then I'll conclude.

First, let me talk about stewardship contracting for a minute. Traditionally, we would contract for particular projects, like a timber sale, stream restoration or a trail reconstruction in the same geographic area with different contracts. The timber sale was the primary vehicle for taking commercial value off that property. With the stewardship contract, we worked together to outline the broad landscape outcomes we want on the land, and then we work with a successful bidder, potentially a nongovernmental organization. That organization helps us figure out specifically what we need to do to get the outcomes we want on the land. With the products they sell, they can re-invest in other restoration work on the land. The focus with the stewardship contract is what you leave on the land, not what you take away. It's a great way to involve the community in managing the land. It's a great way to build support for the work we're doing on the land. It provides a boost to the local economies.

Second, I want to talk very quickly about some of the other approaches we're taking to respond to these trends. Really, it has to do with some of the processes we're using for planning. I think that the fundamental thing to know here is that we're trying to be responsive to the threats that are facing us as well as to use the tools that we have in the 21st century that are really different than tools we had just 30 years ago. A lot of you have heard about the categorical exclusions we're using for projects. A lot of you have heard about the Healthy Forest Recreation Act.

I want to talk about the forest-planning rule just for a minute because it's been in the news so much. This new planning rule, which is the rule that we'll use to write plans for all the national forests and grasslands around the country, will allow us to focus on these future issues more quickly and more adeptly, issues like increased recreation use, invasive species, big fires and ecological restoration. The rule also provides for quickly incorporating the best available science. We are hoping to complete a plan now in 2 years, instead of the average seven it now takes.

Third, it requires a system of independent third party audits to make sure not only that we deliver what we say we'll deliver, but that we're truly improving the environment. These are again, an internationally accepted third party auditing process that we are considering there.

Over the last 2 years we've put all of our senior leadership in the U.S. Forest Service through seminars on global forestry trends. This is where we've gotten a lot of the ideas on independent audits, about markets for ecosystem services, about the market niche that forest products off the national forests might have in a much more global context and about the worldwide movement in community-based forestry. I want to say that because I think you can't operate, we're learning that we can't operate, in isolation of what's going on outside our borders.

In closing, I think that, as we work together locally to protect and conserve our wildlife and other natural resources, it's important to look globally. Gifford Pinchot, the first chief of the U.S. Forest Service traveled a lot around Europe. He envisioned conservation as a global peacemaker. He reasoned that, if we can conserve our renewable resources worldwide, we can eliminate one of the biggest incentives for waging war, which is to plunder the resources of other countries.

In this spirit, I have great hope for the future. Worldwide, the wave of the future is community stewardship based on partnerships and collaboration. While all of us in natural resource management face what appears to be overwhelmingly huge challenges—whether it's invasive species, fire and fuels, climate change, population growth or loss of open space—we have great opportunities for working together across borders and across boundaries. Across governments at all levels, and with partners representing the full conservation spectrum.

As our partnerships have matured over the last decade, so have our successes. It is not just in the innovations of partnerships; it is on the land, with the restoration of habitat and thriving wildlife populations. You all have so much to be proud of, and we in the U.S. Forest Service are very proud to be your partners.

Thank you very much.

Session One.
Retirements and Outsourcing: Who Will Manage Our Natural Resources?

Chair
Steve L. McMullin
Virginia Polytechnic Institute and State University
Blacksburg

Cochair
Gene Stout
Gene Stout and Associates
Loveland, Colorado

Baby Boomers and Leadership in State Fish and Wildlife Agencies: A Changing of the Guard Approaches

Steve L. McMullin
Department of Fisheries and Wildlife Sciences,
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

For as long as I have been in the fisheries and wildlife profession, we have been concerned about the loss of "institutional memory" that would occur with the retirement of senior employees. In the 1970s and 1980s, the generation of fisheries and wildlife professionals who went to college after World War II was approaching retirement age. As the 1990s gave way to the 21st century, concern has focused on baby boomers approaching retirement. The baby boomer generation, the children born between the end of World War II and the early 1960s, have been the driving force throughout the last half of the 20th century in U.S. consumer trends, education and, more recently, national politics. At the dawn of the 21st century, much of the focus on baby boomers shifted to their effects on the demographics of the U.S. population, including retirement and the social security system.

In the natural resource professions, concern for the aging of agency work forces has even greater implications because most natural resource agencies experienced dramatic growth in numbers of personnel during the environmental decade of the 1970s. Nearly all of the new employees hired during that period were baby boomers who now have 25 to 30 or more years of service and are eligible for retirement (even if they are not yet eligible for social security benefits). The concern for loss of "institutional memory" among the baby boomers is heightened when agency administrators consider the paucity of potential replacements resulting from reductions in new hiring and the emphasis on outsourcing functions of government to the private sector that resulted from the lean economic times and budget cuts of recent years.

Although much concern about the impending personnel crisis has been voiced, until recently, little data have been presented. In the proceedings of a conference on personnel trends, education policy and evolving roles of natural resource agencies, Colker and Day (2003) described the dimensions of the impending crisis for federal agencies. They suggested that more than one-half of the senior executive service employees in the U.S. Department of Interior, the U.S. Department of Agriculture, Forest Service and the Environmental Protection Agency will retire by 2007. Furthermore, the age profile of the federal work force (considering all government employees, not just natural resource agency employees) differed significantly from the civilian work force. Forty percent of government workers were over the age of 50, and only 6 percent were under 30 years of age. Only 24 percent of the civilian work force was older than 50, and 38 percent was under 30.

Data are even scarcer for state natural resource agencies. San Julian and Yeager (2002) reported that about 1,900 employees retired over a 5-year period from the 38 state agencies participating in their survey. They projected an additional loss of more than 2,700 employees through 2007 in all 58 U.S. state and territorial fisheries and wildlife agencies. Although San Julian and Yeager reported the average length of service for retiring employees to be greater than 27 years, they presented no information regarding the disciplines or positions within the agencies which employees were leaving. When employees retire from jobs in the upper ranks of agency management and administration, agencies must replace leadership skills and institutional memory in addition to mere positions. However, the extent and potential impact of changes in work force demographics for state fisheries and wildlife agencies nationwide has not been documented.

The purpose of this study was to determine the demographics of retirement from state fisheries and wildlife agencies, with a focus on the major disciplines common to nearly all agencies (wildlife, fisheries, law enforcement and information and education) as well as employees in positions of leadership within the agencies. With help from the staff at the International Association of Fish and Wildlife Agencies, I invited all state and territorial fish and wildlife agencies to participate in an Internet-based survey of their employees. The survey addressed employees' current position titles, length of service, interest in promotion and relocation within the agency, and projected date of retirement. The survey also addressed the importance of the job-related tasks employees performed and how well prepared they were to perform those tasks. In this paper, I report only the results of responses to questions about demographics of retirement and interest in advancement.

Thirty-nine agencies (including one in Puerto Rico) participated, representing all regions of the country. Nearly all agencies in the Southeast and the Midwest participated, but six western agencies (California, Oregon, Nevada, Utah, Colorado, Hawaii) and six northeastern agencies (both Pennsylvania agencies, New Jersey, Massachusetts, Connecticut and Rhode Island) did not participate. The 39 participating agencies provided e-mail addresses of employees in their fisheries, wildlife, law enforcement and information and education divisions, as well as members of their top management teams.

Collectively, the 39 agencies provided names and e-mail addresses of 10,571 employees. I attempted to contact all employees via e-mail in April 2004. At least 1,013 e-mail addresses were unusable, i.e., either the address was incorrect or the employee did not have access to the Internet, resulting in an effective sample size of 9,558. I sent two follow-up e-mail messages to nonrespondents in May 2004. I received 5,258 responses, a response rate of 55 percent. This probably represents a minimum estimate of the response rate. An unknown number of employees never received my e-mail messages because either their personal e-mail filters or their agency system filters deleted them or routed them to a junk mail folder. Response rates varied from 66 percent among management team employees (employees in the directors' offices and division or bureau chiefs) to 46 percent among law enforcement employees. Response rates within agencies ranged from 87 percent (Indiana) to 21 percent (Mississippi). Response rates exceeded 50 percent in 28 of the 39 agencies.

Survey Results

Eighty-nine percent of respondents planned to work for their agencies until they reached retirement age. Overall, 27 percent of respondents said they planned to retire by the end of 2010, with slightly more law enforcement personnel (31%) and many more management team personnel (46%) planning to retire by 2010 (Table 1). At least 41 percent of all groups planned to retire by the end of 2015, including 54 percent of law enforcement personnel and 77 percent of management team personnel. Thus, state agencies face the loss of nearly one-half of employees in leadership positions during the next 5 years and more than three-fourths of them over the next 10 years.

Table 1. Percent of state agency employees in fisheries, wildlife, law enforcement and information and education bureaus, and management team employees who plan to retire during four different time periods.

Bureau	2005–2010	2011–2015	2016–2020	2021+
Fisheries	25.1	17.7	18.5	38.6
Wildlife	24.0	17.4	20.1	38.5
Law enforcement	31.3	22.4	21.1	25.2
Information and education	25.8	19.1	23.7	31.4
Management teams	46.1	30.6	15.8	7.4
Total	27.2	19.5	19.5	33.7

Projected retirement rates for all employees by 2015 in individual states ranged from 30 percent in North Dakota to 59 percent in Alabama (Table 2). Nine states are poised to lose 50 percent or more of their employees to retirement in the next 10 years: Alabama, Alaska, Maine, Maryland, Michigan, Montana, Vermont, Virginia and Wisconsin. Five states will lose less than 40 percent of their personnel to retirement by 2015: Georgia, Idaho, Nebraska, New Mexico and North Dakota (actual rates of retirement in Georgia may be higher as I was unable to contact many law enforcement personnel in that state).

Fifty-nine percent of respondents indicated they were interested in being promoted to higher positions in their agencies, but only 42 percent said they were

Table 2. Percent of employees in each agency who project their retirement during four different time periods (sample sizes in parentheses).

State	2004–2010	2011–2015	Total 2004–2015	2016–2020	2021 and beyond
Alabama (64)	32.3	27.1	59.4	15.3	25.4
Alaska (323)	40.6	13.9	54.5	14.2	31.3
Arizona (262)	24.1	19.0	43.1	22.9	34.0
Arkansas (268)	22.8	20.6	43.4	24.0	32.4
Delaware (24)	17.2	26.1	43.3	21.7	34.8
Florida (373)	25.7	19.3	45.0	18.3	36.8
Georgia (65)	19.1	17.5	36.6	11.1	52.4
Idaho (208)	18.5	18.3	36.8	25.7	37.6
Illinois (25)	58.4	25.0	83.4	16.7	0.0
Indiana (54)	18.6	27.8	46.4	9.3	44.4
Iowa (115)	25.4	20.2	45.6	14.0	40.4
Kansas (87)	25.8	23.5	49.3	18.8	31.8
Kentucky (91)	30.9	11.5	42.4	21.8	35.6
Maine (89)	29.4	21.2	50.6	16.5	32.9
Maryland (73)	30.1	20.0	50.1	22.9	27.1
Michigan (90)	29.0	21.1	50.1	26.7	23.3
Minnesota (311)	26.1	19.5	45.6	17.9	36.5
Mississippi (6)	66.7	0.0	66.7	16.7	16.7
Missouri (329)	27.7	18.9	46.6	21.4	32.1
Montana (159)	33.6	22.7	56.3	18.2	25.3
N Carolina (138)	32.3	16.5	48.8	16.5	34.6
N Dakota (76)	13.1	17.1	30.2	18.4	51.3
Nebraska (43)	19.4	12.2	31.6	22.0	46.3
New Hampshire (36)	27.9	16.7	44.6	25.0	30.6
New Mexico (86)	18.2	19.5	37.7	20.7	41.5
New York (172)	30.5	17.3	47.8	25.0	27.4
Ohio (95)	24.5	24.5	49.0	13.8	37.2
Oklahoma (42)	21.5	21.4	42.9	26.2	31.0
Puerto Rico (9)	25.0	25.0	50.0	25.0	25.0
S Carolina (128)	29.0	11.6	40.6	19.8	39.7
S Dakota (104)	23.6	11.8	45.4	23.5	41.2
Tennessee (40)	31.6	26.3	57.9	21.1	21.1
Texas (334)	24.3	25.0	49.3	18.4	32.2
Vermont (36)	19.5	36.1	55.6	19.4	25.0
Virginia (161)	29.8	22.2	52.0	19.6	28.5
Washington (221)	24.9	15.6	40.5	22.2	37.3
West Virginia (36)	20.1	25.7	45.8	17.1	37.1
Wisconsin (331)	32.2	22.5	54.7	18.2	27.1
Wyoming (154)	26.5	19.2	45.7	15.9	38.4
Total (5,258)	27.2	19.5	46.7	19.5	33.7

willing to relocate to a district or regional office. And, only 32 percent said they were willing to relocate to the state headquarters. Responses, by bureau, showed little variation; however, 63 percent of those who expressed an interest in moving up in the organization said they were willing to relocate to a district office (36% of all employees), and 46 percent of those expressing an interest in moving up said they were willing to relocate to the state headquarters (27% of all employees; Table 3). The most common reasons cited by those who were unwilling to relocate for a promotion included inadequate financial rewards of promotion (53%), close ties to the communities in which they presently lived (50%) and the disruption that moving would cause to another family member's job (45%).

Table 3. Percent of state agency employees who were willing to relocate to district offices or to state headquarters by interest in moving up within their agencies.

	District office		State headquarters	
	Willing to relocate	Unwilling to relocate	Willing to relocate	Unwilling to relocate
Interested in moving up	62.7	37.3	46.4	53.6
Not interested in moving up	11.3	88.7	9.9	90.1

Nearly 34 percent of state agency employees were at least 50 years old, and less than 7 percent were under 30 years of age (Table 4). Thus, state agency workforces are much older than civilian workforces, which had only 24 percent of employees 50 or older and 38 percent less than 30 (Colker and Day 2003). Fifty-nine percent of management team personnel were 50 or older. Law enforcement personnel were least likely to be 50 or older (24%); while, 30 to 34 percent of fisheries, wildlife and information and education personnel were in the top age group.

Table 4. Percent of employees in fisheries, wildlife, law enforcement, information and education bureaus, and management team employees in each of several age groups.

	Age				
Bureau	< 30	30–39	40–49	50–59	60 >
Fisheries	7.8	27.7	35.7	27.4	2.4
Wildlife	5.9	28.7	33.8	28.7	2.9
Law enforcement	7.2	28.4	40.3	22.8	1.3
Information and education	6.8	22.7	36.3	31.1	3.1
Management teams	0.0	5.9	35.1	53.1	5.9
Overall	6.6	26.3	36.5	28.1	2.5

Management Implications

The results of this survey suggest that concerns about an impending personnel crisis are valid and that state fish and wildlife agencies should be preparing for the departure of the nearly one-half of all employees and more than three out of four agency leaders who will retire in the next 10 years. The impending crisis may be exacerbated by low numbers of recently hired employees and reluctance of employees to move up to positions of leadership in their agencies. Succession planning, the process of preparing for an orderly transition of leadership in agencies, should include recruitment of new employees and training of current employees. In the remainder of this paper, I suggest strategies for recruiting the best and brightest students to work for state agencies, followed by suggested strategies for encouraging employees to move up within their agencies and training them for leadership positions.

What State Agencies Can Do

In the 1970s, state fisheries and wildlife agencies rarely had to worry about recruitment of employees. For many fisheries and wildlife professionals of the baby boomer generation, working for a state agency was their first choice of careers. Many of them entered the profession because they liked to fish and hunt. What could be better than working for an agency that managed those resources?

The student of today is more likely to have gained an interest in fisheries and wildlife from watching the Discovery Channel than from a lifetime of hunting and fishing. Although the evidence is anecdotal, the majority of students in my classes seem to be more interested in careers in endangered species management or wildlife rehabilitation than in traditional management of game fish and wildlife. Federal agencies, nongovernmental organizations and wildlife rehabilitation clinics appeal to them more than state fisheries and wildlife agencies as places to work.

Furthermore, the evidence (again, anecdotal) suggests that students are likely to want to work for organizations with which they gain experience as undergraduates. Because federal agencies generally have been more aggressive than state agencies in enticing students to work for them through internships linked to future employment (e.g., Student Career Experience Program), they also have been quite successful in recruiting the best and brightest (as well as diverse) students. State agencies can no longer afford to use passive approaches to employee recruitment. They must compete with federal agencies to aggressively recruit talented students. For example, internship programs could provide students with preference in future hiring processes, in addition to experience, academic credit or financial compensation. This strategy could be particularly effective for recruiting future law enforcement employees, since those employees most often have bachelor's degrees.

State agencies also should strengthen relationships with university fish and wildlife programs by funding research projects that will address agency needs and that will train graduate students who are interested in traditional management positions. Most university fish and wildlife programs rely upon research grants to support graduate student research. If state agencies do not fund research projects, the university programs will seek funding from other sources and the students they produce will be less likely to pursue state agency employment upon completion of their degrees.

State agencies also need to invest in their current employees by funding and encouraging participation in continuing education to develop leadership and management skills. While continuing education is valuable for all employees, agencies should particularly encourage participation among those employees who express an interest in moving up to positions of leadership. Only 27 percent of all state agency employees who responded to the survey said they were interested in moving up and were willing to relocate to the state headquarters. Given such a small pool of potential applicants for future leadership positions, the agencies should nurture and reward that interest.

Finally, state agencies must develop creative solutions to address the reluctance of employees to relocate for the purposes of advancement. Salary increases associated with advancement often do not compensate for losses in salary by a significant other. Furthermore, employees responding to the survey frequently cited close ties to the communities in which they currently lived as well as a perceived loss in quality of life associated with moving to the larger cities where state headquarters often are located. If agencies address these concerns, they may be able to increase substantially the number of employees who are interested in advancing to positions of leadership.

One strategy that state agencies could pursue is to allow more employees who have jobs with statewide responsibilities to live and work in places other than the headquarters office. The possibilities for telecommuting to work increase almost daily. The 20th century model of centralized organizations needs to give way to our 21st century capabilities to communicate and share information instantaneously. Employees in a decentralized organization could travel when their jobs dictate physical presence in the headquarters office. Slightly larger travel budgets would be a small price for agencies to pay if they resulted in more talented people in leadership positions.

What Universities Can Do

University fish and wildlife programs also face a recruitment issue. Compared to 15 or 20 years ago, fewer students in today's fish and wildlife programs seek careers in state agencies. The majority of students at the university where I work seek careers working with endangered species, nongame species and injured wildlife rather than careers managing game fish and wildlife. All of those potential career tracks are important and it appears that we will produce enough students to fill positions in the endangered species and nongame arena. However, a shortage of students interested in traditional game fish and wildlife management seems likely.

University faculty could help to address this shortage by increasing awareness of students to the impending needs of state agencies. Most students respond well to the message, "Many jobs are available in this field." Faculty members also could do more to educate students about what state agency employees do. My experience suggests that most students have little or no idea of what fish and wildlife professionals really do. If students, many of whom long for active, outdoor-oriented jobs, were aware that state agency employees (on average) spend more time in close contact with fish and wildlife than most other fisheries and wildlife professionals, they might opt for state agency employment more often.

Universities also need to evaluate their curricula frequently to be sure that they prepare students adequately for fisheries and wildlife careers. Agency professionals (both state and federal) frequently cite the need for more "people skills" training in university fisheries and wildlife programs. Many university programs have increased their emphasis on the human dimension of resource management. However, most undergraduate university curricula are tightly constrained by general education requirements and the basic science and mathematics that are critical to educating future natural resource professionals. Graduate curricula face fewer constraints and offer more opportunities to address the people skills that natural resource professionals need. Given the nearly universal recognition of this need, universities have little excuse for allowing graduate students to exit their programs without having completed at least one course in the human dimensions arena of natural resource management. Although universities could introduce students to concepts of leadership and management, those topics are best left to continuing education courses for working resource professionals. Concepts of leadership have less relevance for students than they do for people with even a year or two of job experience.

What Professional Societies Can Do

Professional societies, such as The Wildlife Society (TWS) and the American Fisheries Society (AFS), also have important roles in developing future natural resource professionals. Programs such as the AFS Hutton Junior Scholars program may help to introduce high school students to the natural resource professions before they get to universities. Such programs could help to address the pervasive misconception among the public that everyone who works in a natural resource agency is a forest ranger. Professional societies also influence university curricula through their certification programs and by offering continuing education workshops at their meetings. Many university curricula are designed to meet certification requirements. In addition, state-level TWS or AFS annual meetings often provide the best means for fish and wildlife professionals whose agencies provide little or no support for continuing education to attend continuing education workshops.

Conclusions

State natural resource agencies face an impending personnel crisis. Large numbers of the baby boomer generation, many of whom were hired during the 1970s and 1980s, are approaching the age and years of service at which they will retire. Nearly one-half of all state agency employees and more than three-quarters of management team employees will retire within 10 years. This mass exodus, coupled with reduced hiring of new employees due to the economic slow down of the last several years that caused many states to tighten their budget purse strings, portends a shortage of experienced employees to advance into the vacated leadership positions. In addition, only about one in three state agency employees is interested in moving up and relocating to district or regional offices and one in four is willing to move to the state headquarters.

Agencies, university fish and wildlife programs and professional societies should collaborate to actively recruit future natural resource professionals. State agencies must abandon their passive recruitment strategies for more active strategies if they are going to effectively compete with federal agencies for the best students coming out of university fish and wildlife programs. State agencies also need to develop creative strategies for encouraging employees to advance to leadership positions. University fish and wildlife programs should increase their students' awareness of career possibilities in state agencies. Professional societies should assist in attracting students to the natural resource professions and continue to emphasize continuing education opportunities for their members.

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An Aging Federal Agency Workforce: Implications for Natural Resource Science and Management

Ryan M. Colker
Renewable Natural Resources Foundation
Bethesda, Maryland

Introduction

Government agencies charged with managing the United States' renewable natural resources are facing two unprecedented challenges. First, significant demographic changes in the federal workforce in the near term will deprive agencies of significant numbers of senior scientists and managers; an alarming percentage of employees, particularly in leadership, are becoming eligible to retire. These impending retirements raise serious questions about agencies' abilities to maintain core competencies and to properly manage the nation's natural resources.

Second, while coping with these workforce issues, federal agencies are confronting questions about their future roles. The questions stem from decades of budget cutting and reductions in force, changing national priorities and the quest for new and diminished roles of government by some interests.

The seriousness of these challenges to federal natural resources management first was suggested to Renewable Natural Resources Foundation (RNRF) in 1999, when Thomas A. Fry, then director of the U.S. Bureau of Land Management (BLM), met with members of RNRF's Washington Round Table on Public Policy. Fry reported that BLM was reexamining the kinds of skills that its workforce should possess in light of continuing workforce reductions. He observed that BLM's capabilities and mission were changing in response to diminishing financial and human resources. He also observed that the changes were occurring; although, there had been no congressional action to amend BLM's organic act.

Upon further examination, discoveries included an impending wave of retirements in all environment and natural resources agencies and also universal agency concerns about maintaining core scientific and managerial competencies.

An emerging and more complete appreciation of what was happening to the natural resources agencies led to questions of how we had gotten to this point. Leaders of RNRF concluded that the time had arrived for the natural resources and related professions to assess these demographic trends, to determine how we and the federal agencies were responding, and to discern how the future roles of government were being profoundly affected. We also wanted to consider how the professional, scientific, educational and engineering communities should respond to these trends in the current fiscal and political environment. Finally, there was a consensus that the academic community also should be challenged to reexamine its role and leadership responsibilities in the emerging social and political landscape.

Thus, the Conference on Personnel Trends, Education Policy and Evolving Roles of Federal and State Natural Resources Agencies was conducted from October 28 to 29, 2003. The conference was presented in association with the American Association for the Advancement of Science (AAAS) and conducted at its headquarters in the District of Columbia. Participating in the conference were more than 80 delegates from 25 states and from numerous natural resource disciplines.

Conference presentations and discussions concentrated on three primary issues:

1. the emerging workforce demographic trends, how they are affecting agencies and how agencies are responding
2. the role of government in natural resources management and research, how it is changing and what impact it is having on the resources, the agencies and the related professions
3. new responsibilities that should be assumed by educational institutions and the new skill sets natural resource agencies desire in their employees.

This paper is based on the findings and recommendations of the conference delegates and presenters. I will focus mainly on the first two issues, but will mention the role of educational institutions as part of the solution to overcoming these challenges. For a more in depth discussion, please see the special report published in *Renewable Resources Journal*, volume 21, number 4, entitled "Federal Natural Resources Agencies Confront an Aging Workforce and Challenges to Their Future Roles."

The Numbers

To understand the impacts that these workforce demographics have on agencies and its missions, it is first necessary to understand the demographics.

The U.S. Government Accountability Office (GAO) compiled the following statistics on workforce trends governmentwide and in selected natural resource agencies (U.S. Department of the Interior [Interior], U.S. Department of Agriculture, Forest Service [Forest Service] and Environmental Protection Agency [EPA]).

Governmentwide, total employment has been decreasing since fiscal year 1997 with the exception of a slight upturn beginning in 2001 largely due to the addition of the Transportation Security Administration. The covered natural resource agencies have shown slight increases over the same period.

Permanent full-time employees at the end of fiscal year 2002 were:

- Governmentwide: 1,608,587
- Interior: 58,857
- Forest Service: 30,811
- EPA: 16,776

One striking characteristic of the government workforce, in contrast to the civilian labor force, is the age profile. Over 40 percent of the government workforce is over the age of 50, about 23 percent have more than 25 years of service and only about 6 percent are under the age of 30. In the civilian labor force, about 24 percent are over age 50, and about 38 percent are under 30.

The natural resource agencies mirror the governmentwide statistics with length of service slightly longer. This age distribution illustrates the significance of the numbers of anticipated retirements, particularly among the more experienced managers and scientists. Governmentwide, the Office of Personnel Management projected that 19 percent of the workforce would retire between 2001 and 2005.

When looking at agency leadership, over one-half of career Senior Executive Service (SES) members, about 46 percent of GS-15s and about 34 percent of GS-14s, likely will leave government service between October 2000 and October 2007. In late 2003, Interior had an overall attrition rate of 20 percent over the previous 4 years. Over one-half of its SES members will have left by October 2007. Several key functions within Interior will see a high turnover within the same period including computer operations (74%), program managers (61%) and engineers (44%).

At the Forest Service, 50 percent or more of the leadership in key areas will become eligible to retire by 2007. Forty-six percent of its permanent workforce is projected to turn over in the same period. In some key specialties, the projections are particularly significant—entomologists (81%), foresters (49%), engineers (40%) and wildlife biologists (35%). Competitive sourcing activities likely will increase the attrition rate in occupations associated with programs or functions under study for competition.

According to GAO and the National Research Council (NRC), the EPA has struggled with maintaining adequate scientific expertise to carry out its mission. NRC believes these concerns are related to EPA's ability to attract and retain first-rate scientific talent largely due to intense job market competition from the private sector and academic institutions. This challenge could intensify as a significant portion of EPA's scientists and technical staff will become retirement eligible by 2008—including about 45 percent of toxicologists, about 40 percent of health specialists, around 30 percent of biological scientists and environmental specialists, and over 20 percent of ecologists, environmental engineers and physical scientists. Additionally, about 52 percent of the SES members will have left by 2007.

In response to these worrisome trends, federal agencies have begun strategic human capital management planning. Interior has determined that, in addressing its strategic management and major programmatic challenges and achieving performance goals, it must overcome skill gaps in technical and leadership areas. These technical skill gaps include fire management, natural and physical science, mediation and negotiation skills, and strategic business planning skills. Programmatic challenges of extreme urgency and importance include Indian Trust Fund management, wildland fire management and law enforcement and security.

The Forest Service also has determined specific competency needs and current skill gaps. Administrative employees need skills in database management, conflict resolution, analysis, communication and geographic information systems (GIS). The professional staff needs skills in recreation-related activities, communication, collaboration, analysis, social sciences, GIS, statistics, conflict resolution, databases and natural resource program knowledge. Technical staff needs skills in GIS, data identification and gathering, databases, landscape-scale data gathering, and organization.

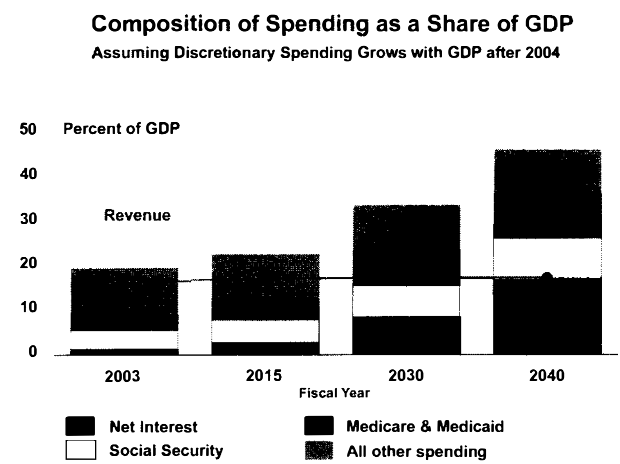
EPA has lagged behind in strategic human capital management. It has conducted a study of its workforce and has issued a human capital strategy. However, the agency still must determine the number of employees necessary to accomplish its mission, the technical skills required and how best to allocate employees among EPA's strategic goals and geographic locations. Similarly, EPA needs to fully prepare for the loss of leadership, institutional knowledge and scientific expertise that likely will result from upcoming retirements.

To provide a framework for addressing pervasive human capital challenges, GAO has developed a model for strategic human capital management. This framework is based on:

- leadership, continuity and succession planning
- strategic human capital planning and organizational alignment
- acquiring and developing staffs whose size, skills and deployment meet agency needs
- creating results-oriented organizational cultures (Government Accountability Office 2002).

Agencies must address these human capital challenges in the context of a dismal fiscal picture. The government faces a gross debt of $7 trillion. The Congressional Budget Office estimated that the total deficit for fiscal years 2003 and 2004 would be $562 billion and $644 billion, respectively (excluding social security surpluses). Finally, discretionary spending (which includes natural resource agencies) will face increasing pressure and competition for limited funds. Figure 1 illustrates the fiscal challenges that decision-makers may encounter in the future.

Figure 1. U.S. Government Accountability Office projection of future federal spending versus revenue



Notes: Although expiring tax provisions are extended, revenue as a share of GDP increases through 2014 due to (1) real bracket creep, (2) more taxpayers becoming subject to the AMT, and (3) increased revenue from tax-deferred retirement accounts. After 2014, revenue as a share of GDP is held constant.

Source: GAO's September 2004 analysis.

Why It Matters

Accompanying these demographic trends is a concern for the continued vitality of federal agencies charged with managing and conserving our natural resources.

Institutional Memory and Core Competencies

Experienced employees, including significant numbers of senior management and scientists, are headed toward retirement in unprecedented numbers. When these employees leave, so may the institutional memory—the expertise and wisdom derived from long-term employees on how things were done and why, and the agency history and experiences. Steps must be taken to ensure that this knowledge is passed on to future leadership and that new employees are provided the mentorship necessary to maintain agency strength.

Agency core competencies also are at risk. With significant numbers of scientists and professionals likely to retire in the next few years, questions remain as to the agencies' ability to evaluate and perform the science that is critical to their missions. Due to a decade of downsizing, skill gaps are now evident—particularly in the mid- to senior levels. Changing skill requirements have strained hiring—for example, the government will need to increase its information technology workforce by 16,000 over the next 10 years. Competition for the best talent is increasing due to the shrinking U.S. labor force, and fewer candidates are graduating with needed scientific and technical skills.

The general lack of diversity in the retiring population may provide an opportunity to diversify the workforce. The influx of younger hires could introduce fresh and innovative approaches to solving problems. New professionals and scientists also have the benefit of recent changes in higher education, including new emphasis on cross- and interdisciplinary curricula.

Agencies may face difficulty in attracting these young hires—particularly when the current workforce is practically devoid of employees under the age of 30. Recent natural resource program graduates are reluctant to enter government service citing a lengthy and confusing hiring process, a perception of more interesting and challenging work in the private sector, and a general lack of preparation for public service. Agency mobility requirements and salary discrepancies with the private sector may further deter the best candidates.

Changing Role of Government

These demographic shifts, along with shifting budgets and shifting national priorities, are affecting government's role in natural resources conservation. Natural resources agencies have a long and admirable history in the growth of the nation. Federal agencies have provided leadership in science, management and within the professional communities—including having employees elected to offices within their professional societies.

Over the past few decades, federal agencies have been challenged to mediate disputes over how public lands are managed. Demands for outdoor recreation and for maintenance of ecosystems and habitat have overshadowed some traditional market products, such as timber and grazing. Special interest groups have lobbied Congress and the agencies to produce the services and products that they favor. Precious few have lobbied to support a holistic approach to management.

Most recent controversies over management have centered on questions of values rather than on questions of science. Natural resources managers have not been trained to divine the relative merits of different people's values. Congress has not given very specific direction on what mix of services and products should flow from national lands. Managers in the field are left to determine the balance of multiple uses. Ongoing administrative processes and appeals have become part of the managers' daily routine.

Finally, there have been calls to diminish or eliminate the role of government altogether. Congress has entertained selling federal lands, shifting ownership to the states, diminishing the federal workforce and assigning ministerial responsibilities to private or local government entities.

How Changing Roles Effect Natural Resources

John Gordon—Pinchot Professor Emeritus and former dean of the School of Forestry and Environmental Sciences at Yale University and chairman of Interforest, LLC—examined these changes and some of the continuing questions they raise. Gordon argues that the role of government has remained relatively constant in general terms over the past century. However, changed conditions and societal goals are challenging agency structures and people to change. An inadequate response will lead to a decline in the number and importance of federal natural resources agencies. Despite the increasing pressures for and on natural resources, we are flirting with fade out and irrelevance.

Central to the role of federal government is the allocation of natural resources of the public domain, the wise use of individual resources and the retention of options for the future. From the beginning, a significant part of the "American idea" was to see land and resources as tradable commodities. The federal government has served as trader, and it still serves as the allocator of resources (timber, fish, water) derived from public and some private land and water resources. It also acts as arbiter to assure trade on a level playing field and that noncommodity values are not ignored.

These roles continue to be necessary but now must be accomplished in the face of radically different societal goals and shifting agency workforce demographics. Old methods no longer fit the goals, so government is struggling with its role. For example, much of the federal forestry establishment has spent most of its time and expertise worrying about timber. The notion that only as much timber as grows on an area should be harvested has guided more than one federal agency. Today, however, people seem more concerned about recreation, biological diversity and water. Some old worries, like fire, remain, but new ones, like urban sprawl, have emerged.

Before moving headfirst into change, it is important to understand what is at risk if there is no change. At greatest risk is resource national security, a subset of environmental security, which describes the role of the environment in making the foundations and operations of the country secure. These roles include making sure we: do not run out of resources, do not fall behind other countries in technology for environmental management, do not make unnecessary enemies, maintain a livable environment and support economic development.

To meet these changed concerns and to serve new goals, agencies are attempting to shift from conservation, the metering out of resources at some agreed upon rate, to maintaining complex systems. Shifting from sustained yield to sustained systems involves a shift in goals from "get what you want within rational limits" to "maintain the system and take what it gives you." The forest rather than the trees, and the ocean ecosystem rather than fish populations become the focus of management and policy.

Implementing a sustained-systems approach demands the integration of several federal functions, including knowledge creation (research and outreach), regulation, direct management of the public estate (applying knowledge and regulation to specific places), and support of state, local and private efforts. Change will occur with a shift in emphasis among these functions—either through funding or personnel. Although these functions, and even the emphasis among them, may seem obvious, severe problems exist that must be solved if security is to be served adequately. The most important functions are the least funded (knowledge creation and support), the most funded is most easily done by others (direct management), and the least understood is the most critical (regulation). The resource-knowledge deficit constrains positive change. This has become more severe with the increased complexity of the world.

The central challenge to resource security is the reconciliation of short- and long-term risks. Short-term risks usually dominate. Therefore, the maintenance of a long, integrated view is a central task for the federal resource management establishment. This long view is particularly important when looking at natural and policy processes—for a sustainable legislative agenda. It should be formed with a high level of citizen involvement and awareness and also in support of other national goals (economic, social and diplomatic). A long view implies long effort, and that requires stability of funding and quality.

Today, natural resources have a smaller slice of the pie. In fact, the slice may be inadequate to maintain resource security. There are more people, more complex goals, more problems, and there is more science. Yet, there is no more effort, in terms of budgets and numbers of personnel, than before. Natural resources less clearly are linked to the national economic welfare, and fewer people derive their livelihoods directly from the land and water. This translates into natural resource agencies being less important in the federal establishment and a resulting decline in bipartisan support. Professionals within the agencies lose access and influence at the highest level of policymaking, and the agencies lose power. In addition, the increased complexity of resource problems has eroded agencies' abilities to provide clear solutions to problems.

Government's principal role has been and remains stewardship of natural resources informed by scientific knowledge. This role includes management, setting standards and monitoring, and public education. Natural resource agencies are competing with other agencies for limited funding (Figure 1). Such constraints force administrators to choose among priorities, leaving critical mission-oriented programs underfunded or understaffed. The role of government is changing by default and accident, not with discussion and deliberation. No one is taking a holistic, strategic look at how the role of government is changing.

The overall approach to governance is changing from one focused on rules and regulations to one oriented by values and goals (e.g., desire for a sustainable ecosystem). Current approaches no longer are conducive to solving current environmental problems. For example, methods designed to control point sources of water pollution cannot adequately control nonpoint sources. Transportation choices and conspicuous-consumption lifestyles also suggest government's role as educator to facilitate movement toward sustainability.

Congress plays a key role in determining the government's role and responsibilities. Legislation sets priorities, guides budgets and steers outcomes, yet current natural resource legislation is old and does not comprehensively reflect current national needs and priorities. However, passing new or updated legislation today could be challenging or even counterproductive.

There is reason for serious concern about the future of federal science and research programs. To remain leaders in natural resource management, federal agencies must sustain and improve their research and science capabilities. However, agencies and scientists are under increasing pressure to produce rapid results. Political managers expect programmatic results right away. Congress requires research outcomes within 3 years. It is difficult, and often impossible, for researchers to produce results that quickly. Serendipitous discoveries are limited, and long-term research is negatively impacted. Government research funding is especially susceptible to attack in the current political/fiscal environment. For example, recent assaults questioned the value of long-term national water quality and quantity monitoring.

Next Steps

Understanding the demographic trends and their potential impact on U.S. natural resources is a crucial first step. However, as professionals, policymakers, scientists and others interested in natural resources, we have an obligation to develop actions to counteract those impacts about which we are most concerned. Such actions must focus on numerous populations including the public, existing agency employees, students at all levels of education, policymakers and the natural resources community as a whole.

In order to address the most immediate risks—loss of institutional memory and maintenance of core competencies—actions must focus on recent retirees, current agency employees, students enrolled in natural resource programs and current agency structures. To retain and conserve this memory, employees could be recruited to move into an emeritus status where they would work with agency personnel on a regular basis as a mentor. Retirees also should be encouraged to associate with universities where they can educate natural resource students who will become agency employees.

Some employees should be encouraged to remain beyond their 30th anniversary with an agency. Encouraging these employees to stay—using new retirement requirements—will help assure that necessary leadership and scientific expertise can remain in the agency longer. Agencies also should embrace the idea of a knowledge-based organization that promotes lifelong learning and continuous training. Such programs tend to revitalize employees and to keep them interested in their work. Preparing existing younger employees for leadership through accelerated SES training programs can help fill anticipated leadership vacancies. Examining what the private sector has done in similar situations may provide additional options.

While natural resource program enrollments continue to decline, even graduates of natural resource programs do not choose government employment. Agencies and universities must work together to reestablish an interest in government service. Recent graduates are looking for meaningful work. This requires thoughtful planning by employers. Therefore, agencies should not rush to fill vacated positions but should consider the need for the position or the creation of a position requiring new skills. Increased options for college students and recent graduates, including internships and mentoring programs, may help interest students in public service. Some programs also ease the transition to government employment. The current agency hiring process also is too long and too difficult—reform is necessary.

While attracting current natural resource students and maintaining the existing employee base is important in the short run, long-term solutions require a systematic and holistic approach. Agencies will continue to have the same problems, though perhaps delayed by 5 or 10 years in the face of moderately effective solutions. Workforce models should account for changes in career trends and job turnover rates.

A Role for Universities

Along with federal and state agencies, universities are an essential partner in the conservation and management of natural resources. They are responsible for educating future employees, helping existing professionals maintain up-to-date skills, and furthering resource management theory and practice. Universities, like government, also may face changes in priorities through declining budgets and changing personnel. Universities, in conjunction with agencies, can lead the discussions---or even can lead the changes. In light of the changes occurring in government through shifting roles and changing demographics, universities have new responsibilities to assure an adequate cadre of natural resource professionals with desired skill sets and to assist in providing support for essential natural resource programs.

Universities and government must reestablish lines of communication to discuss and solve mutual problems. Universities—through their research, publication and education missions—have a part to play in describing and supporting the necessary role of government in natural resource management. The public perceives academicians as having the freedom to speak out and to provide leadership. Professors and administrators should act through and with the support of their professional and scientific societies.

Following years of limited opportunities for government positions, particularly at the entry level, universities have severely curbed preparing students for careers in the federal workforce. Federal agencies heavily curtailed and even stopped university recruitment programs. However, impending agency employee retirements should result in new opportunities for university graduates. Universities—in partnership with government—will need once again to prepare students for public service. Universities can identify positive and rewarding aspects of public service.

Student and employer needs have changed, and curricula and teaching methods must change to reflect these new needs. Courses should encourage the use of critical thinking and should introduce the concept of critical and integrative decision-making. Elective credits should be available for students to take courses of interest, which will encourage creativity, adaptability and flexibility. Including social skills and human dimensions is important. Providing students with insight about working in different environments will be increasingly useful. Students need context knowledge. Ecological literacy should be taught in all majors; citizens are more likely to support natural resource programs if they have knowledge and connections.

Changing the current university tenure structure would encourage the development of professors, and subsequently students, who better understand current societal needs. Promotion and tenure criteria should include alternatives to publication, including activities outside the university such as policymaking and interdisciplinary activities. A flexible structure should promote experiences across government, academia, nonprofits and the private sector. This experiential mobility would help establish links within these sectors and would better prepare students for whatever career path they choose. Universities also should encourage this mobility among its students through internships. These temporary work experiences will open up career paths and will give students an understanding of how particular sectors work.

Recruiting and Preparing Students

More than just producing natural resource graduates, universities will be asked to teach many of the new skills that agencies seek. These skills are a reflection of the evolving role of government, technological developments and societal changes. Universities need to produce scientists capable of working in teams. At the same time, scientists who comprise teams must still be able to apply their own discipline in order to make good assessments and analysis.

There is no single skill set necessary for all employees. However, all skill sets should include context competencies and content competencies. Context competencies include communication skills, critical thinking, teamwork, conflict resolution capabilities, interpersonal skills, project management and planning skills, and synthesis skills. Content competencies include necessary disciplines, such as ecology and economics, which form the basis for an agency's mission. Other important skills include the ability to use and manipulate information science and the enthusiasm to take work to the next step (i.e., thinking outside the box). Incorporating social science skills, such as policy and politics, also may benefit resource science.

Recruitment must begin at an early age. Once most students reach college, their interests and possible career paths already are decided. Young people are avoiding natural resource career paths due to a lack of interest in natural resources. People's connection to the land and water is more tenuous than in previous generations. That connection must be reestablished. Beginning in elementary school, teachers should incorporate decision-making skills and environmental issues into lessons. They need a better understanding and appreciation of government and how it works. New curricula that focus on urban natural resource issues could help.

Involving and Educating the Public

A serious outreach program to the public is necessary, using all available media to inform about land management, conservation and environmental issues. Federal agencies must recognize the importance of significantly increasing public outreach activities and, if necessary, must provide funding from existing programs. However, budget limitations, political resistance and the diversity of the audiences will make these efforts difficult. As conservation programs have dropped on the list of national priorities, it has become increasingly difficult to secure necessary budget support.

Another symptom of the challenge ahead is that the public is largely unaware of who is responsible for particular management decisions. Federal agencies should highlight their services and projects at the local level. Also, make delivery of services as seamless (and painless) as possible. The expansion of responsibilities within agency regions and the breakdown of barriers across agencies may help. Such a breakdown promotes the use of colocation and the utilization of place-based science. By working together via a community approach, perceived problems with federal ineffectiveness at the local level can be overcome. However, challenges do exist, including the current lack of uniformity of regional divisions among agencies. Fragmented or even competing missions need reconciling (e.g., the U.S. Bureau of Reclamation and the U.S. Fish and Wildlife Service within Interior compete to provide water for farmers and fish, respectively).

A greater focus on human capital and on natural capital can counteract the perception by some segments of the public that natural resource scientists are more concerned with the environment than with humans. Scientists should no longer take their concern for humans as a given. Promotion of the human value of natural resources as opposed to the economic value (e.g., Parks for the People) could help.

The Importance of Partnerships

Federal agencies and state and private universities, should consider partnerships that result in political advantage for natural resources management and science. Greater cooperation among federal and state natural resources agencies also would be mutually beneficial. The professional, scientific and educational communities should undertake a strategic campaign to support a continuing vigorous role for the federal government in natural resources stewardship, science and research. Natural resource professionals should identify common interests and should enlist the support of environmental groups and organized labor.

The use of DC-based coalitions has become more prevalent in defining and defending the roles of federal agencies. The National Institutes of Health, the National Science Foundation and the U.S. Geological Survey (among others) have coalitions comprised of universities and of professional, scientific and educational organizations supporting federal agency programs. These coalitions focus their efforts on members of Congress and their staffs, on federal political appointees and on agency personnel. Their expanded use should be considered.

Conclusion

Natural resources agencies, their associated professions and the resources themselves are facing increasing challenges. Assuring the continued viability of natural resource programs depends on the cumulative efforts of the agencies themselves, their employees, universities, professional and scientific societies, nongovernmental organizations, Congress, and society as a whole. Strategic planning that includes all necessary partners is essential.

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Changing the Face of Natural Resources: An Unprecedented Opportunity and a Strategic Imperative

David L. Trauger
Natural Resources Program,
Virginia Polytechnic Institute and State University
Alexandria, Virginia

Margaret R. Burks
Natural Resources Program,
Virginia Polytechnic Institute and State University
Alexandria, Virginia

A major demographic transition is currently underway throughout the natural resources and environmental professions (Durant 2003). Over the next 5 years, significant workforce changes are forecast in federal natural resources agencies, as well as throughout the federal government and across the nation (U.S. Department of the Interior 2003). While implications of aging agency workforces and anticipated agency retirements for natural resources management received considerable attention in recent years (San Julian and Yeager 2001, Colker and Day 2003), workforce diversity ramifications are little noted by either government or industry (DeLong 2004, Gropp 2004).

The demographics of the United States' workforce have been changing over the past 50 years, but concern about progress in achieving greater representation of minorities has increased in recent years (U.S. Merit Systems Protection Board 1993). Diversity goals remain unattained in most natural resources agencies because they have difficulty in recruiting and retaining qualified minority workers (Colker and Day 2003). Nevertheless, the limited progress in achieving greater ethnic and cultural diversity may be further jeopardized concomitant with losses in institutional memory and changes in organizational culture as underrepresented groups are also impacted by retirements. The purpose of this paper is to examine likely demographic impacts on workforce diversity during the imminent massive agency retirements.

Methods

In broad terms, "diversity" is defined to include racial, religious, color, gender, national origin, disability, sexual orientation, age, education, geographic origin and skill characteristics (U.S. Department of the Interior 2003). For purposes of this paper, the focus will be on ethnic diversity, i.e., race, color and national origin.

Current ethnic diversity represented at the major natural resources and environmental management agencies was examined. In addition, interviews were conducted with human resources professionals to determine the anticipated retirements of minority workers during the next 5 years. For purposes of this paper, ethnic minorities are classified as African American, Hispanic, Asian American/Pacific Islander, and American Indian/Alaskan Native. Numerical comparisons of minority representation are made throughout with Caucasian. Ethnic identities are self-designated by employees in all cases.

The focus of this paper is on ethnic minorities in life-science disciplines; physical scientists, engineers and technicians were excluded. Genders were lumped in the analysis, except where key differences were noteworthy. The workforce statistics cited in this paper refer to permanent, full-time employees only; part-time, temporary and internship positions are not included. Underrepresentation was determined by comparing agency data with that for the National Civilian Labor Force (NCLF) as provided by the agencies.

The study was based on the 2002 to 2004 fiscal years' workforce demographics of 138,247 employees within the principal federal agencies employing scientists in the natural resources and the environmental professions. U.S. Department of the Interior (DOI) agencies include the U.S. Fish and Wildlife Service (9,323 employees), U.S. Geological Survey (10,170 employees), U.S. National Park Service (23,898 employees), U.S. Bureau of Land Management (11,688 employees), U.S. Bureau of Reclamation (5,773 employees), U.S. Bureau of Indian Affairs (10,990 employees) and five other smaller bureaus and offices (5,085) (U.S. Department of the Interior 2002). U.S. Department of Agriculture agencies include the Forest Service (31,684 employees) (U.S. Department of Agriculture, Forest Service 2004) and the Natural Resources Conservation Service (NRCS) (11,987 employees) (U.S. Department of Agriculture Natural Resources Conservation Service 2003). The U.S. Environmental Protection Agency (EPA) (17,649 employees) is also represented (U.S. Environmental Protection Agency 2004a).

Evaluation of comparable data was difficult because each agency compiles and reports their data in accordance to different criteria, needs and schedules. There appears to be no central location where agency demographic data is available to the public.

Findings

Recent demographic data for the biological sciences positions from DOI (fiscal year 2002), Forest Service (fiscal year 2004) and NRCS (fiscal year 2003), and the EPA (fiscal year 2004) are shown in Table 1. With precious few exceptions, minorities are underrepresented in the workforces of the principal natural resources and environmental federal agencies, a condition that chronically persists despite more than a decade of concerted efforts to bring greater ethnic diversity into agency workforces.

Table 1. Ethnic distribution within biological science series in federal natural resources agencies.

Agency	Caucasian	African American	Hispanic	Asian American/ Pacific Islander	American Indian/ Alaskan Native	Total
U.S. Department of the Interior[a], fiscal year 2002	6,701 (90.5%)	95 (1.3%)	206 (2.8%)	109 (1.5%)	291 (3.9%)	7,402
U.S. Department of Agriculture, Forest Service[b], fiscal year 2004	5,908 (90.9%)	104 (1.6%)	245 (3.8%)	100 (1.5%)	148 (2.3%)	6,497
Natural Resources Conservation Service[c], fiscal year 2003	5,541 (86.0%)	466 (7.2%)	222 (3.5%)	40 (0.6%)	171 (2.7%)	6,440
U.S. Environmental Protection Agency[d], fiscal year 2004	990 (82.6%)	88 (7.4%)	44 (3.7%)	66 (5.5%)	10 (0.8%)	1,198
National Civilian Labor Force[e]	76.8 %	11.4%	10.8%	3.8%	0.8%	100%

[a] U.S. Department of the Interior. 2002. *Fiscal Year 2002 Distribution by Major Occupations.*

[b] U.S. Department of Agriculture, Forest Service. 2004. *U.S. Department of Agriculture, Forest Service Workforce Analysis, Fiscal Year 2004.*

[c] Natural Resources Conservation Service. 2003b, c. *Change in Natural Resources Conservation Service Work-Force Profile by Major Job Occupation Categories with 100 or More Employees: Work Force Demographic Profile, Affirmative Employment Program Report for Fiscal Year 2003.*

[d] U.S. Environmental Protection Agency. 2004b. *Participation Rates for Major Occupations–Distribution by Race, Ethnicity and Sex, as of September 30, 2004.*

[e] U.S. Department of the Interior. 2003. *Strategic Human Capital Plan, Implementation and Workforce Planning Report, September 30, 2003.*

U.S. Department of the Interior

By its own admission, DOI has not done a good job of attracting, hiring, developing and retaining a diverse workforce (U.S. Department of the Interior 2003). At the end of fiscal year 2001, about 75 percent of the workforce was Caucasian, and about 62 percent was male. With the exception of the American Indian/Alaskan Native category, DOI was below the NCLF recommendation for all ethnic groups.

Biologists represent the preponderance of scientific expertise at DOI (U.S. Department of the Interior 2002). Biological Scientist (0401), Wildlife Biologist (0486) and Fishery Biologist (0482), the top three disciplines, comprise more than 70 percent of the biological positions (Table 2). Overall, minorities represent only 9.5 percent in the Biological Science Series and even less (8.4 percent) in the three primary disciplines. African American, Hispanic and Asian American/Pacific Islander scientists are underrepresented in this occupational series. Caucasian women are also underrepresented in these three major disciplines. Rising retirement rates will interact with recruitment and retention

Table 2. Distribution by biological science occupations at the U.S. Department of the Interior.

Biological scientist series	Total	Caucasian	African American	Hispanic	AsianAmerican/Pacific Islander	American Indian/Alaskan Native	Total Minority
General biologist (0401)	3,287	3,015	40	81	49	102	272
Ecologist (0408)	366	344	2	6	10	4	22
Botanist (0430)	125	110	0	8	5	2	15
Rangeland manager (0454)	374	338	0	16	0	20	36
Forester (0460)	444	355	2	3	2	82	89
Fish and wildlife specialist (0480)	163	146	4	5	3	5	17
Fishery biologist (0482)	823	735	22	22	17	27	88
Wildlife refuge manager (0485)	717	637	15	34	5	26	80
Wildlife biologist (0486)	1103	1021	10	31	18	23	82
Total	7,402	6,701	95	206	109	291	701
Representation within series	100.0%	90.5%	1.3%	2.8%	1.5%	3.9%	9.5%
National Civilian Labor Force		76.8%	11.4%	10.8%	3.8%	0.8%	23.2%

practices to impact these levels over the next 5 years. Approximately one-third of both the Caucasian and minority populations retired during fiscal year 2001 (U.S. Department of the Interior 2003).

U.S. Department of Agriculture, Forest Service

Past downsizing and projected retirements are creating a human capital deficit at the Forest Service, and ethnic diversity is one of the key issues of concern in the Workforce Plan for 2001 to 2005 (U.S. Department of Agriculture, Forest Service 2002). Compared to the NCLF, Hispanics have dropped in parity at the Forest Service (Salinas 2002). In 1990, Hispanics were at 64 percent parity with the NCLF, at 50 percent in 2000 and are projected to be at 45 percent in 2010 at present rates of hiring. This decline in Hispanic representation in the workforce has occurred while Hispanics in the NCLF have increased from 2 percent to 12 percent over the past 40 years. African Americans are underrepresented as well. An analysis of African American employees in the Forest Service during fiscal year 2004 notes that recent gains in regional and student hiring are not enough to offset the two-decade long, 4-percent plateau for this minority group (Howard 2004). Salinas (2002) concluded that the Forest Service's expenditure of millions of dollars ($58.6 million in fiscal year 1999) on diversity issues has yielded negative results.

Biological science occupations (6,497 employees) represent approximately one-fifth of the Forest Service workforce (T. Baughman, personal communication 2005). The top three position series, Forester (0460) (2,500 employees), General Biologist (0401) (1,631 employees), and Wildlife Biologist (0486) (764 employees) make up 75 percent of the workforce in the biological sciences (Table 3). According to the Forest Service's workforce plan (U.S. Department of Agriculture, Forest Service 2002), the professional positions in need of the greatest number of hires to reach parity with the NCLF are almost all among the Biological Science Series. The most significant minority underrepresentations are African American Foresters (0460), and Asian American/Pacific Islander General Biologists (0401) and Wildlife Biologists (0486).

U.S. Department of Agriculture, Natural Resources Conservation Service

Faced with more than 30 percent of the total workforce eligible for retirement by 2008, NRCS (2003c) is being proactive in taking steps concerning anticipated workforce changes. NRCS's (2003a) recruitment efforts for women

Table 3. Distribution by biological science occupations at the U.S. Department of Agriculture, Forest Service.

Biological scientist series	Total	Caucasian	African American	Hispanic	AsianAmerican/Pacific Islander	American Indian/Alaskan Native	Total Minority
General biologist (0401)	1,631	1,498	29	57	20	35	141
Ecologist (0408)	294	280	4	5	3	2	14
Entomologist (0414)	126	117	0	4	3	2	9
Botanist (0430)	179	166	4	4	4	1	13
Plant pathologist (0434)	70	65	2	0	1	2	5
Rangeland management specialist (0454)	365	320	0	30	5	10	45
Forester (0460)	2,500	2,293	44	68	39	56	207
Soil scientist (0470)	176	152	10	9	2	3	24
Fishery biologist (0482)	392	351	3	17	11	10	41
Wildlife biologist (0486)	764	666	8	51	1	27	98
Total	6,497	5,908	104	245	100	148	597
Representation within series	100.0%	90.9%	1.6%	3.8%	1.5%	2.3%	9.2%
National Civilian Labor Force		76.8%	11.4%	10.8%	3.8%	0.8%	23.2%

and minorities contributed to increases in representation between 2002 and 2003. The agency points to such significant gains as a 29 percent increase in Asian American/Pacific Islander women and an almost 10 percent increase in Hispanic men. But overall success is uneven. The number of African American and American Indian/Alaskan Native employees decreased during the same period. As of September 30, 2003, approximately 85 percent of the workforce was Caucasian, and 70 percent was male; over 60 percent was Caucasian male (U.S. Department of Agriculture, Natural Resources Conservation Service 2003a). With the exception of American Indian/Alaskan Native men, the NRCS was below NCLF levels for all ethnic groups.

Biological Science Series positions represent over half of the agency's total workforce. Within the series, expertise is highly concentrated in the Soil

Sciences. In 2003, Soil Conservationists (0457) made up approximately 36 percent of the total agency workforce and over 66 percent of the Biological Science Series positions. Minorities represented 14 percent of the biological scientists, as well as 14 percent of the two soil scientist positions (Table 4). Asian Americans/Pacific Islanders were underrepresented throughout the series, as were women in every ethnic group (U.S. Department of Agriculture, Natural Resources Conservation Service 2003b).

Table 4. Distribution by biological science occupations at the U.S. Department of Agriculture, Natural Resources Conservation Service.

Biological scientist series	Total	Caucasian	African American	Hispanic	AsianAmerican/Pacific Islander	American Indian/Alaskan Native	Total Minority
General biologist (0401)	859	712	72	40	3	32	147
Rangeland manager (0454)	271	244	1	18	0	8	27
Soil conservationist (0457)	4,270	3,670	316	143	29	112	600
Soil scientist (0470)	920	806	75	16	8	15	114
Agronomist (0471)	120	109	2	5	0	4	11
Total	6,440	5,541	466	222	40	171	899
Representation within series	100.0%	86.0%	7.2%	3.4%	0.6%	2.7%	14.0%
National Civilian Labor Force		76.8%	11.4%	10.8%	3.8%	0.8%	23.2%

U.S. Environmental Protection Agency

Minorities represent 30 percent of the EPA's 17,649 permanent workforce (U.S. Environmental Protection Agency 2004a). According to the agency, current employment figures compare favorably with NCLF levels: minorities above by 8.4 percentage points (30.2 percent vs. 21.8 percent) agencywide and Caucasians below by 8.1 percentage points (69.8 percent vs. 77.9 percent). But, Asian Americans/Pacific Islanders are below parity agencywide.

Biological scientists comprise only 6.8 percent of EPA's total workforce. Minorities represent approximately 17 percent of the agency's 1,198 Biological

Science Series positions (Table 5). African Americans and Hispanics are substantially below NCLF parity in Biological Science Series.

Table 5. Distribution by biological science occupations at the U.S. Environmental Protection Agency.

Biological scientist series	Total	Caucasian	African American	Hispanic	AsianAmerican/Pacific Islander	American Indian/Alaskan Native	Minority
General biologist (0401)	821	687	65	34	26	9	134
Microbiologist (0403)	95	72	10	4	8	1	23
Ecologist (0408)	109	104	1	2	2	0	5
Toxicologist (0415)	173	127	12	4	30	0	46
Total	1,198	990	88	44	66	10	208
Representation within series	100.0%	82.6%	7.3%	3.7%	5.5%	0.8%	17.4%
National Civilian Labor Force		76.8%	11.4%	10.8%	3.8%	0.8%	23.2%

Projected Agency Diversity Changes

Although personal decisions on when workers will retire are unknown at this time, agency managers, working with their respective human resources professionals, have determined when personnel will be eligible for retirement. Colker (2005) summarized the projected retirements among scientists and managers for the principal natural resources agencies. Although comprehensive data were not available for anticipated retirements in relation to ethnicity for all agencies, minority employees are expected to retire at comparable rates to their Caucasian colleagues. Indeed, retirement data from the DOI (fiscal year 2001) shows a 32-percent retirement rate for minorities, compared to a 37-percent rate for Caucasians. There are several reasons for this slight differential, but it is likely due to ethnic age structure, i.e., the relatively recent emphasis on workforce diversity compared to historic dominance in natural resources by Caucasians, primarily Caucasian males. Currently, minorities represent approximately 15 percent of the total workforce in NRCS (2003a). About 12 percent of these employees were eligible to retire by the end of fiscal year

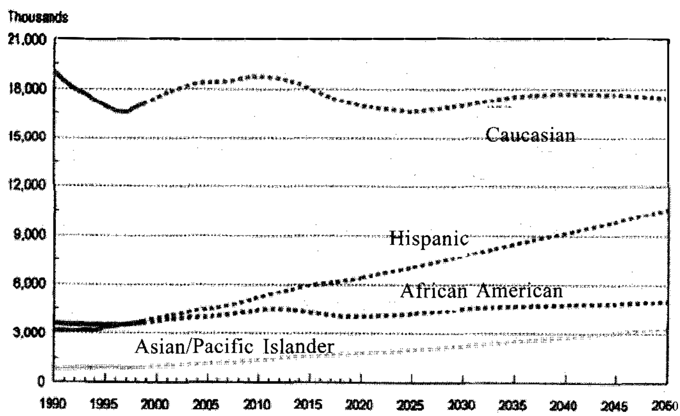
2003. This proportion will increase to nearly 26 percent by the end of fiscal year 2008, compared to 31 percent retirement eligible agency-wide.

Demographic Changes and Resource Management Implications

Decker (2004) expressed concern about anticipated demographic trends and losses of critical mass, institutional memory and philosophical clarity in state and federal natural resources management agencies. In view of the magnitude, proportions and precipitous nature of this demographic transition, he noted that some observers characterized these changes as an emerging crisis in public natural resources management.

The proportion of the U.S. population that is minority will continue to rise rapidly in the first half of the 21st century (U.S. Bureau of the Census 2005). According to current population projections (Figure 1), ethnic minorities (Hispanics, African Americans and Asian American /Pacific Islanders) will constitute more than half (52 percent) of the resident college-age (18–24 years old) population of the United States by 2050, a 34-percent increase from 1999. By 2050, Caucasians will constitute an estimated 48 percent of the U.S. college-age (18–24 years old) population, a 66-percent decrease from 1999. The greatest growth among minority groups will be for Hispanics and Asian Americans/Pacific Islanders, reflecting projected immigration trends. Relatively little growth is projected for college-age African Americans and American Indians/Alaskan Natives; these populations will remain at 14 and 0.9 percent, respectively, of all U.S. 18- to 24-year-olds in 2050 (U.S. Bureau of the Census 2005).

Figure 1. U.S. population 18 to 24 years old, by ethnicity, July 1990 to 1999 and projections to 2050. (U.S. Bureau of the Census 2005)



The implications for agency recruitment efforts are clear. Greater emphasis must be placed on outreach to Hispanics and to Asian Americans/Pacific Islanders. Because of persistent underrepresentation in natural resources professions, efforts must continue to recruit African Americans and American Indians/Alaskan Natives. However, major new initiatives must be mounted to overcome challenges looming in attracting greater numbers of ethnic groups, especially Hispanics, into the workforces of natural resources agencies.

Recruitment of minorities and programs to enhance ethnic diversity in the natural resource professions will be expensive, both in money and time. Some managers, faced with declining budgets, may wonder where they will find the funding and personnel to support such programs, especially in view of the increasing competition for funds for core ongoing programs. The mounting federal deficits and increasingly austere budgets do not provide a favorable outlook for most agencies (Colker 2005). Nevertheless, agency managers must affirmatively assert workforce diversity as one of the highest priorities. Failure to do so is already costing agencies substantially. For example, the Forest Service spends $25 to $30 million annually to resolve equal employment opportunity complaints (Salinas 2002), despite nearly $60 million annually ($58.6 million, fiscal year 1999) spent on diversity issues. Salinas (2002) predicts that if present trends continue, the Civil Rights/Human Resources Management Division will have one of the largest staff budgets at the Forest Service, exceeding both range and watershed programs. He advocates change and better solutions. The long-term ramifications of failing to diversify the workforce inevitably will lead to unacceptable consequences for sustainable management of natural resources. In the final analysis, the cost/benefit ratio of increasing workforce diversification would be exceedingly favorable.

Workforce Diversity Challenges and Opportunities

Although this paper has focused on minority representation at several federal natural resources agencies, the problem of ethnic underrepresentation and demographic change is a common one at all levels of government and academia, as well as among nongovernmental organizations. Facing a changing of the guard in natural resources agencies, institutions and organizations provides the current generation of leaders with an unanticipated responsibility and an unprecedented opportunity. How we, as a profession, respond to these challenges may chart the future course of natural resources conservation. We stand at the threshold of decisions that may well determine the social and political relevance of conservation and management of natural resources in coming decades.

Over the past several decades, natural resources agencies have attempted various programs to recruit ethnic minorities into the workforce. DOI (2003) recently promulgated a comprehensive strategic plan for enhancing the agency's diversity initiatives. Key features of the plan are changing the mindsets of managers from "have to go" to "want to do," identifying best practices and achieving results. The plan also encourages better use of current hiring authorities to increase the participation of Hispanics and other minority groups. Although there have been many well-intended initiatives to increase workforce diversity, few have succeeded. Agencies must stop the prevalent practice of reporting failed efforts as success stories (Salinas 2002). Compared with the proactive diversity programs pursued by business, industry and other professions, most natural resources agencies have often been ineffectual, inadequate and belated in their recruitment efforts. Reasons for lack of success or failure are many, and it would not be productive to point fingers or to engage in blame games. Rather, we need to learn from the past and to redouble our efforts for the future.

There is a mounting urgency to break through the formidable and pervasive barriers to minority recruitment. We need to change our mindsets and to expand our outreach. We especially need to overcome the conventional wisdom that properly trained and educated minorities do not exist in natural resources disciplines because this viewpoint may not square with the facts or reality. We need to make better use of authorities that are already on the books to recruit and to support minority career development. If we fail to find qualified applicants for our positions, we need to "grow" our own through various recruitment incentive programs, such as the Student Career Experience Program (SCEP). A national scholars program for the natural resources disciplines is needed, one modeled after the National Research Council's (1996) program for increasing the number of underrepresented minorities in mathematics, the physical sciences and engineering.

Although the record for attracting ethnic minorities into the geosciences is poor (Czujko and Henly 2003), the biosciences appear to be lagging behind efforts to address diversity in the earth sciences (Karsten 2003). We can expect intensifying competition from other scientific disciplines for the limited number of minorities entering the workforce after graduating from college or university.

Business, industry and other professions are also actively pursing diversity goals in their strategic and business planning. Natural resources professions will have to be much more aggressive to successfully recruit and retain the "best and brightest" minorities than we have in the past.

We also need to be much more sensitive and sophisticated in our outreach to minority populations. The same approaches and incentives used to recruit African Americans likely will not be as effective for Hispanics. In fact, successful recruitment within Hispanic populations will vary considerably depending on state or country of origin, e.g., Puerto Rican Hispanics of Spanish origin will respond differently to various programs than Californian Hispanics of Mexican origin. Likewise, African Americans from eastern urban centers will respond to different appeals than those from southern rural areas. Clearly, one generic program does not and will not fit all cultural and ethnic groups. We will need a variety of creative approaches and a diversity of effective programs.

Looking ahead, the voters and taxpayers of the next several decades are already advancing in the educational system. One of the more sobering realities is that the next generation of natural resources managers, administrators, professors and leaders are already at the age when they may have made career choices and are well along in their educations. Indeed, future natural resources professionals are already in the critical 10 to 15 years of age class, when initial career choices are being determined. How well we are able to influence these career decisions demands immediate attention. The future success of natural resource professions during 2010 to 2050 is NOW!

More than anything, our success will require a change of hearts, values and perspectives. As Salinas (2002) observed, the current emphasis on presence of minority employees rather than on need for their participation is a direction fraught with peril. In view of the unprecedented turnover in resource management expertise and rapid changes in national ethnic composition, the passing of the torch to a new generation of dedicated and knowledgeable employees representing all races should be our shared and supported vision throughout natural resource professions. In the final analysis, it is a matter of commitment, accountability and persistence.

Workforce Diversity: A Strategic Imperative

The issues are clear, and the stakes are high. The future outcome for our wildlife and wild places hangs in the balance. Will we act now to ensure that natural resources remain relevant to ethnically diverse populations that are rapidly emerging as political majorities in many areas? Will we diversify our professional ranks to better reflect this changing face of North America? Failing to meet these challenges squanders an opportunity to pass on hard won advances in protection of our natural heritage to future generations. The consequences will be that natural resources will increasingly be perceived as less relevant in the day-to-day needs of people with different social priorities and cultural aspirations. Conservationists face the prospect of watching from the political sidelines as resource management is pushed further down the societal agenda.

After a century of progress in building popular programs and productive partnerships for protecting and appreciating wild fauna and flora, the continuity of our conservation legacy appears to be in jeopardy if we fail to act. Clearly, we must chart a new course that ensures a secure and sound future for preserving and managing parks, forests and refuges. We must work creatively and aggressively to enhance professional recognition and political support throughout the diverse ethnicity represented in our rapidly changing regional populations. Colleges and universities must expand their outreach to diverse populations. Agencies must diversify their workforces to better reflect changing population demographics. Diversifying the cultural ethnicity of women and men who work in the natural resources professions represents a strategic imperative. Academia and the professional societies should convene a summit meeting on ethnic diversity in natural resources, in cooperation with the various state and federal agencies to coordinate activities and optimize initiatives in minority outreach. To be most successful, agencies, academia, professional societies and conservation organizations should forge a strategic partnership to educate and develop a new generation of natural resources professionals that better represent the changing face of North America.

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Observations on Outsourcing Natural Resources Management on Military Lands

Gene Stout
Gene Stout and Associates
Loveland, Colorado

Outsourcing is nothing new to the U.S. Department of Defense (Defense). Defense has made it a priority to outsource federal career employees since the early 1980s. This effort was kick-started under Office of Management and Budget Circular A-76, which requires federal agencies to conduct cost comparisons between its in-house work forces and contractors for activities that are not governmental-in-nature (GIN). This process is often called a commercial activities study, or a CA study.

Fort Sill, Oklahoma, where I was the Chief of Natural Resources for the state, was an early test bed for CA. As a part of the installation public works directorate that was undergoing CA, we were to be included in the CA study. The supposedly short process entirely changed the character of the Fort Sill workforce, almost overnight. That change is perhaps the most insidious part of the CA process. However, in the interests of presenting a much bigger picture, I will briefly summarize my observations during that CA study, which lasted 3 years.

- Huge battles were fought over whose positions were GIN (protected from CA) and whose positions were within the contracting package. Job descriptions were changed; organization functions were completely changed to segregate GIN from CA. It was a very messy process that was obviously affected by workforce politics in some cases. It created a chasm in a workforce that had been recognized as one of Defense's best public works teams in the nation.
- Since the premise of CA is to minimize cost, the "helping each other" way of doing business disappeared almost immediately. Public works formed a behind-locked-doors, in-house CA team to secretly develop its contract bid package. This CA team established a complex tracking system to determine how much each activity cost. "No money, no help" became the way of life.

- The primary priority of more than 500 members of the public works team became winning the CA study, not providing services to the Fort Sill community.
- Thousands of pages of justifications for every phase of running facilities and managing lands at Fort Sill were prepared. We were assured that the contract, which was to be bid on by the government and by contractors, would accurately reflect what we did. The end result was a washed out, minimal qualifications, contract, particularly for functions that required considerable innovative use of professional skills. Even if the public works CA team, which was composed of our internal work force members, agreed with our contract verbiage, higher-level CA reviewers would invariably butcher anything but bare minimum descriptions. The hundreds of pages that I prepared for use in the contract were reduced by more than 90 percent. Statements of work for conducting deer census, making management decisions and operating a deer season, as well as similar documents for the fish program, conservation education program, enforcement program, etc., were reduced to only a few pages.

And, what was the result? Fort Sill's public works won that CA competition—won by over $5 million. We gutted our work force to be competitive, ruined work relationships and drastically affected our customers. But we won. And, the team won again the next time it was studied (without the natural resources program as it was moved to another organization). And, the third time . . . well, they lost, and now public works is being run under a contract mode.

CA requires periodic reevaluations. After a while, contractors know everything there is to know about your operation since you have put it in writing on previous attempts, and you have nothing left to cut. Contractors also know that there are many options to modify contracts, based on inadequate contract language. It is a severely stacked deck. This process is happening throughout the federal government these days, and many federal natural resources agencies are undergoing CA studies as we meet here.

On military installations, inevitably, the number of GIN positions is minimized. The Federal Activities Inventory Reform (FAIR) Act of 1998 requires federal agencies to annually submit lists of non-GIN positions being performed by federal employees. In 1999, Defense classified over 2,800 natural resources positions as subject to CA cost studies (U.S. Department of Defense 2005). That did not include the U.S. Air Force, which had its own list (U.S. Federal Register 1999). These 1999 data included positions only marginally affecting natural resources. In 2000, Defense clarified its definition and identified only 868 total natural resources positions, of which only 259 (30%) were classified as GIN (Aldridge 2001). As the worst case, in 2000 the U.S. Army classified only 54 (12%) of 455 natural resources positions as GIN. All GIN positions were at command levels; not a single one was an on-the-ground professional. The U.S. Navy classified 37 (26%) of 145 positions as GIN; the U.S. Air Force classified 130 (70%) of 186 positions as GIN; the Marines classified 32 (40%) of 81 as GIN. These huge classification differences occurred for the same positions but in different services. Such huge discrepancies in interpretation of the same set of laws, federal regulations and policies result in tremendous frustrations among federal employees fighting for their existence.

This classification of natural resources positions, many of which are clearly professional, continues in spite of clear verbiage in federal regulations from the U.S. Department of Natural Resources Management, which asserts that the management and conservation of natural resources under DOD stewardship is an inherently governmental function and that natural resources planning and management is a governmental function not to be reported. Defense policy supports the exemption of these positions from CA studies, but obviously somebody forgot to tell that to the headhunters within Defense, particularly in the U.S. Army.

However, Defense natural resources professionals have an ace in the hole that other agencies do not. Despite significant Defense opposition and with a lot of help from organizations, such as The Wildlife Society, International Association of Fish and Wildlife Agencies, National Wildlife Federation, Wildlife Management Institute and the National Rifle Association, the Sikes Act was amended in 1986 to preclude Defense's natural resources professionals from cost comparison studies under Office of Management and Budget Circular A-76 and its successors. With the two amendments of the Sikes Act since then, this language has been strengthened to try to stop Defense's continued attempts to outsource natural resources management.

That fight has been carried into the courts. Two natural resources employees at Edwards Air Force Base were included in a CA study. These employees and the National Military Fish and Wildlife Association sued the U.S.

Air Force. Public Employees for Environmental Responsibility (PEER) became the employees' primary champion in this case, and the case still has not been settled. That process has already taken over 5 years and tens of thousands of dollars in case you are thinking about the courts for fast relief. In spite of clear Sikes Act language, the exemption from outsourcing Defense professional natural resources still has not been decided by the courts.

In 2003, the Office of the Secretary of Defense Competitive Sourcing reported that only 292 environmental positions, which include natural resources, were competitively bid. Of those, only 59 were associated with private contract awards (outsourced under CA). Thus, very few natural resources positions have been contracted under CA.

However, Defense natural resources outsourcing continues and is largely successful, if you consider success to be the replacement of governmental workers with nonfederal workers. How can this be?

The answer is that Defense also uses other ways to replace its federal work force. The easiest is to not recognize or authorize new federal positions. This tactic can be augmented by taking away authorizations (and funding) for current positions. When federal authorizations are taken away, and, at the same time, funding for contracted positions is provided, natural resources managers must either find contract employees or do without.

This has happened on an immense scale within Defense natural resources programs. For example, the U.S. Army has built a worldwide integrated training area management (ITAM) program to manage training impacts to the landscape. This program has hundreds of full-time and seasonal personnel, and most of them are professional natural resources managers, including range conservationists, biologists, foresters, soil scientists and botanists. In the early days of ITAM (mid-1980s) some positions were federal, but now, almost all are contract.

Do ITAM personnel make professional judgments and deal with budgets, things that determine whether a position is GIN? Yes, at all levels, and that is no secret.

And this same process is happening across the nation to positions in programs that have been in place for decades. As positions are created or vacated, contract biologists, foresters, botanists, *et cetera* are being hired. If the installation is large, generally one civil service professional position is protected, in theory to make all GIN-related decisions. Often, all that means is to sign off on decisions made by contract professionals. If the installation is small, somebody like an environmental engineer or general environmentalist may be the token GIN person for natural resources.

There are other creative ways to convert. One innovative way is to noncompetitively contract installation functions, including natural resources, to Alaska Native Corporations, which is allowed by law. In this case, the Native Corporation may then simply subcontract the whole deal to another corporation. Large corporations have sought partnerships with Alaska Native Corporations to facilitate this type of noncompetitive contracting.

Does this outsourcing to contract employees save money? I don't see how. As a contractor, I have checked on the costs of putting contract personnel on installations. A rule of thumb regarding natural resources contractors is that any cost approximately twice the government salary is competitive. Saving money is not driving this conversion. It simply is a dedicated body count of federal positions.

Is this conversion politically motivated? Yes, but it does not seem to be political party sensitive. It started during the Reagan years, but I saw no change in momentum during the Clinton years, and it continues with the Bush, Jr. Administration. Our elected leaders in both parties seem compelled to privatize federal positions.

Who are these contractors? Well, I believe this is the crux of this personnel conversion. Under CA studies, only major corporations can effectively compete since CA generally involves large operations, such as public works and logistics. Thus, if a natural resources program is thrown into this mix, a contractor likely would be a very large company. Since contracts are written with minimal qualifications for natural resources professionals (4-year degree in related field), positions were often filled with eager, but minimally educated, personnel.

The important aspect to understanding effects of using CA or other mechanisms to replace entire functions, such as installation operations, with contract personnel is the profit motive. The amount of profit made by contractors is directly related to staff costs. Hiring low paid, minimally qualified staff pays off for contractors. Conducting programs to the minimal degree required by the contract pays off even more since that equates to less staff. Requirements to implement a function are important. There are no requirements to staff at a certain level in terms of either numbers of personnel or qualifications above minimums. There is no incentive, and indeed are profit penalties, to be innovative or to hire better educated, more experienced personnel.

Compare this to the process of replacing individual federal positions with contract personnel. Within Defense, there are two major types of contractors for replacing positions, called body-shopping by many. Universities are often contractors of choice for military installations and commands, often via noncompetitive cooperative agreements, which make it easy to quickly obligate funds to the university of choice. Colorado State University, New Mexico State University, University of Oklahoma, California Polytechnic, University of Illinois and many others have or are placing hundreds of personnel on military installations to manage natural and cultural resources programs. Colorado State University, as probably the best example, has a Center for Ecological Management of Military Lands. The center has about 160 personnel on military installations and at command levels with another 40 to 60 personnel in support positions on campus.

Other common contractors are relatively small environmental firms. Installations that use these firms for other projects, such as biological surveys, monitoring, environmental documentation and planning, often request that the same firms provide personnel to replace vacancies or to operate new programs. A few installations provide funds to the U.S. Fish and Wildlife Service, the U.S. Department of Agriculture, Natural Resources Conservation Service or, in a few cases, the state wildlife agency to provide personnel.

It is important to recognize that profit from this type of contracted employee comes only from the contracted cost of the employee. It is, essentially, a fixed profit. The more satisfied the installation is with the employee, the more likely it will use the same contractor for more employees, increasing total profits. Such contractors are likely to quickly replace contracted employees who are not performing to expectations.

In fact, if the installation is impressed with a particular individual in the job market, a contractor will often hire that person for a position, provided the person is qualified. Installations often have a great deal of input into the hiring, professional development and, if needed, replacement of these contract personnel.

Is this process of individually replacing federal employees with contract employees on a position-by-position basis working? Federal workers do not want to hear it, but I believe the answer is a qualified "yes."

I say qualified because it is not working well in many places. This generally comes down to the matter of forming a team of core federal employees (one or more) and contract employees. This team must grow to respect each other, and therein is the problem.

The process of creating such a team is brutal on emotions. As federal positions are lost to contract employees, remaining federal workers may take out their frustrations on new contract employees. Often, federal workers deem it important for outsiders to be able to identify real federal workers from these outsiders. One common way to do this is to require them to answer the phone in this fashion, "Hello. This is Gene Stout, contract employee for Gene Stout and Associates. May I help you?" This is the case on many, if not most, Defense installations. Frankly, it is a cheap shot that does nothing but confuse the caller in many instances, and it is demeaning to contract employees trying to do their job.

Federal workers cannot directly supervise contract employees, but if a proper team is established, such supervision unofficially occurs without rancor. Often the official supervisor of these employees is hundreds of miles away, and this supervisor is not available or often knowledgeable of issue specifics. A federal/contract team can, and must, form unofficial lines of communication where the federal program leader's professional decisions are efficiently implemented in terms of routine position performance. That can happen, but it requires mutual respect.

I will not point out specific instances where this process is not working, but there are many. In my opinion, these will eventually change as personnel with strong emotions regarding contract employees either change attitudes or leave. My advice to you, if you are in this category, is to fight the system that put these workers in your office, but if forced to hire them, work hard to get contract employees whom you can respect and work with. I think the first option of fighting the system is relatively fruitless, but two decades of this fight may have sapped my enthusiasm too much.

I firmly believe that the former almost all federal employee system (and I deliberately use the term former with regard to Defense) is better than the one that is upon us now. Maybe I have sold out, but I now believe it is time to get on with reality and to work to improve these evolving federal/contractor natural resources teams responsible for management on this nation's 25 million acres (10.1 ha) of Defense lands.

I have worked with natural resources programs on almost 200 Defense installations. I know of programs that are as good if not better than any on federal lands in the nation and other programs that are not the best. Some of both types are implemented by largely federal workers; others are mostly contractor. Program success is largely determined by personnel attitudes and skills, not the name of the person signing the payroll check.

I said that I will not suggest places where federal/contractor teams are not working. However, I will stick my neck out and provide two examples where they are working reasonably well, not perfectly, but well.

The U.S. Army Reserve's nationwide program is being implemented by contract workers at the command level and on all but the largest installations. This program has its problems, but outsourcing is not one of them. And, its personnel work well together to manage important pieces of Defense lands.

The Directorate of Environmental Compliance and Management at Fort Carson, Colorado, has a workforce that is a mix of Defense employees, U.S. Fish and Wildlife Service employees, university employees, and private contractor employees. If you go there, you would not be able to pick out the federal employees in terms of skills, job performance, or titles (or even how they answer the phones). That is the goal of using all personnel hiring options.

The outsourcing of federal positions within Defense has occurred during the past two decades during a period of unprecedented growth of Defense natural resources and environmental programs. That growth was due to extremely large funding increases to meet compliance requirements and to manage lands for long-term military use.

During this same period, the percentage of federal workers implementing these programs has dropped from almost 100 percent to far less than that. CA studies are no longer a threat to Defense federal positions within natural resources programs, but the percentage of contract employees continues to increase, largely due to individual federal position replacements, mostly occurring as federal employees leave rather than adverse actions.

Defense natural resources programs are now literally being gutted nationwide by funding cuts. This purge is a deliberate effort on the part of Defense to eliminate as many environmental and natural resources programs as possible, mirroring what is happening across the board with this Administration. However, outsourcing is not associated with this downsizing, as evidenced by the fact that outsourcing has been going on for almost two decades within Defense under many presidential administrations, while this current, unholy crusade has only just begun in the last few years.

Regardless of my position that outsourcing can, and is, working in some cases, I totally agree with what Dr. Thomas Wray, testifying for the National Military Fish and Wildlife Association, told a congressional commercial activities panel that government natural resources personnel invariably demonstrate a deep level of concern, conviction, and even passion for their land.

There are contract natural resources employees who also have such convictions and dedication. However, they are far more subject to "toeing the line or hitting the road" types of persuasions since their jobs can disappear virtually overnight if they step on the wrong toes.

If you want to try to stop this speeding privatization train, you might put your efforts toward amending the FAIR Act to recognize natural resources as a long-term investment for our nation's future. The act could be amended so that all natural resources positions would be inherently governmental, not be subject to CA review, outsourcing, privatization or any successor program which would convert these functions to the private sector.

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Retirements and Outsourcing: Who Will Manage Our Natural Resources? The Role of the Private Sector and Landowners' Attitudes Toward Fish and Wildlife Management and Wildlife-related Recreation

Mark Damian Duda
Responsive Management
Harrisonburg, Virginia

Peter E. DeMichele
Responsive Management
Harrisonburg, Virginia

Martin Jones
Responsive Management
Harrisonburg, Virginia

Andrea M. Criscione
Responsive Management
Harrisonburg, Virginia

Steven J. Bissell
Responsive Management
Harrisonburg, Virginia

Introduction

As retirements take their toll on fish and wildlife agency personnel (McMullin 2005) and the public sector is forced to do more with fewer resources as the result of budgetary constraints, the private sector, especially private landowners, will need to play an increasingly important role in the future of fish and wildlife management and in the provision of wildlife-related recreation.

Fish and wildlife management in the United States is primarily a function of state or federal government agencies; this is a historical observation, not intrinsic to the nature of fish and wildlife management (Bean and Rowland 1997). Historically, the private sector, including landowners and nongovernmental organizations, played a not insignificant role. The Wildlife Management Institute was one such nongovernmental organization, founded in 1911 by private interests and established to develop a scientific basis for wildlife management in the United States (http://www.wildlifemanagementinstitute.org). Aldo Leopold, generally considered the founder of wildlife management as a scientific discipline in the United States, often discussed wildlife management in terms of private property. In his scientific *magnum opus*, *Game Management*, Leopold wrote: "[Game management] promulgates no doctrine, it simply asks for land and the chance to show that farm, forest, and wild life products can be grown on it, to the mutual advantage of each other, of the landowner, of the public" (1933:422–3).

Leopold was concerned that wildlife management was being viewed as primarily a government function: "That there is some basic fallacy in present-day conservation is shown by our response to it. Instead of living it, we turn it over to bureaus. Even the landowner, who has the best opportunity to practice it, thinks of it as something for the government to worry about" (Leopold 1947:336--7). Since over two-thirds of the nation's land is privately owned, we must not only recognize the importance of private lands for management of fish and wildlife from a pragmatic standpoint, but we must also recognize the importance of instituting a land ethic within the public, especially landowners. Recognition that the private sector can have more than an ancillary role in the conservation and management of the nation's wildlife resources means that Leopold's land ethic can indeed be embraced by the public.

Given the importance of private lands to the future of fish and wildlife management, it is vital to understand landowners' attitudes toward wildlife and wildlife conservation, as well as landowners' interest in providing wildlife-related recreational opportunities on their land.

Methodology

All of the studies in the following discussion entailed telephone surveys conducted by Responsive Management. For each survey, telephones were selected as the preferred sampling medium because of the universality of telephone ownership. Pretests of the questionnaires were conducted, and revisions, if necessary, were made to the survey instruments based on the pretests.

A central polling site at the Responsive Management national office allowed for rigorous quality control over the interviews and data collection. Responsive Management maintains its own in-house telephone interviewing facilities. These facilities are staffed by interviewers with experience conducting computer-assisted telephone interviews on the subjects of natural resources and outdoor recreation.

The software used by Responsive Management for data collection was Questionnaire Programming Language 4.1. The analysis of data was performed using Statistical Package for the Social Sciences software as well as proprietary software developed by Responsive Management. Samples were randomly selected from county property tax records for the Texas, Virginia, West Virginia and Georgia landowner studies. The sample for the Delaware farmer study was obtained from the Farm Service Agency, U.S. Department of Agriculture. The sample of Washington landowners was obtained from the Washington Department of Fish and Wildlife (WDFW) and includes landowners who participated in the Private Lands Wildlife Management Area program.

The survey of Texas landowners was administered to Texas landowners who owned more than 640 acres (259 ha) of contiguous land in Texas; thus, when we refer to Texas landowners in this paper, we are referring to landowners with large holdings unless otherwise specified. A total of 563 landowners were interviewed. The survey was conducted with landowners in each of the seven travel and tourism planning regions for statewide representation. The sampling error is at most 4.10 percent.

The survey of Virginia landowners was administered by telephone to randomly selected Virginia landowners. A total of 530 landowners were interviewed. The sampling error is at most 4.00 percent, and results are reported at the 95 percent confidence interval.

The study of West Virginia landowners was conducted to obtain rural landowners' opinions on deer, deer management and issues related to hunting. A total of 549 landowners in West Virginia were interviewed, with 408 landowners owning more than 10 acres (4.05 ha) in their single largest tract of land and 141 landowners owning less than 10 acres (4.05 ha) in their single largest tract of land. The sampling error for landowners with large holdings is at most 5.00 percent

Studies of Georgia landowners' attitudes entailed two telephone surveys of Georgia landowners. The first study examined attitudes toward deer management and obtained a total sample of 212 landowners who own at least 100 acres (40.47 ha). In the second study, 310 interviews with Georgia landowners who own at least 100 acres (40.47 ha) were completed to determine attitudes toward law enforcement in Georgia. The sampling errors for these studies could not be calculated because the total population of landowners in Georgia who own such land was not available. Results for both studies are reported at a 95-percent confidence interval.

The study of Delaware farmers' attitudes entailed a telephone survey of 203 farmers. Results were reported at a 95-percent confidence interval, and the sampling error is at most 6.67 percent.

The study of Washington landowners' opinions on the DFW's Private Lands Wildlife Management Area Program entailed a telephone survey of 213 landowners.

Results

Landowners' Attitudes Toward Conservation, Wildlife and Habitat

Most landowners support wildlife and habitat conservation. A large majority of Virginia landowners (89%) indicated that it is important to know that they, personally, can participate in providing habitat for fish and wildlife, with most of those saying it is very important. On their own tracts of land, Virginia landowners also placed the most importance on caring for and protecting fish and wildlife and their habitats (93%) and on wildlife viewing (89%) over other activities, such as hunting, farming, timber production and fishing. A majority of landowners in Texas (52%) rated providing habitat for fish and wildlife as a very important activity for their property while a large majority of landowners in Texas (78%) said they enjoy having wildlife around. Forty-three percent of Georgia landowners said they enjoy having deer around, and 36 percent of Georgia landowners said they enjoy having deer around but worry about the problems they cause.

Many landowners state that they are likely to open up their land for more wildlife and habitat conservation if incentives were offered. Forty-six percent of landowners in Texas agreed that if they could receive significant cash benefits, such as tax breaks or cash payments, they would be very likely to open their land for more wildlife and habitat conservation (22% strongly agreed and 24% moderately agreed). Many landowners in Washington, however, agreed that landowners should receive law enforcement and technical assistance as an incentive for enhancing wildlife habitat on their property and for allowing hunter access (47% strongly agreed and 21% moderately agreed).

A majority of landowners enjoy seeing and having wildlife around. A large majority of landowners in Texas (78%) agreed that they enjoy seeing and having wildlife around. Much smaller percentages enjoyed the presence of wildlife but worried about the problems they cause (14%) or regarded wildlife as a nuisance (1%). Most Virginia landowners (92%) thought it was very or somewhat important to have wildlife around their homes. Regarding deer, a majority of farmers in Delaware (66%) said they like having deer around. In Georgia, 43 percent of landowners said "I enjoy seeing and having deer around" best described their feelings about deer while 36 percent indicated that they enjoyed having deer around but worry about the problems they cause.

Although a majority of landowners enjoy having deer and wildlife around, many landowners have experienced problems or damage caused by wildlife, and some regard deer as a nuisance. Despite a large majority enjoying the presence of wildlife, almost half of landowners in Texas (44%) indicated that they had experienced problems with nuisance animals or with damage caused by animals within the past 2 years. Forty-three percent of West Virginia landowners had also experienced some damage to their land caused by deer. A majority of Delaware farmers (66%) said they like having deer around, but most of those who indicated this position worry about problems that deer cause, and 28 percent regard deer as a nuisance. The study in Georgia revealed that landowners were much more likely than the general population to regard deer as a nuisance (16% of landowners compared to 7% of the general population).

It is important to a majority of landowners that deer populations are properly managed. Vast majorities of Delaware farmers (93%) and Georgia landowners (88%) said knowing that deer populations are being properly managed in their state is very or somewhat important to them. Furthermore, 44 percent of Georgia landowners believed the deer population was overabundant, and a majority of farmers in Delaware (63%) indicated that they support a decrease in the deer population.

Many landowners are willing to work with state agencies to manage wildlife on their properties. In Delaware, 59 percent of farmers said the Delaware Department of Natural Resources and Environmental Control (DNREC) should give more assistance for managing deer to private landowners; while, only 3 percent of them said less assistance should be given. Landowners (94% of

Delaware farmers and 96% of Georgia landowners) and the general population (82% of Delaware residents and 82% of Georgia residents) said that they support legal hunting as a way to manage deer populations. About a third of Delaware farmers (32%) were interested in enrolling their land in the Deer Damage Assistance Program; while, 16 percent already had their land enrolled.

Many landowners support state programs and assistance to help manage deer populations. In Delaware, a majority of farmers (74%) supported having the state's DNREC institute a voluntary, certified deer hunter program to help control deer populations. A majority of Georgia landowners indicated that they support hunting (93%) as a way to manage deer populations. Substantial percentages of Georgia landowners supported hunting (29%) and trapping and relocation (13%) for controlling the deer population in urban and suburban areas. More than twice as many landowners in Washington expressed support for the existing Private Lands Wildlife Management Area Program as opposed it (53% supported and 21% opposed). A substantial percentage of Washington landowners (43%) also supported having WDFW institute a cost-share electric fencing program for specialty crops, such as melons and berries, that are commonly damaged by wildlife.

Landowners' Attitudes Toward Wildlife-related Recreation Activities

A majority of landowners support legal hunting and fishing, and many landowners support trapping. In West Virginia, 76 percent of landowners felt that hunting, fishing and other forms of wildlife recreation were important (49% very and 27% somewhat important). In Georgia, 83 percent of landowners said that they strongly support legal deer hunting, and another 13 percent said that they moderately support legal deer hunting. An overwhelming majority of Virginia landowners said that they approve of legal hunting (90%) and legal, recreational fishing (94%), with most of those strongly approving. Many Virginia landowners (59%) also indicated that they support legal trapping.

A majority of landowners feel that hunting, fishing, and other wildlife-related recreation opportunities are important. In Delaware, 96 percent of farmers said that they think having the opportunity to hunt in Delaware was very or somewhat important to them (87% said it was very important). Overwhelming majorities of Virginia landowners said it was important to them to know that people had the opportunities to hunt (94%), to fish (96%) and to view wildlife (97%) in Virginia.

A majority of landowners allow hunting on their land. Large majorities of Virginia landowners (83%) and Texas landowners (78%) said that they allow hunting on their land. Seventy-eight percent of West Virginia landowners indicated that they allow deer hunting on their land. An overwhelming percentage of Georgia landowners (80%) who own a tract of at least 20 acres (8.09 ha) said that they personally hunt deer or allow others to deer hunt on their land.

Substantial percentages of landowners allow wildlife-related recreational activities other than hunting on their land, but there is room to increase those percentages. The activity for which the most landowners in Washington allowed open access was wildlife watching (30% of Washington landowners allowed open access for this activity), followed by hiking (23%), hunting (20%) and fishing (16%). At the bottom of the list was camping (6%). Landowners in Texas indicated that they allowed access to their land for fishing (37% of landowners in Texas allowed access for this activity), camping (30%), and for hiking, wildlife viewing and nature study (29%). A large majority of Virginia landowners indicated that they allow wildlife viewing on their land, and many said that they allow fishing on their land.

Although majorities of landowners had not experienced problems with the behavior of hunters on their lands, substantial percentages of landowners, and landowners of large holdings in particular, have experienced hunter behavior problems. Most West Virginia landowners (64%) had not experienced problems with the behavior of hunters. A higher proportion of West Virginia landowners who owned more than 200 acres (80.94 ha) (52%) reported having experienced hunter behavior problems than did other landowners. Of West Virginia landowners who reported experiencing problems, 71 percent reported trespassing as the problem. Of Georgia landowners who own tracts of at least 20 acres (8.09 ha) and who answered that they do not allow deer hunting, nearly a quarter (24%) previously had allowed deer hunting. Those Georgia landowners who had previously allowed hunting cited poor behavior of hunters (30%), trespassing (20%), crowding (20%) and legal liability (20%) as reasons that they stopped allowing deer hunting on the tract. Majorities of Washington landowners said that litter or garbage dumping (57%) and vandalism (53%) were extremely important factors in considering whether to allow public access onto their property. Three additional factors had nearly a majority of Washington landowners who said the factor was extremely important when considering whether to allow public access onto their property: liability (50%), unethical behavior (46%) and safety (45%).

Substantial percentages of landowners worry about legal liability of allowing hunting, fishing and other wildlife-related recreation activities on their land. Half of Virginia landowners (51%) were concerned about legal liability when considering allowing access to their land for outdoor recreation, but it was more of a major concern when considering access for hunting and outdoor recreation in general. Concern for legal liability among Virginia landowners for fishing or wildlife viewing access was more evenly split between being a major concern and being a minor concern.

As mentioned previously, legal liability was acknowledged as an extremely important factor by 50 percent of Washington landowners when deciding whether to allow access to their land and by 20 percent of Georgia landowners who previously allowed access to their land for hunting but have discontinued doing so, citing legal liability as one of the reasons for their decision. A majority of Georgia landowners (53%) who own tracts of at least 20 acres (8.09 ha) said legal liability is a major concern when considering whether to allow hunting access, and an additional 25 percent said it is a minor concern (78% in total said legal liability is a concern).

As much of a concern as legal liability was for Georgia landowners, a slight majority (57%) of owners of tracts of at least 20 acres (8.09 ha) of land in Georgia would not likely allow more deer hunting even if they did not have to worry about legal liability issues. However, 39 percent of landowners in Texas agreed that they would be very likely to open up their land for more outdoor recreation opportunities if they did not have to worry about legal liability issues. In addition to concern for legal liability, awareness of government assistance or relief for legal liability is low. Few West Virginia landowners (23%) were aware that state law in West Virginia provides certain liability protection for landowners that allow public recreational use of their land. Awareness of Virginia's recreational use statute was also low with 83 percent of Virginia landowners completely unaware of the statute.

Landowners support certain incentives for allowing access to their land. A majority of landowners in Washington (55%) strongly or moderately agreed that private landowners should be compensated for providing hunter access. When asked about specific incentives for allowing hunter access and enhancing wildlife habitat on their property, landowners in Washington strongly agreed that landowners should receive law enforcement and technical support (47%), distantly followed by providing cooperative road management (30%). In Texas, substantial percentages agreed that they would be very likely to open up their land for more outdoor recreation opportunities if they did not have to worry about legal liability issues (39% agreed) or if they received significant cash benefits, such as tax breaks or cash payments (36% agreed). A slight majority (53%) of West Virginia landowners supported the Advanced Hunter Safety and Ethics Program, conducted by the West Virginia Department of Natural Resources (WVDNR), and hunter presentation of their training certificate when asking permission to hunt on a landowner's land.

While landowners in Texas agreed that cash incentives or compensation should be received, other landowners were less supportive of financial incentives and preferred law enforcement and technical support assistance as mentioned previously. West Virginia landowners were more likely to oppose financial incentives for increasing deer hunting opportunities on their land: 80 percent of landowners opposed the option to lease the hunting rights for their land, thereby allowing the public to hunt on their land in return for an annual payment; 73 percent opposed the option of being paid for the days of public hunting allowed on their land; 52 percent opposed the option of implementing certain management practices on their land in return for partial payment of their property taxes. Over half of Georgia landowners (55%) disagreed that they would be very likely to allow more deer hunting if they received a financial benefit for doing so. Consistent with landowners who say financial incentives would not make them more likely to allow access to their land for wildlife-related recreation, low percentages of landowners in Delaware who allow hunting on their land charge a fee for hunting.

Landowners desire law enforcement for managing wildlife and for dealing with hunting and fishing violations. A substantial percentage of Georgia landowners who think the Georgia Department of Natural Resources (GDNR) should provide more assistance to private landowners say they desired law enforcement assistance. Although a majority (73%) of Georgia landowners agreed that Georgia had maintained a sufficient conservation ranger law enforcement presence in the state over the past 2 years, nearly half (49%) of landowners still said that they would like to see more conservation ranger presence.

Conclusion

The results of recent landowner studies by Responsive Management suggest a positive outlook for the future of fish and wildlife management on private lands.

Overall, landowners expressed strong support for stewardship of the land and wildlife-related recreation activities, demonstrating increased opportunities for fish and wildlife management agencies to work cooperatively with private landowners on conservation and recreation issues.

It is important to many landowners that wildlife populations, deer populations in particular, are properly managed, and they are willing to take some of the responsibility for this task. Landowners' interest in and willingness to participate in the management of wildlife on their property suggests that the opportunity to work with landowners in the private sector on conservation, habitat and wildlife issues continues to exist and that landowners are receptive to cooperative efforts. However, landowners' support of fish and wildlife programs and incentives, as well as their desire for law enforcement and technical support as an incentive, indicate that, while landowners are willing to take on some of the responsibility, they also want some assistance from the government.

Strong majorities of landowners approved of legal hunting and fishing, and many approved of legal trapping. Majorities of landowners also indicated that it was very important to them that people have the opportunity to participate in these activities. Given their support for wildlife-related activities, landowners may be motivated or persuaded to allow additional hunting, fishing and other wildlife-related activities on their land if they received incentives and assistance to alleviate their concerns, such as law enforcement, technical support and relief or reassurance regarding legal liability. Substantial percentages of landowners did indicate that they would be willing to open up their land for wildlife and habitat conservation and for recreational opportunities if they received incentives for doing so.

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Status of Citizen Science in State Natural Resource Management Agencies: Opportunities and Challenges

Brian N. Kertson
*University of Washington, Wildlife Science Group,
College of Forest Resources*
Seattle, Washington

Christian E. Grue
*University of Washington, Washington Cooperative Fish
and Wildlife Research Unit, School of Aquatic and Fishery Sciences*
Seattle, Washington

D. John Pierce
Wildlife Program, Washington Department of Fish and Wildlife
Olympia, Washington

Loveday L. Conquest
University of Washington, School of Aquatic and Fishery Sciences
Seattle Washington

Introduction

Natural resource management must be based on sound ecological principles and defensible scientific information. Natural resource agencies are faced with multiple management issues encompassing a broad range of species, habitats and management objectives. These agencies face challenges in meeting management objectives stemming from budget constraints and staffing limitations. The long-term success of natural resource management may ultimately depend on significant public involvement at the local level—collaborative citizen science programs in which well-trained volunteers collect data on species or habitats in a rigorously scientific manner. Such programs may not only help to meet the data needs of management agencies and the research community, but they may also increase public awareness and understanding of management issues and programs. The use of citizen science programs by federal natural resources agencies, such as the U.S. National Park Service and the Environmental Protection Agency, by national nonprofit environmental organizations (Audubon Christmas Bird Counts) and by wildlife research programs outside of the United States has been well documented (Birks 1997, Bildstein 1998, Taylor 1999, Lepage and Francis 2002). However, information on the use of citizen science programs within state fish and wildlife agencies has not. The status, perceived limitations and potential of citizen science within these agencies should be addressed. In an effort to determine the current status of citizen science in state natural resource management agencies, we surveyed the principal natural resource agency responsible for wildlife and fisheries management in each state. Our survey was designed to obtain information on the current use of citizen scientists, on the factors limiting their use and on the potential for citizen scientists to assist these agencies to meet their management objectives in the future. We hope the information collected and insights gained from the questionnaire can be used to strengthen citizen science programs, to guide future research on their use and to address real or perceived limitations to expansion of citizen science within state natural resource management agencies.

Methods

We identified and surveyed the principal natural resource agency in each state charged with the responsibility of managing and conserving fish and wildlife resources. Agencies (Appendix A) were identified using the National Wildlife Federation's Conservation Directory (National Wildlife Federation 2004) and state agency homepages linked to the homepage of Montana Fish, Wildlife and Parks (www.fwp.state.mt.us/). With the assistance of the Director of the Washington Department of Fish and Wildlife, we mailed a hardcopy questionnaire and cover letter to the director of each agency with directions to distribute the questionnaire to the person(s) with the greatest understanding of the use of citizen scientists in their agency. To facilitate and expedite the completion and return of the questionnaire, we provided additional instructions for completing and submitting the questionnaire on-line. The questionnaire consisted of 19 multiple-choice and short-answer questions (Appendix B). Respondents were asked to provide answers to a series of questions designed to identify current and future use of citizen scientists to meet their agency's research and management objectives, and they were asked to identify the factors limiting their use. Questions included the extent to which volunteers are currently being used to collect empirical data, the potential for their use in the future, specifics on how volunteers are being used or could be used, the experience and training desired, and the relative importance of factors—such as liability, credibility of data and resources (time and funding) in limiting the use of volunteers.

We calculated raw percentages and constructed frequency distributions to quantify and characterize agency responses to the questionnaire. Trends and differences observed are real and do not require statistical extrapolation because of the complete sample received. To analyze and compare factors limiting the use of citizen science and citizen scientist preferences (Questions 10 and 12, Appendix B), we had respondents score variables from 1 (very important/very valuable) to 4 (unimportant/not valuable). Each question was analyzed using analysis of variance (ANOVA), taking into account that, since each state scored each category, each state then acted as a "block" for all the categories. We were not interested in whether the states showed any statistical differences in average responses. We were interested in whether there were statistical differences (at the 0.05 level of significance) among the factors limiting the use of volunteers and volunteer data (Question 10), with regard to level of importance, and among the types of volunteers (Question 12), with regard to perceived value. If a factor was deemed significant via the results of the ANOVA, this was followed by the Student-Neuman-Keuls (SNK) multiple comparison technique (Zar 1999) to uncover where differences between the categories for a particular question existed.

Results

Questionnaire Respondents

We received completed questionnaires from all 50 states, representing a complete sample of the natural resource agencies responsible for the management of fish and wildlife resources. Thirty agencies returned a completed questionnaire via a paper copy with the remaining 20 agencies completing and submitting responses on-line. Questionnaire respondents encompassed a wide array of positions within natural resource management agencies with respondents averaging 18.9 years (standard deviation = 9.75, range = 1.5–36 years) of tenure within their agency. Five respondents indicated they worked primarily with fisheries resources, 20 indicated wildlife, 4 habitat and 12 indicated they worked with all three. One respondent indicated education as their area of focus and eight did not indicate an area of focus. All respondents claimed to have direct knowledge about the use of volunteers in their agency to collect scientific data and information on fish, wildlife and their habitats.

Current Status of Citizen Science

All of the state natural resource management agencies surveyed use volunteers. When asked in what capacity these volunteers are primarily used, 48 percent of agencies specified labor, 58 percent education and outreach, 50 percent scientific data collection, and 10 percent unspecified purposes (Figure 1). Forty-six agencies (92%) actively recruit volunteers. Of these agencies, 54 percent utilize the agency's Internet homepage, 66 percent issue press releases advertising the need for volunteers, 70 percent contact local universities and 86 percent contact local nonprofit environmental organizations (Figure 2). Despite the widespread use of volunteers, only a third of state agencies have a formal training or certification process for volunteers, with 44 percent of agencies providing training on a case-by-case basis and 30 percent providing training for hunter education instructors.

Figure 1: Primary use of volunteers by state natural resource management responsible for fish and wildlife management. State fish and wildilfe agencies could specify more than one primary use of volunteers.

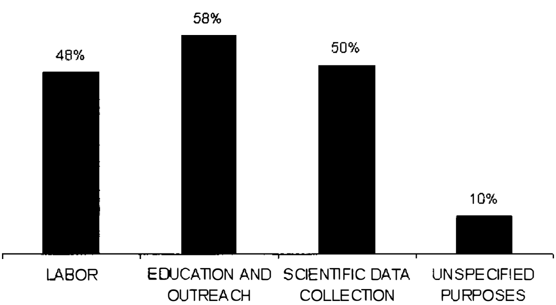
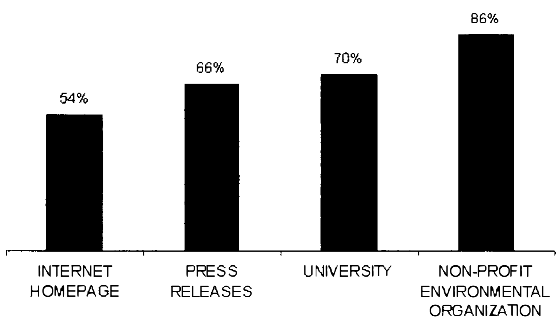
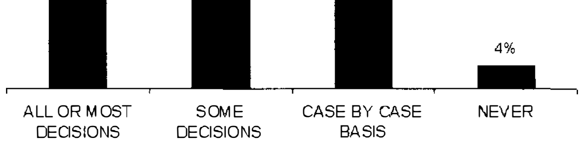


Figure 2: Recruitment methods of state natural resource management agencies responsible for fish and wildilfe management that recruit volunteers (n = 46, where n equals the number of agencies), including: posting volunteer positions on agency homepages, issuing press releases, contacting university natural resource programs and contacting local nonprofit environmental organizations.



When asked specifically if their agency utilizes volunteers to gather scientific data for management and conservation of fish, wildlife and habitat resources (citizen science), 78 percent of agencies replied "yes" (80% of states). There were no regional or national trends in the use of citizen science with the agencies not using volunteers randomly distributed throughout much of the country. Of the 40 states that currently utilize citizen scientists, 26 percent use them on several projects, 71 percent use them on a limited number of projects, and 3 percent were unsure to what extent citizen scientists are utilized for agency projects. For agency projects that have used or are currently using volunteers for scientific data collection, 19 percent of agencies incorporate this information in all or most of their fish or wildlife management, policy and decision making, 30 percent incorporate volunteer data in some decisions, 47 percent incorporate information into individual decisions on a case-by-case basis and 4 percent of agencies never incorporate volunteer collected data and information into management, policy and decision making (Figure 3). None of the 50 agencies surveyed believe volunteers are over utilized in fish and wildlife research and management activities, 28 percent believe they are currently utilized in the right amount, 60 percent believe volunteers are under utilized in fish and wildlife research and management, and 12 percent of agencies were unsure.

Figure 3: Degree to which data and information collected by citizen scientists are incorporated into fish and wildlife management decisions and policies by state natural resource agencies responsible for fish and wildlife management (n = 47).



Agency Perceptions of Citizen Science

The perceived value and ability of volunteers to assist natural resource agencies in meeting fish, wildlife and habitat research and management objectives varies. Twelve percent of agencies believe citizen scientists contribute at a very high level (an essential resource for achieving agency objectives); 36 percent reported a high level of contribution (contribute to some, but not all agency objectives); 52 percent feel volunteers make a moderate contribution (contribute to a very limited number of agency objectives) (Figure 4). None of the agencies rated volunteer contribution as low (not contributing to agency objectives). State natural resource management agencies expressed conservative attitudes about the ability of their typical volunteer to assist agency biologists, researchers and managers gather scientific data and information on fish and wildlife. Twelve percent of agencies believe their typical volunteer is very capable of assisting agency biologists, researchers and managers gather scientific data and information, 30 percent viewed them as capable, 44 percent as somewhat capable, 4 percent as not capable and 8 percent were unsure of the typical volunteer's capability (Figure 5). Agency perceptions of citizen scientists' contributions and abilities likely reflect concerns about the accuracy of information generated by citizen scientists. Forty-two percent of agencies believe a lack of information exists regarding the ability of volunteers to gather scientifically credible data and information for fish, wildlife and habitat research and management with an additional 38 percent indicating they were unsure. Only 20 percent of state agencies believe a lack of information does not exist. If empirical data demonstrated that citizen scientists were capable of collecting accurate scientific information on fish, wildlife and habitat, 72 percent of the agencies would promote the involvement of citizen science in their agency's fish and wildlife projects; whereas, 16 percent of agencies would not, and 12 percent were unsure of what they would do. Of the 36 agencies that would promote the use of citizen science, 71 percent would do so as much as possible, and 29 percent would promote their use some. These results are consistent with agency responses towards expanding the role of volunteers to gather scientific data and information on fish, wildlife and habitats within their agency. Eighty-six percent of agencies indicated the role of volunteers could be expanded within their agency, 4 percent believed the role of volunteers could not be expanded and 10 percent were unsure if the role of volunteers could be expanded. Sixty-nine percent of the agencies that felt the role of volunteers in collecting scientific data and information could be expanded in their agency believe that it could be expanded some. Twenty-four percent believe this role could be expanded a lot, and 7 percent believe this role could be expanded very little.

Regardless of agency perceptions of the scientific merits and potential for expansion of citizen science in agency fish and wildlife research and management activities, 86 percent of state agencies believe incorporating

Figure 4: Level of contribution volunteers make in assisting state natural resource management agencies to meet management, research, and conservation objectives for fish, wildlife and their habitats (n = 50). Very high: volunteers are an essential resource to achieving agency objectives. High: volunteers contribute to some but not all agency objectives. Moderate: volunteers contribute to a very limited number of agency objectives. Low: volunteers do not currently contribute to agency objectives.

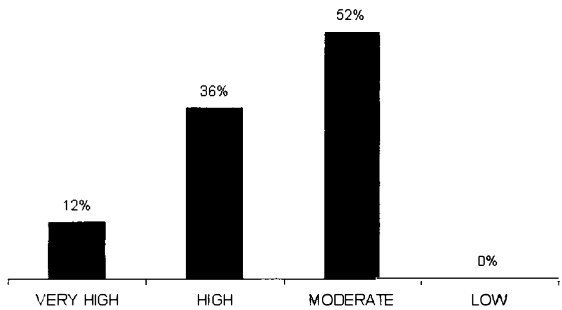
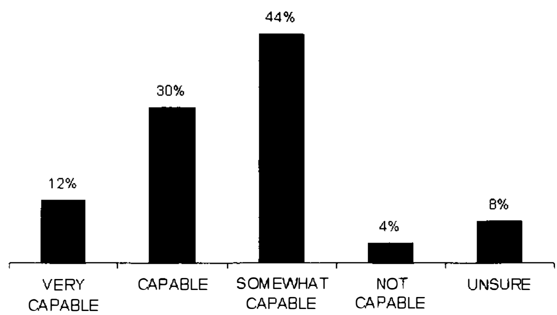


Figure 5: State natural resource management agency perceptions of the ability of their typical volunteer to directly assist agency biologists, researchers and managers in gathering scientific data and information on fish, wildlife and habitat (n = 51).



volunteers into fish and wildlife research and management activities increases the public's understanding of natural resource issues; whereas, 8 percent of agencies did not think it increased public understanding, and 6 percent were unsure. Sixty percent of the agencies that believe citizen science increases the public's understanding of natural resource issues believe that citizen science could contribute substantially, and 33 percent believe it would contribute equally in comparison to other forms of information transfer (i.e., information booklets, public meetings or presentations and press releases). Only a small percentage (7%), believe citizen science would contribute little (in comparison to preexisting programs) to public understanding of natural resource issues. Sixty-four percent of state natural resource management agencies envision citizen science will play an increasingly important role in fish and wildlife research and management in the 21st century, 24 percent see the role similar to what it is today, and 12 percent were not sure how important citizen science will be. No agencies believe the role will be diminished.

Factors Limiting Citizen Science

The hypothesis that all seven factors limiting the use of volunteers and volunteer data would yield the same mean score (μ) was rejected (probability (P) = 0.000). Further investigation using the SNK multiple comparison technique revealed the most important category regarding limiting factors was logistics (μ = 1.79). The combined category, lack of dedication/lack of interest (μ = 2.93), had the lowest importance relative to the others (categories listed together as a combined category were not statistically different at the 0.05 level of significance). Between logistics and lack of dedication/lack of interest was the combined category liability issues/attitudes of agency personnel (μ = 2.36/2.43). Multiple comparison techniques sometimes end up with categories that cannot be distinctly assigned to a single group; that occurred here. The two categories, concerns regarding volunteers' ability (μ = 2.02) and lack of funds for volunteer programs (μ= 2.15), were not statistically different from each other. However, they also could not be distinctly separated (in terms of their importance scores) from logistics; nor could they be statistically separated from liability issues/ attitudes of agency personnel.

Volunteer Preference

The hypothesis that all eight types of volunteers yielded the same mean score in terms of value to the agency was also rejected (P = 0.000). Further investigation using the SNK multiple comparison technique revealed two types of volunteers, retired natural resource professionals (μ = 1.31) and natural resource science undergraduates and recent graduates seeking experience (μ = 1.40); these were scored as the most valuable and were not statistically different from each other. Local K through 12 students (μ = 2.88) were scored as the least valuable. The remaining five volunteer types fell between those two extremes. Ranked just below the retired natural resource professionals and the natural resource science undergraduates and recent graduates seeking experience were private landowners and volunteers from nonprofit organizations (μ = 2.15/2.16). Just above the local K through 12 students were independent individuals (μ = 2.51). In between the landowners and nonprofit volunteers and the independent individuals were the local sportsmen and nonnatural resource undergraduates (μ = 2.33/2.35). This last combined category was not statistically separable from landowners and nonprofit volunteers nor from independent individuals.

Discussion

Citizen Science Defined

For the purpose of our survey, we defined citizen science as the use of trained volunteers to collect scientific data and information on fish, wildlife and their habitats. But, citizen science may be defined and utilized in different ways. Most well known national citizen science programs, such as Breeding Bird Surveys and Audubon Christmas Bird Counts, use highly skilled, trained volunteers, but the types of data collected are limited and are used primarily as indices of change (Bildstein 1998, Lepage and Francis 2002). Citizen science moves beyond our definition when volunteers not only collect scientific data on fish, wildlife and habitats, but volunteers also work in the design of ecological experiments and data analysis with education acting as a driving force (Dvornich et al. 1995, Tudor and Dvornich 2001). It is our belief that our definition of citizen science is the most widespread, but we also believe citizen science is best defined by the agency using volunteers to meet research and management objectives.

Current Status of Citizen Science

Responses to the citizen science questionnaire indicated widespread use of citizen science by state natural resource management agencies with these programs making valuable contributions to the management and conservation of fish and wildlife resources. Volunteers contribute to a variety of fish and wildlife management and conservation objectives stemming from participation in a wide array of research and management activities, including fish and wildlife population assessments and monitoring, resource mapping, fish and wildlife capture and tagging, habitat classification, and countless other activities that encompass the fields of wildlife and fisheries science. This participation suggests confidence in, and a need for, citizen science programs by state resource management agencies. The perceptions of agency personnel regarding the roles, contributions and abilities of citizen scientists to assist in the management and conservation of fish and wildlife resources are positive and likely reflect the broad participation and contributions of these volunteers. Ninety-five percent of agencies that utilize citizen science indicated they incorporate information gathered by citizen scientists into policy and management decisions. Participation of private citizens and stakeholders in the decision-making process often increases support for state natural resource management agencies and their respective programs, including management actions that are considered controversial (Chase et al. 2002, Schluster and Decker 2002, Lafon et al. 2004).

There do not appear to be regional trends in the use of citizen science by natural resource management agencies. We hypothesized that the western state agencies would be more likely to use citizen scientists than eastern states because of the greater geographic extent of the resources they are charged with managing. The lack of regional trends and overall widespread use of citizen scientists may suggest that budgets and personnel resources available to state natural resource management agencies may be limited, regardless of size and resource base. The willingness to utilize citizen science regardless of location may strengthen the case for the tangible and intangible benefits citizen science can provide.

Beyond agency perceptions of citizen science and the direct contribution of these programs to assist state agencies meet their objectives, the involvement of volunteers in fish or wildlife research or management is seen as increasing the public's understanding of, and stake in, natural resource management and conservation. The ability to increase the involvement, knowledge and vested interest of private citizens in the process of managing and conserving natural resources through direct channels of participation in the process may provide the greatest benefit to state natural resource management agencies utilizing citizen scientists (Guynn and Landry 1997, Chase et al. 2002, Lafon et al. 2004).

Future of Citizen Science in State Natural Resource Agencies

A majority of state natural resource management agencies believe citizen science is under utilized by agencies and see citizen science playing an increasingly important role within their agencies in the future. Responses to the citizen science questionnaire, combined with the current budget constraints of many state agencies and the looming wave of retiring natural resource professionals, suggest tremendous potential for the expansion of citizen science within state natural resource management agencies. However, our survey indicates not all volunteers are viewed equally and real limitations exist for expanding the role of citizen scientists in agency fish and wildlife research and management activities. For citizen science to be an effective tool of state fish and wildlife personnel, concerns surrounding the use of volunteers and limitations to citizen science need to be addressed.

Logistical constraints and concerns about the accuracy of data collected by citizen scientists are the two factors currently viewed as most limiting the expansion of citizen science within state agencies. Research that addresses the ability of citizen scientists to collect accurate scientific data and information would go a long way towards increasing the use of citizen science by state agencies. Seventy-two percent of agencies surveyed indicated they would promote the use of citizen science within their agency if empirical data demonstrated that volunteers can collect scientifically credible data and information on fish, wildlife and their habitats. Many of these agencies would promote the involvement of citizen scientists as much as possible if this were the case. Logistical limitations may be a greater challenge to the expansion of citizen science than concerns of data quality. The use of citizen scientists in fish and wildlife research and management often requires specific training and instruction for complex scientific and technical concepts as well as supervision and coordination of resources in rugged or remote environments. These circumstances can present unique obstacles for professional scientists and managers, let alone volunteers. Few state agencies that utilize citizen scientists have formal training programs to prepare volunteers for participating in agency activities. The creation of formal training programs that provide baseline training and instruction to citizen scientists with specific, specialized training provided by project biologists used in combination with citizen science project coordinators could help to alleviate many of the logistical limitations related to the use of citizen scientists.

Differences exist in agency perceptions of different types of citizen scientists. Overwhelmingly, natural resource undergraduates and retired natural resource professionals were the volunteer preferred by state agencies with this preference likely driven by the perception, correct or not, that these individuals need less training and less supervision while generating higher quality results. Preferences for these particular volunteers may also reflect views that these groups are more likely to be impartial and familiar with the scientific method. Other citizen science resources (nonprofit environmental organizations, sportsmen and women, and private landowners) may be viewed as having (real or perceived) biases or agendas, particularly for controversial management or conservation issues. Assumptions and perceptions about different types of citizen scientists should be empirically tested as these citizen scientists may in fact provide a valuable resource to meet the increasing demands on natural resource management agencies.

Conclusions

Results of our survey suggest that citizen science has the potential to be a powerful tool to help offset budget and staffing shortfalls faced by state natural resource management agencies. Eighty percent of the agencies surveyed use citizen scientists. The majority of these agencies believe citizen scientists are making a moderate to significant contribution toward agency objectives and that the role of citizen science can be expanded. Ninety-five percent of agencies that utilize citizen science incorporate the resulting information into policy and management decisions. Concerns over logistics and data quality are the most significant factors limiting the expansion of citizen science within state natural resource management agencies. All respondents indicated their agency would expand the use of citizen science if empirical data demonstrated that volunteers were capable of gathering scientifically credible data. However, few of the state agencies that utilize citizen scientists have formal training programs to prepare volunteers for participating in agency activities. The creation of formal training programs that provide baseline training and instruction to citizen scientists with specific, specialized training provided by project biologists in combination with citizen-science project coordinators may alleviate many of these concerns. Finally, citizen science programs provide benefits beyond the collection of scientific data by increasing public awareness and understanding of natural resource management issues and the challenges agency personnel face in addressing them.

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Appendix A

List of the State Natural Resource Management (Fish and Wildlife) Agencies Surveyed on Their Use and Perceptions of Citizen Science

Alabama Department of Conservation and Natural Resources, Division of Wildlife and Freshwater Fisheries
64 North Union Street
Montgomery, Alabama 36130

Alaska Department of Fish and Game
Post Office Box 25526
Juneau, Alaska 99802

Arizona Department of Game and Fish
2221 West Greenway Road
Phoenix, Arizona 85023-4312

Arkansas Game and Fish Commission
2 Natural Resources Drive
Little Rock, Arkansas 72205

California Department of Fish and Game
1416 Ninth Street
Sacramento, California 95814

Colorado Division of Wildlife
6060 Broadway
Denver, Colorado 80216

Connecticut Department
of Environmental Protection, Wildlife
Division
79 Elm Street
Hartford, Connecticut 06106-5127

Delaware Division of Fish and Wildlife
89 Kings Highway
Dover, Delaware 19901

Florida Fish and Wildlife Conservation
Commission
620 South Meridan Street
Tallahassee, Florida 32399-1600

Georgia Department of Natural
Resources, Wildlife Resources Division
2070 U.S. Highway 278, Southeast
Social Circle, Georgia 30025

Hawaii Division of Forestry and Wildlife
1151 Punchbowl Street
Honolulu, Hawaii 96813

Idaho Fish and Game Department
600 South Walnut
Post Office Box 25
Boise, Idaho 83707

Illinois Department of Natural Resources
524 South 2nd Street
Springfield, Illinois 62701-1787

Indiana Department of Natural
Resources, Division of Fish
and Wildlife Resources
402 West Washington Street
Indianapolis, Indiana 46204-2748

Iowa Department of Natural
Resources, Wildlife Bureau
East 9th and Grand Avenues
Des Moines, Iowa 50319-0034

Kansas Department of Wildlife
and Parks
1020 South Kansas
Topeka, Kansas 66612-1327

Kentucky Department of Fish
and Wildlife Resources
1 Game Farm Road
Frankfort, Kentucky 40601

Louisiana Department of Wildlife
and Fisheries
2000 Quail Drive
Baton Rouge, Louisiana 70808

Maine Department of Inland
Fisheries and Wildlife
284 State Street
Augusta, Maine 04333-0041

Maryland Department of Natural
Resources, Wildlife and Heritage
Division, Tawes State Office
580 Taylor Avenue
Annapolis, Maryland 21401

Massachusetts Department
of Fisheries, Wildlife, and
Environmental Law
Enforcement
251 Causeway Street, Suite 400
Boston, Massachusetts 02114

Michigan Department
of Natural Resources
Post Office Box 30444
Lansing, Michigan 48909

Minnesota Department of Natural
Resources, Wildlife Section
500 Lafayette Road
Saint Paul, Minnesota 55155-4040

Mississippi Wildlife Fisheries
and Parks Department
1505 Eastover Drive
Jackson, Mississippi 39211

Missouri Department of
Conservation, Wildlife Division
Post Office Box 180
Jefferson City, Missouri 65102-0180

Montana Fish, Wildlife
and Parks Department
Post Office Box 200701
Helena, Montana 59620-0701

Nebraska Game and Parks
Department
1212 Bob Gibson Boulevard
Omaha, Nebraska 68108

Nevada Division of Wildlife
1100 Valley Road
Reno, Nevada 89512

New Hampshire Fish
and Game Department
2 Hazen Drive
Concord, New Hampshire 03301

New Jersey Division of Fish and Wildlife
Post Office Box 400
Trenton, New Jersey 08625-0400

New Mexico Department
of Game and Fish
Post Office Box 25112
Sante Fe, New Mexico 87504

New York Division of Fish,
Wildlife, and Marine Resources
625 Broadway
Albany, New York 12233-4750

North Carolina Wildlife Resources
Commission
1701 Mail Service Center
Raleigh, North Carolina 27699-1701

North Dakota Game and Fish
Department
100 North Bismarck Expressway
Bismarck, North Dakota 58501

Ohio Department of Natural Resources
1930 Belcher Drive Fountain Square, D
Columbus, Ohio 43224

Oklahoma Department
of Wildlife Conservation
Post Office Box 53465
Oklahoma City, Oklahoma 73152

Oregon Department of Fish and
Wildlife
2501 Southwest 1st Avenue
Portland, Oregon 97201

Pennsylvania Department of
Conservation and Natural
Resources, Rachel Carson State
Office Building
Harrisburg, Pennsylvania 17105-8551

Rhode Island Department
of Environmental Management
235 Promenade Street
Providence, Rhode Island 02908-5767

South Carolina Department of Natural
Resources, Wildlife and Freshwater
Fisheries Division
1000 Assembly Street
Columbia, South Carolina 29201

South Dakota Department
of Game, Fish and Parks
523 East Capitol
Pierre, South Dakota 57501

Tennessee Wildlife Resources Agency
Post Office Box 40747
Ellington Agricultural Center
Nashville, Tennessee 37204

Texas Parks and Wildlife
Department
4200 Smith School Road
Austin, Texas 78744

Utah State Department of Natural
Resources, Division of Wildlife
Resources
Post Office Box 146301
Salt Lake City, Utah 4114-6301

Vermont Agency of Natural
Resources, Department of Fish
and Wildlife
103 South Main Street
Waterbury, Vermont 05671

Virginia Department of Game and
Inland Fisheries
4010 West Broad Street
Richmond, Virginia 23230

Washington Department of Fish
and Wildlife
600 Capitol Way, North
Olympia, Washington 98501

West Virginia Division of Natural
Resources, Wildlife Resources
Section
1900 Kanawha Boulevard, East
Building 3
Charleston, West Virginia 25305

Wisconsin Department of Natural Resources, Bureau of Wildlife
Post Office Box 7921
Madison, Wisconsin 53702

Wyoming Game and Fish Department
2219 Carey Avenue
Cheyenne, Wyoming 82002

Appendix B

Survey on the Use of Volunteers by State Agencies in Fish, Wildlife and Habitat Research and Management

Before beginning the questionnaire, please provide some information about yourself.

Title: ______________________________

Years of experience with the agency: _______

Do you work primarily with fish, wildlife, or habitat? ________________

Please provide a brief description of your position and the responsibilities it entails: ______________________________

Do you have direct knowledge of the activities of volunteers associated with your agency and its research and management personnel (frequency of use, types of activities and perceptions of agency personnel)? (Please circle one)

a. yes
b. no

For all multiple-choice questions, please circle your response. Questions with multiple responses or specific directions are provided with the question.

1. Does your agency use volunteers?
   a. yes
   b. no (please go to 1i)

1i. Why not? Please explain: ________________________

2. Does your agency actively recruit volunteers to work on projects related to fish, wildlife and their habitats?
   a. yes (please go to 2i)
   b. no

2i. How? Please, check all that apply.

___ agency website

___ press releases (television, radio, local papers)

___ contact local universities or colleges

___ provide information to local nonprofit conservation organizations

3. In what capacity are volunteers primarily used by your agency?

a. labor

b. community education and outreach programs

c. scientific data collection

d. other:______________________________

4. Does your agency have a formal training or certification process for volunteers?

a. no

b. yes (please go to 4i)

4i. Please elaborate: ______________________________

5. What is the level of contribution volunteers currently make to your agency's research, management and conservation objectives for fish, wildlife and their habitats?

a. very high: volunteers are an essential resource to achieving agency objectives

b. high: volunteers contribute to some but not all agency objectives

c. moderate: volunteers contribute to a very limited number of agency objectives

d. low: volunteers do not currently contribute to agency objectives

6. To what extent do you believe your agency currently utilizes volunteer resources for fish, wildlife and habitat research and management in your state?

a. over utilized

b. just right

c. under utilized

d. unsure

7. How capable is the typical volunteer of directly assisting your agency's biologists, researchers and managers in gathering scientific data and information on fish, wildlife and habitat?

a. very capable

b. capable

c. somewhat capable
d. not capable
e. unsure

7i. Please elaborate:______________________________

8. Does your agency use volunteers to gather scientific data and information for research, management and conservation of fish, wildlife and their habitats in your state?
a. yes (please go to 8i)
b. no (please go to 8ii)

8i. To what extent?
a. all or most projects statewide
b. several projects under the direction of individual biologists, researchers and managers
c. a limited number of projects under the direction of individual biologists, researchers and managers
d. unsure, we don't keep track of volunteers

8ii. Why not? Please explain: ______________________________

9. Can the role of volunteers gathering scientific data and information on fish, wildlife, and their habitats be expanded within your agency?
a. yes (please go to 9i)
b. no (please go to 9ii)
c. unsure

9i. To what extent?______________________________

9ii. Why not? ______________________________

10. How important are the following factors in limiting the use of volunteers and volunteer data in your agency's fish and wildlife research and management projects? Please, rank each from 1 to 4 (1: very important, 2: important, 3: sometimes important, 4: unimportant).
___ lack of funds to support volunteer programs
___ lack of interest, limited number of potential volunteers
___ concerns regarding the ability of volunteers to gather scientifically credible data and information
___ liability issues
___ logistics associated with using volunteers (e.g., vehicles, access to study areas, supervision, training)
___ lack of dedication or vested interest by volunteers
___ attitudes of agency personnel

11. Which type of volunteer is a better investment of agency resources and training to perform tasks related to research and management of fish, wildlife or their habitats?
   a. an individual or group with enthusiasm, motivation and dedication but having little or no education and experience in natural resources
   b. an individual or group with an education and experience in natural resources but having limited time to commit to a project
   c. they would be an equally valuable investment of resources and training. Why? ______________________________
12. Which type of volunteer is or would be most valuable to your agency to gather scientific data and information on fish, wildlife and their habitats? Please rank each from 1 to 4 (1: very valuable, 2: valuable, 3: sometimes valuable, 4: not valuable).
   ___ a natural resource science undergraduate or recent graduate looking to gain experience
   ___ a retired natural resource professional looking to remain active or learn new skills
   ___ a non-natural resource undergraduate or college graduate with an interest in natural resources
   ___ local K through 12 students receiving natural resource education and training in their local schools
   ___ a group or volunteer associated with an established nonprofit conservation organization
   ___ an independent individual or group looking to be more involved in environmental issues
   ___ private citizens or landowners with an interest or a stake in a specific project
   ___ local sportsmen and women
   Briefly describe the reasoning behind your ranking: ______________
13. Do you believe a lack of information exists regarding the ability of volunteers to gather scientifically credible data and information for fish, wildlife and habitat research and management?
   a. yes
   b. no
   c. unsure

14. If empirical data existed to demonstrate that volunteers can gather accurate scientific information on fish, wildlife and habitat, would you be more inclined to promote volunteer involvement in your agency's fish and wildlife projects?
 a. yes (please go to 14i)
 b. no (please go to 14ii)
 c. unsure

14i. To what extent?
 a. as much as possible
 b. some
 c. very little

14ii. Why not? Please explain:______________________

15. If your agency uses volunteers to gather scientific data and information for fish, wildlife, and habitat research and management, what types of and how much data do volunteers gather? Please list:____________
 a. a lot
 b. some
 c. very little
 d. unsure

16. What types of scientific data do you believe volunteers are capable of gathering for fish, wildlife and habitat research and management? ______________________

17. Of the projects that have used or are currently using volunteers for scientific data collection, how much of the data and information gathered by volunteers is actually incorporated into fish and wildlife management, policy and decision-making?
 a. considered in all or most decisions
 b. some decisions
 c. individual decisions, decided on a case by case basis
 d. never

18. Do you believe that incorporating volunteers into fish and wildlife research and management is a good way to increase the general public's understanding of natural resource related issues?
 a. yes (please go to 18i)
 b. no (please go to 18ii)
 c. unsure

18i. How much?

a. It could contribute substantially to the public's understanding.

b. It would contribute equally to other existing programs (e.g., information booklets, public meetings or presentations, press releases).

c. It would contribute little (less than the aforementioned programs).

18ii. Why not? Please explain:______________________________

19. As fish and wildlife research and management continues to evolve in the 21st century, what role do you believe volunteers will play?

a. an increasingly important and vital role in fish and wildlife management and research

b. similar to what it is today

c. a decreasingly important and vital role in fish and wildlife management and research

d. unsure

Please elaborate: ______________________________

20. If your agency does use volunteers to collect scientific data for projects related to fish, wildlife and habitat research and management, would you be willing to participate in a follow-up interview over the phone to describe details of these projects and the role that volunteers play? If yes, please provide your contact information below. ________________

Communication: The Future Wildlife Manager's Greatest Asset

Billy W. DeLany, Jr.
McNeese State University, Harold and Pearl Dripps Department of Agricultural Sciences
Lake Charles, Louisiana

Earl Johnson
Louisiana State University, Agricultural Center, Institutional Research and Organization Development
Baton Rouge, Louisiana

Safia Dawood
Objectsoft Group Inc.
Port Jefferson, New York

Introduction

Communication skills are the most effective tools to negotiate compromises among stakeholders for the sustained development of renewable natural resources. Scientific and management findings are meaningless unless the findings are communicated to the interested stakeholders. Students graduating from any academic program (regardless of the level—baccalaureate, Master's, or doctoral) will face communication difficulties and require experienced mentoring; however, from the beginning to the end of one's higher education, communication skills should be a common thread throughout the curriculum (Burger and Leopold 2001). Finally, while wildlife management is founded on reliable science, successful management depends upon human relationships.

Wildlife managers must be capable and positive communicators to conserve and protect dwindling natural resources (Caudell 2000). Managers who effectively communicate through written and oral communications (i.e., negotiate and compromise, educate and communicate) to diverse stakeholders (consumptive and nonconsumptive users) are more likely to succeed in their conservation efforts (Teer et al. 1990). As we have heard before, wildlife management is 90 percent people management and 10 percent wildlife management (Lumsden 1957, Thomas 2000).

Wildlife management is a mixture of science, management and human dimensions (Thomas 2000). While wildlife graduates generally are well educated in the sciences, Janik and Radloff (2000) indicated that entry-level employees have difficulty collaborating. They require training to understand the cooperation needed in successful interdisciplinary teamwork, which indicates the need for communication skills. To identify the communication skills needed by entry-level employees, the employers of wildlife graduates must be solicited (Wilhelm 1999, Miller 2000, Woolf 2000). Then, higher education leaders can develop natural resource curricula to integrate pertinent knowledge and skill requirements (Leopold 2000). Furthermore, new wildlife graduates applying for entry-level employment need job skill experiences, such as oral and written communication skills (Ledford 1996).

To determine a contemporary list of entry-level job communication skills, the Delphi technique was utilized (DeLany 2004). As with other works (Coates 1975, Jones and Hunter 2002, Linstone and Turoff 2002), the Delphi technique is a research tool to collect geographically spread, expert opinion. Furthermore, the validity of a Delphi study is related to the particular needs of a phenomenon (Dalkey 1969, Cyphert and Gant 1971, Linstone and Turoff 2002), such as the entry-level job skills needed by managers, the curriculum development needs of higher education, and the workplace needs of the wildlife industry.

Methods

The Delphi panel of wildlife management experts was selected by a confidential steering committee (DeLany 2004). The panel's purpose was to construct a consensus list of entry-level job skills needed by wildlife managers (DeLany 2004). Panelists from the academic, private and public sectors participated in three consecutive survey rounds. Survey data was solicited and collected via email transmission. The data was summarized by median, mean, standard deviation and level of panel consensus.

Panel Selection

The expert wildlife managers were currently employed professionals who were innovative and forward thinking in their approach to wildlife management. Thirty-nine panel members were selected from a pool of 81 nominees. Panel members were evenly distributed among the academia, private and public sectors. Of the academic sector panelists, six were professors, four were department heads, and three worked in cooperative extension. The private sector panelists were supervisors and managers. The public sector panelists were composed of 10 federal and 3 state wildlife managers.

All panelists were from the United States. Twenty-three panelists were from the southeastern United States, and 16 were from other geographic areas of the United States. Of those 16, 7 were from the northcentral area, and 3 each were from of the following areas: Northeast, Northwest and Southwest.

Instrumentation

The survey instruments for rounds one, two and three were individually unique. To guide the panel members, the round one instrument utilized the focus question, "What are the job skills needed by entry-level wildlife managers," and the following eight job skill areas: biological sciences, physical sciences, basic statistics, quantitative sciences, humanities, communication, policy administration (The Wildlife Society 2004) and practical daily work skills (Ledford 1996).

The round two instrument was the compilation of unique items from round one for each of the eight job skill areas. In round two, the panelists rated each item on the following anchored scale: 5 equals high importance, 4 equals substantial importance, 3 equals moderate importance, 2 equals low importance and 1 equals no importance (Gaspard 1992).

The round three instrument was unique for each panelist. Each panelist's instrument contained the group's rating and the panelist's unique rating for each item. Each panelist was requested to review his or her item(s) that were not in consensus with the group median and rerate the item within one point of the group median or provide a reason as to why their rating was more accurate.

Data Collection

Each panelist's perceptions were solicited by e-mail transmission. The email provided instructions and a hotlink to each survey round's instrument. Upon completion of each instrument, the panelist submitted his or her results by clicking the submit button.

Data Analysis

In round one, similar job skills were compiled into one job skill item. However, to facilitate the diversity of workplaces and panelists' opinions, some job skill items that were slightly different were maintained as unique items. The objective was to err on the side of caution and to not delete data (panelist opinion) based on the researcher's bias of item similarity.

The round two data was summarized by group median, group mean and standard deviation for each job skill (item). The group median, group mean and standard deviation were used to develop the round three instrument.

The round three data was summarized by the group median, mean, standard deviation and consensus for each item. Items were ranked by descending mean scores, ascending standard deviation and descending level of consensus. Consensus was calculated by dividing the number of panelists who were within one point of the median by the total number in the panel. Item consensus was reached when 51 percent of the respondents rated the item within one point of the median on the five-point, anchored scale of importance. In the case of tied means and standard deviations, the level of consensus was used to break the tie.

Results

The respondent panel members for rounds one, two and three numbered 31, 32 and 31, respectively. The round one panel was composed of 10 academic, 10 private and 11 public sector members. The round two panel was composed of 9 academic, 11 private and 12 public sector members. The round three panel was composed of 9 academic, 10 private and 12 public sector members. Panel members who did not respond to round two were removed from the study for round three.

High Importance Items

Overall, 384 items were developed and rated by the Delphi panel (Table 1). Forty-two of the 384 items (11%) were communication job skills. In the high-importance category, 25 of the 72 job skill items (35%) were communication job skills, which indicated the perceived importance of communication skills by expert wildlife managers. Of the 42 communication items, 25 were of high importance, 15 were of substantial importance, and 2 were of moderate importance. There were no items rating of low importance for communication job skills (Table 1).

Table 1. Summarized entry-level job skills needed by wildlife management professionals by importance rating and job skill areas as perceived by wildlife management experts in third round of a Delphi Survey.

Job skill area	High importance 5.00–4.50	Substantial importance 4.49–3.50	Moderate importance 3.49–2.50	Low importance 2.49–1.50	Total
Biological sciences	13.00	56.00	36.00	3.00	108
Practical	15.00	16.00	17.00	6.00	54
Quantitative sciences	4.00	18.00	26.00	1.00	49
Communication	25.00	15.00	2.00	0.00	42
Policy administration	3.00	26.00	8.00	1.00	38
Physical sciences	0.00	8.00	24.00	3.00	35
Humanities	7.00	19.00	5.00	0.00	31
Basic statistics	5.00	17.00	5.00	0.00	27
Total	72.00	175.00	123.00	14.00	384
Percent frequency	18.75	45.57	32.03	3.65	100

Entry-level Job Communication Skills

Overall, 42 entry-level communication job skill items were identified and rated by the Delphi panel (Table 2). The median ratings of communication job skills ranged from three to five. Twenty-six items had medians of 5, 14 items had medians of 4, and 2 items had medians of 3 (Table 2). The means ranged from 2.87 to 4.90. The level of consensus ranged from 90.3 to 100. Redundancy did occur among entry-level communication job skill items (Table 2); however, item uniqueness was maintained, which conveyed the subtle differences among items. Overall, communication skills included the following general topics: writing, speaking, human dimensions and computer transmissions. Writing skills included preparing plans, technical reports and articles for diverse audiences. Speaking skills included the ability to communicate with diverse individuals and groups. Human dimension skills included positive attitude, collaboration, listening and win-win outcomes. Computer skills included e-mail, software presentations and media presentations.

Discussion and Conclusions

Communication skills are highly important to entry-level wildlife managers, as indicated by the number of communication items that were rated high importance. Of the 72 entry-level job skills identified as high importance, 25 were communication skills (Table 1). More than 50 years ago, Cottam (1947)

Table 2. Importance of communication entry-level job skills needed by wildlife management professionals as perceived by wildlife management experts in a round three delphi survey.[a]

Rank	Item	Med[b]	X[c]	SD	Percent[d]
1	the ability to write a simple technical report	5	4.90	0.30	100.0
2	the ability to write plans, reports, technical papers and other documents using good grammar, punctuation and techniques	5	4.90	0.30	100.0
3	the ability to skillfully communicate with diverse groups and individuals	5	4.87	0.34	100.0
4	the ability to professionally and effectively communicate one-on-one at any level of understanding (technical and lay person)	5	4.84	0.37	100.0
5	the ability to keep a positive, friendly and outgoing attitude	5	4.84	0.37	100.0
6	the ability to develop and to maintain interpersonal relationships	5	4.81	0.40	100.0
7	the ability to be a team player and to recognize the role of effective teamwork in organizations	5	4.81	0.40	100.0
8	the ability to lead and follow as the situation warrants	5	4.77	0.43	100.0
9	the ability to professionally present information to a group of peers	5	4.71	0.46	100.0
10	the ability to write effectively for various audiences	5	4.71	0.46	100.0
11	the ability to communicate through written professional correspondence	5	4.71	0.46	100.0
12	the ability to communicate through good telephone etiquette	5	4.71	0.46	100.0
13	the ability to be an effective and responsive active listener	5	4.71	0.53	96.7
14	the ability to explain complex issues to layman stakeholders	5	4.68	0.48	100.0
15	the ability to interact well with stakeholder groups	5	4.68	0.48	100.0
16	the ability to communicate using computer technology	5	4.68	0.48	100.0
17	the ability to effectively manage and to interact with diverse staff personnel	5	4.61	0.50	100.0
18	the ability to effectively network and to interact with diversified groups (e.g., public, private, academic, media)	5	4.61	0.50	100.0
19	the ability to interact, communicate and respond with others on a daily basis to facilitate an effective win-win situation	5	4.61	0.50	100.0
20	the ability to articulate natural resource knowledge and management intent to the public in an understandable manner, which requires understanding the audience's perspective	5	4.61	0.56	96.7
21	the ability to be an effective public speaker	5	4.58	0.62	93.5
22	the ability to speak to a group of people in a variety of forms and formats	5	4.55	0.51	100.0
23	the ability to deal with and discuss controversial issues in a hostile environment	5	4.55	0.57	96.7

Table 2 continued. Importance of communication entry-level job skills needed by wildlife management professionals as perceived by wildlife management experts in a round three delphi survey.[a]

Rank	Item	Med[b]	X[c]	SD	Percent[d]
24	the ability to navigate and locate information on the Internet	5	4.55	0.62	93.5
25	the ability to use software programs (e.g., PowerPoint) to construct one-on-one, lay-groups, professional and Web-based presentations to reach a diversity of audiences	5	4.52	0.57	96.7
26	the ability to e-mail correspondence	5	4.48	0.89	90.3
27	the ability to communicate scientific information to managers and scientists with sound technical writing skills	4	4.42	0.62	100.0
28	the ability to work with difficult people	4	4.35	0.71	100.0
29	the ability to avoid or to resolve potential human conflict situations with the most effective and appropriate conflict resolution methods	4	4.29	0.74	100.0
30	the ability to communicate points convincingly to the public in print	4	4.26	0.77	96.7
31	the ability to summarize and to effectively communicate information through charts and figures for presentation and publication	4	4.26	0.82	100.0
32	the ability to effectively present a professional presentation to a large audience	4	4.16	0.78	100.0
33	the ability of the natural resource manager to effectively work with stakeholders through contemporary public relation practices	4	4.16	0.86	96.7
34	the ability to effectively manage diverse visitors or user groups	4	4.13	0.81	100.0
35	the ability to use specific knowledge to interact, influence and communicate with community groups (action leaders, opinion leaders, etc.)	4	4.13	0.88	96.7
36	the ability to resolve conflict through consensus building	4	3.94	0.81	96.7
37	the ability to effectively communicate ideas and technical information through popular publications	4	3.90	0.83	96.7
38	the ability to use informed consent to effectively accomplish the mission, when consensus development is ineffective	4	3.81	0.79	100.0
39	the ability to use marketing principles and to effectively communicate ideas through educational and awareness programs to stakeholders.	4	3.77	0.84	96.7
40	the ability to edit and critically to review communication media (manuscripts and presentations)	4	3.65	0.66	100
41	the ability to speak with the media and get your most important message across in a 30-second sound bite	3	3.19	0.95	90.3

Table 2 continued. Importance of communication entry-level job skills needed by wildlife management professionals as perceived by wildlife management experts in a round three delphi survey.[a]

Rank	Item	Med[b]	X[c]	SD	Percent[d]
42	the ability to write grants	3	2.87	0.72	100

[a] Mean ratings were classified according to the following interpretive scale: 5.00–4.50 = high importance; 4.49–3.50 = substantial importance; 3.49–2.50 = moderate importance; 2.49–1.50 = low importance; 1.49–1.00 = no importance.

[b] median of ratings assigned by Delphi panelists

[c] mean rating based on following anchored scale: 5 = high importance; 4 = substantial importance; 3 = moderate importance; 2 = low importance; 1 = no importance

[d] level of consensus = percentage of responding panelists within ± 1 of the median

indicated that a criticism of wildlife managers was poor communication skills. Currently, in the natural resource profession, communication skills are recognized professional needs (Peek 1989, Jensen et al. 1998, Thomas 2000). Entry-level job communication skills also involve the ability to communicate successfully for collaborative problem solving (Day and Koorland 1997, Lee and Blaszcznski 1999, Paulson 2001). Finally, wildlife management has been described as 90 percent people management and 10 percent wildlife management (Lumsden 1957, Thomas 2000), which is founded on good communications.

Based on these findings, we recommend that the communications skills be given a high level of priority when making curricular decisions for wildlife management programs.

Applications

Communication skills identified by this research are embedded as a common thread (Burger and Leopold 2001) to build a communication foundation in the McNeese State University (McNeese) wildlife management curriculum. As previously stated, the uniqueness of survey items was maintained to preserve panelist opinions and to reduce researcher bias. However, due to the similarity of items, the items from Table (2) were grouped as foundation concepts for application at McNeese (Table 3). Additionally, this research is presented to the students to encourage and to enhance their participation.

In order to implement communication concepts at the most basic level, students critically review and discuss journal articles to develop a foundation for preparing an adaptive resource management proposal. Through this method of

Table 3. Common-thread communication skills embedded in the McNeese State University wildlife management curriculum.

Item ranking[a]	Entry-level job, communication skills[b]
1, 2, 10, 27, 30, 32, 35, 37, 40	the ability to write plans, reports, technical papers and other documents using good grammar, punctuation and techniques to communicate with scientists, managers or laymen
3, 4, 9, 11, 22, 41	the ability to skillfully and professionally communicate with diverse groups and one-on-one in a variety of formats (classroom, seminar, television, mock one-on-one)
5, 6, 17	the ability to maintain a positive and friendly attitude to develop and maintain interpersonal relationships with the public and staff
7, 8,	the ability to lead or follow, to be a team player and to recognize the role of effective teamwork in organizations
12	the ability to communicate through good telephone etiquette
13	the ability to be an effective and responsive listener
14, 15, 18, 19, 20, 21, 23, 28, 29, 33, 34, 36	the ability to interact and explain (public speaking) natural resource knowledge and management practices to a diversity of laymen stakeholders to avoid or resolve conflict situations to facilitate a win-win situation
16, 24, 25, 26	the ability to use computer technology (software and internet) to navigate the internet, locate information, communicate
31, 39	the ability to summarize and effectively communicate information through charts and figures, as well as to effectively communicate ideas for educational awareness
38	the ability to use informed consent to effectively accomplish the mission, when consensus development is ineffective
42	the ability to write grants

[a] ranking levels of combined entry-level job communication skills

[b] combined job-skill descriptions

literature review, students learn to utilize published information to formulate management proposals. Manuscripts are developed through a basic thesis format of scientific inquiry, following the publishing rules of the *Journal of Wildlife Management*, and are presented via PowerPoint. However, educing active learning of communication skills requires rigorous and persistent effort from the student and professor. Furthermore, students are encouraged to express their opinions and to respect the opinions of others by agreeing to disagree (e.g., consumable and nonconsumable wildlife users). The process has not been an easy task. Individual bridges of understanding are constructed among students and between each student and the professor (mentor).

Communication foundation development begins in the first freshman course and follows through to the senior level capstone course. In the freshman level Introduction to the Wildlife Profession, one to two professional speakers are invited per week to discuss how they have succeeded as wildlife professionals. The discussion is an open forum for the guest speaker. However, guest speakers are requested to discuss the need for reading, writing and presentation skills.

In the sophomore level Principles of Wildlife Management course, students compose a personal land ethic based on *A Sand County Almanac* (Leopold 1949) and on the writings of contemporary authors. The purpose is for the student to critically review the ideas of others, discussing those ideas with their peers and mentor, to compose a manuscript, and to present their land ethic philosophy.

In the junior level Small Wildlife Management course, students review and present the findings of a peer-reviewed journal article of choice concerning an endangered species. Then, they prepare an adaptive management plan and present the plan to the class for peer review. The purpose is to learn management techniques concerning endangered species, to learn to develop an adaptive resource plan, and to experience peer review.

In the junior level Large Wildlife Management course, students review and present a journal article of choice concerning a large wildlife conflict issue. Then, they prepare a conflict management plan and present it to the class for peer review. In addition to the purposes previously mentioned, the purpose is to develop an understanding of stakeholder diversity and conflict resolution.

In the senior level Wildlife Techniques course (capstone), students critically review selected journal articles on the essence of reliable knowledge and science in wildlife management, on selected articles that focus on contemporary wildlife techniques, and on a particular journal article that the student chooses to focus his or her adaptive management proposal. For example, in the fall of 2004, students focused on the use of GPS and GIS applications in wildlife management. Their proposal was presented in a mock one-on-one presentation to a higher authority (i.e., upper management, legislator), which, in this case, was facilitated by Don Voros, Southwest Louisiana National Wildlife Refuge Complex manager. The purpose was to conduct a thorough review of literature, to compose a plan, and to present the plan to a primary stakeholder.

Student Reactions

As we all know, young wildlife students envision themselves as capturing and handling wildlife on a frequent basis. Student reactions to this active learning process are at first indecisive, and they do procrastinate. However, due to the common-thread principle, students are encouraged to submit multiple drafts for the professor's review to improve the quality of their work and skills. By the completion of the principles or the small wildlife course, most students understand the intensity of the workload required to develop and communicate a plan. By completion of the capstone course, the student's communication skills are good to excellent at that point of their professional development.

Concerning these reading, writing, discussing and presenting exercises, the following course critiques were submitted by anonymous undergraduate students.

"Good course. It is hard to instruct and encourage new students to work on a theory paper or even to think critically. I felt it was done very professionally and I look forward to other classes."

"I have learned more through theory development using journal articles than I thought possible two semesters ago. Forming a plan for white-tailed deer management is second nature. I wouldn't have said this before. Once you become interested in a subject, it is pleasurable to acquire information about it."

"I have enjoyed researching my theory topic. I have learned new interesting facts and techniques about the red wolf, but not limited to the red wolf. I strongly agree with the way the course is organized and how the literature assignments were distributed."

"As for this semester, our class has formed a different schema toward literature review. As for myself, I have opened my eyes to published literature research. I didn't realize that there was such a tremendous amount of research conducted on subject matters such as the one I am interested in. Forming the ability to research work conducted by another biologist and formulate a management plan or experiment is difficult but essential to wildlife managers."

In closing, we were successful in developing a communication foundation based on reliable wildlife knowledge and communication. Albeit, in order to succeed at this endeavor, sometimes the instructor's patience runs very thin, and there have been a few class and one-on-one discussions to coerce students to the right track. The reward is knowing that, when a student is challenged to solve a problem, he or she will have a sound foundation to research, discuss, assimilate, communicate and solve.

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Succession Planning and Leadership Development: The Fish and Wildlife Service Process, Programs and Results

Rick Lemon
U.S. Fish and Wildlife Service, National Conservation Training Center
Shepherdstown, West Virginia

Bill Ashforth
U.S. Fish and Wildlife Service, National Conservation Training Center
Shepherdstown, West Virginia

Karen Cartlidge
U.S. Fish and Wildlife Service, National Conservation Training Center
Shepherdstown, West Virginia

David Medaris
U.S. Fish and Wildlife Service, National Conservation Training Center
Shepherdstown, West Virginia

Introduction

In the late 1990s, the U.S. Fish and Wildlife Service (FWS) was facing three concurrent leadership challenges—the impending retirement of experienced leaders, an unwillingness of potential leaders to step forward into leadership positions, and a lack of knowledge, competency and experience of leadership candidates. These challenges manifested themselves into what hiring officials and managers were referring to as inadequate "bench strength" in applicants for vacant leadership positions in FWS. FWS conducted demographic analysis of retirement trends to pinpoint levels of management where retirements would most impact the organization. A survey of leadership competencies focused development efforts on competencies most important to success in FWS and on competencies most in need of development within FWS. Two programs were developed to address leadership development needs at two levels of the organization. Experienced FWS leaders teamed with training experts to design and implement the programs. Experienced leaders also serve as instructors and coaches in the programs. A comprehensive, five-level evaluation has demonstrated the success of one of the two programs. Comprehensive evaluation of the second program is scheduled for 2006. Another indicator of success is the high number of program graduates who have either been promoted into positions of higher leadership responsibility or have transferred laterally within the organization to broaden their leadership perspective.

Needs Analysis and Program Development

In order to address these challenges, FWS embarked on a detailed needs assessment, followed by the development and implementation of a structured leadership development program.

To validate and quantify the general impression of a pending wave of retirements, FWS analyzed demographic trends, including retirement eligibilities for various management levels and job categories. The five management categories, reflecting FWS organization in 1999, were: field project leader; regional branch and division chiefs; programmatic managers, including programmatic assistant regional directors, deputy assistant directors, and branch and division chiefs in Washington, DC; geographic assistant regional directors and deputy regional directors; and employees at the FWS directorate level.

In order to identify the most important leadership competencies in FWS and to determine which competencies most needed to be addressed and strengthened, FWS surveyed 537 managers spread across the 5 levels described above. The survey was distributed to incumbents in the targeted positions, to the next higher level of management for the targeted position and to employees who reported to the targeted position.

For survey purposes, FWS utilized the 27 leadership competencies which have been researched and validated by the U.S. Office of Personnel Management (OPM) (Appendix).

The survey used was a modified version of the OPM Leadership Effectiveness Inventory and included 105 task-related items that are directly linked to the 27 leadership competencies. Respondents scored the survey by indicating the level of importance of each task to the designated position on a five-point scale. Respondents then rated the level of current skill of incumbents and potential candidates for the position on a five-point scale.

Of the 537 surveys distributed, FWS received 190 responses. This represents a 35-percent return, with a high of 49 percent of field project leaders to a low of 24 percent of directorate members.

The data were scored by computer, and a report was prepared to identify the competencies considered to be of most importance to success in FWS. Reports were prepared to display the relative rankings of leadership competencies for each of the five levels of management. The data were also analyzed to identify common needs between groups.

The data were then analyzed to identify development needs by looking at relative strength or weakness of existing capability for each competency in FWS. This data was analyzed for each of the five management levels and also was analyzed for common themes across levels.

The FWS identified gaps between high priority leadership competencies and its existing ability to implement those competencies. Areas of high competency importance and relatively low current capability were targeted to be addressed in leadership development programs.

Based on the data of retirement eligibility at various management levels and on the results of the competency gap analysis, the FWS identified a need to address leadership development at two levels: for GS 11 through 12 level employees to prepare them for GS 13 level positions, and for GS 13 through 14 level employees to prepare them for more senior, GS 15 level positions. Based on analysis of competency gaps, FWS identified the leadership competencies that most needed to be addressed at each of these two levels.

A decision was made to explore the development of leadership programs that address the needs at these two levels. For each of the two programs, a team of FWS leaders representing a cross section of management levels, from field project leader to senior leadership, was assembled to work with and guide program development.

The teams first corroborated the findings of the surveys and discussed in more detail the relative importance of each leadership competency identified. They also discussed how each competency is actually practiced on the job and how success or failure in each of the competencies would be manifested in leadership performance.

The teams also worked with instructional systems designers on the outlines of the programs and also identified potential instructors and speakers from among the leadership cadre of FWS.

Based on the work of the teams, two programs were developed: the Stepping Up to Leadership (SUTL) Program for GS 11 and 12 level employees, and the Advanced Leadership Development Program (ALDP) for GS 13 through 14 level employees. The programs were presented and approved for implementation by the FWS directorate.

Stepping up to Leadership Program

The SUTL program has two broad goals. One goal is to help participants better understand what leadership is so that they can make an informed decision of whether to pursue leadership positions. The other goal is to prepare participants for leadership positions.

Selection for the program is competitive and merit-based. The program is announced nationally in FWS. Applicants apply and are ranked against five factors. Applicants are first ranked at the regional level and the headquarters level. Each region and the headquarters office select among the best qualified to fill their allotted number of slots. Allocation is based on the *pro rata* share of GS 11s and 12s in each region and the headquarters office. Each year, 24 participants are selected for each of 2 offerings of the program for a total of 48 participants per year.

The program starts with a 2-week session of personal and 360 degree leadership assessments and with leadership training. During this phase and based on feedback from the leadership assessment, participants complete an individual development plan (IDP) to guide their learning during the program. Instructors during phase one are a mix of FWS training staff, FWS leadership representatives from all levels of the organization and other conservation leaders.

Participants then return to their job and, over the next 5 months while operating in their position of record, they also complete field-based team assignments, interview and job-shadow conservation leaders, and write a personal leadership philosophy. Working in teams, participants analyze and discuss the natural resource case study assigned to them and prepare a 5-page analysis and a 20-minute presentation to be delivered at a subsequent session. Also working as a team, participants prepare a lesson plan to be presented subsequently to their classmates on one of four leadership competencies.

Participants return for a 1-week session and graduation exercise. During this session participants continue to learn about leadership issues and competencies. As an active learning exercise, participant teams teach leadership competencies to the rest of the class in the areas of vision, strategic thinking, political savvy and partnering. Teams also present the results of their analysis of assigned natural resource case studies to classmates and to a panel of FWS leaders who critique the analysis and presentations.

Another important component of the SUTL program is the use of experienced FWS leaders as coaches to the participants. There are eight coaches, or one coach for every three participants. The coaches receive specialized training to prepare them for their role. Coaches assist participants in interpreting and accepting 360-degree feedback and in developing their IDP, which is used during the program and in later career development decisions. They also assist team members on team assignments. This coaching component contributes to the development of the participants and also teaches coaches the importance of developing future leaders. In addition, it helps with knowledge management within FWS by passing knowledge, wisdom and organizational values from one generation to the next.

The SUTL program began in 2000. Since that time, eight classes have been completed with approximately 170 graduates. Of those graduates, 40 percent have moved into higher level management positions, and 6 percent have transferred into a new position at the same grade.

In 2004, a five-level evaluation and return on investment analysis was completed on the SUTL program as part of a doctoral dissertation. The analysis demonstrated a greater than 300-percent return on investment for the program (Willis 2004). The evaluation followed the standard Kirkpatrick model for levels 1 through 4, (Kirkpatrick 1998) and the Phillips return on investment model for level 5 (Phillips 2003). In brief, level 1 measures participant reaction to the program and how well they believe the program met the objectives. Level 2 is a measure of learning from the program as measured by before and after testing. Level 3 measures behavior and how behavior has changed back on the job as a result of the program. Level 4 measures results of that changed behavior on mission accomplishment. Level 5 quantifies a monetary return on that application and compares the return to the investment as measured against the cost of the program.

Advanced Leadership Development Program

The ALDP is a program designed for employees at the GS 13 to 14 level. The goal of the program is for participants to explore leadership in FWS and to assess, learn and develop themselves as leaders. The cohort structure of the program allows for leadership development at the individual and organizational level.

The ALDP is advertised nationally within FWS, and applicants address and are evaluated against five executive core qualifications—leading people, leading change, results driven, business acumen, building coalitions and communication. The director makes final selection of 20 participants for this program per year.

The development process includes three phases focusing on leadership at the individual, team and organizational level. There are three structured classroom segments over the course of a year, which include one 2-week session and two 1-week sessions.

The program begins with an intensive 2-week session focusing on individual feedback and leadership principles and competencies. Participants receive leadership feedback from their training peers and coaches, supervisors, work peers and direct reports. Feedback concentrates on their effectiveness measured against the 27 leadership competencies. Participants also receive feedback using other validated instruments, such as Benchmarks 360, Extended DISC, Human Element (FIRO B, F, S), EQi (Emotional Intelligence) and Kolb Learning Styles Inventory. Based on this feedback and in consultation with their coach, each participant develops an IDP to guide learning and development during the program and in postprogram career decisions.

Throughout the program, participants are exposed to executive leaders from FWS, other federal agencies, Congress, state agencies, not-for-profits and the corporate community. These leaders share personal leadership philosophies and also serve as role models for participants. Leadership experts are also used as instructors.

In addition to classroom training, participants complete two developmental assignments. The first assignment is a 30-day rotational assignment where each participant switches jobs with another participant in the program. This forces participants outside of their comfort zone to lead and to manage in a work area where they have no technical expertise. Participants are also required to solicit and deliver feedback to the participant who worked in their position.

The second assignment is a 60-day leadership assignment which provides a high degree of challenge and visibility for the participant. The assignments are real-world, high-level, leadership positions. The assignments are selected by senior FWS leadership, and participant placement is a joint decision between the participant, their coach and the Deputy Regional Director or the Deputy Assistant Director from their home region or program.

The coaching component is critical to the success of the program. Ten GS-15 coaches are selected, are trained and participate in the program. This provides a ratio of one coach for every two participants. As in the SUTL program, coaches provide assistance with interpretation and acceptance of feedback, interpretation of leadership lessons, developmental program planning and career guidance and counseling. This is a learning experience for the coaches as well as the participants, and it helps to pass knowledge, wisdom and organizational values from one generation of FWS leaders to the next.

Evaluation of ALDP has been limited to Kirkpatrick level 1, participant feedback and reaction. Anecdotal feedback about the results of the program has been received from supervisors and leaders of FWS. A comprehensive evaluation of ALDP is scheduled for 2006.

As with the SUTL program, there has been significant movement of graduates. Of the first three cohorts to graduate the program, 34 percent have received promotions, moving into positions of higher responsibility. An additional 19 percent have transferred into a new position at the same grade. This is viewed positively as it broadens their perspective programmatically and geographically. Seven percent have left FWS, two of whom went to the U.S. Geological Survey, our sister science bureau. Again, this is viewed as a positive move for the organization and the resource.

One of the problems identified in the late 1990s was that good people were not stepping forward within the organization to compete for higher-level leadership positions. Dual career earners, a reluctance to relocate to urban centers and to step into positions of increased stress, complexity, and controversy were often anecdotally mentioned as barriers.

A competitive selection process is bringing the best and brightest into these programs. The leadership programs provide a safe mechanism for potential leaders to explore leadership and to learn more about themselves as potential leaders. Graduates say that the programs give them a better sense of what is entailed in leading at higher levels of the organization. They also say that the programs increase their confidence in their ability to perform in these positions. Finally, they say that the programs help them to recognize the need for dynamic leaders and inspire them to step forward for the good of FWS and the fish and wildlife resource.

Conclusion

Analysis of demographic retirement trends in FWS confirmed that the FWS needed to address leadership succession. Data pinpointed the leadership levels most critical to address. A comprehensive leadership competency survey of managers at various levels within the organization provided data to focus developmental efforts on the most critical leadership competencies. The involvement of FWS leaders in the design and implementation of the programs has been critical to the success of the programs. A comprehensive evaluation, including an analysis of return on investment of the SUTL program, makes it easier for senior leaders to continue to support the program in times of tight budgets. Being able to track and to demonstrate the movement of program graduates into positions of increasing or broader responsibility has addressed another need identified by FWS leadership and has also helped to solidify support for the programs.

Sound analysis of the leadership needs of the organization allow limited resources to be targeted for maximum effect. Sound instructional design enhances efficiency and effectiveness of the programs. But in the end, leaders develop leaders. The key to success is to have dedicated leaders from inside and outside the organization serve as instructors and role models in the program. It is also critical that experienced, proven leaders from within the organization serve as coaches and mentors for those in the program.

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Appendix

Leadership Competencies

Accountability. The employee assures that effective controls are developed and maintained to ensure the integrity of the organization, holds self and others accountable for rules and responsibilities, can be relied upon to ensure that projects within areas of specific responsibility are completed in a timely manner and within budget, monitors and evaluates plans, and focuses on results and measurement of outcomes.

Conflict management. The employee identifies and takes steps to prevent potential situations that could result in unpleasant confrontations, and the employee manages and resolves conflicts and disagreements in a positive and constructive manner to minimize negative impact.

Continual learning. The employee grasps the essence of new information, masters new technical and business knowledge, recognizes personal strengths and weaknesses, pursues self-development, seeks feedback and opportunities to master new knowledge from others.

Creativity and innovation. The employee develops new insights into situations, applies innovative solutions to make organizational improvements, creates a work environment that encourages creative thinking and innovation, and designs and implements new or cutting-edge programs and processes.

Customer service. The employee balances the interests of a variety of clients, readily adjusts priorities to respond to pressing and changing client demands, anticipates and meets the needs of clients, achieves quality products, and is committed to continuous improvement of services.

Decisiveness. The employee exercises good judgment by making sound and well-informed decisions, perceives the impact and implications of decisions, makes effective and timely decisions—even when data is limited or solutions produce unpleasant consequences—and is proactive and achievement oriented.

Entrepreneurship. The employee identifies opportunities to develop and to market new products and services within or outside of the organization, is willing to take risks, and initiates actions that involve a deliberate risk to achieve a recognized benefit or advantage.

External awareness. The employee identifies and keeps up to date on key national and international policies and on economic, political and social trends that affect the organization; the employee understands near-term and long-range plans and determines how best to be positioned to achieve a competitive business advantage in a global economy.

Financial management. The employee demonstrates broad understanding of principles of financial management and marketing expertise necessary to ensure appropriate funding levels; prepares, justifies and administers the budget for the program area; uses cost-benefit thinking to set priorities; monitors expenditures in support of programs and policies; identifies cost-effective approaches; and manages procurement and contracting.

Flexibility. The employee is open to change and new information; adapts behavior and work methods in response to new information, changing conditions or unexpected obstacles; and adjusts rapidly to new situations warranting attention and resolution.

Human resources management. The employee assesses current and future staffing needs based on organizational goals and budget realities and—using merit principles-—ensures staff are appropriately selected, developed, utilized, appraised and rewarded; the employee also takes corrective action.

Influencing and negotiating. The employee persuades others, builds consensus through give and take, gains cooperation from others to obtain information and to accomplish goals, and facilitates win-win situations.

Integrity and honesty. The employee instills mutual trust and confidence, creates a culture that fosters high standards of ethics, behaves in a fair and ethical manner toward others, and demonstrates a sense of corporate responsibility and commitment to public service.

Interpersonal skills. The employee considers and responds appropriately to the needs, feelings and capabilities of different people in different situations, is tactful, compassionate and sensitive, and treats others with respect.

Leveraging diversity. The employee recruits, develops and retains a diverse high-quality workforce in an equitable manner; leads and manages an inclusive workplace that maximizes the talents of each person to achieve sound business results; respects, understands, values and seeks out individual differences to achieve the vision and mission of the organization; and develops, measures and rewards to hold self and others accountable for achieving results that embody the principles of diversity.

Oral communication. The employee makes clear and convincing oral presentations to individuals or groups, listens effectively and clarifies information as needed, facilitates an open exchange of ideas, and fosters an atmosphere of open communication.

Partnering. The employee develops networks, builds alliances, engages in cross-functional activities, collaborates across boundaries, finds common ground with a widening range of stakeholders, and utilizes contacts to build and strengthen internal support bases.

Political savvy. The employee identifies the internal and external politics that impact the work of the organization, approaches each problem situation with a clear perception of organizational and political reality, and recognizes the impact of alternative courses of action.

Problem solving. The employee identifies and analyzes problems, distinguishes between relevant and irrelevant information to make logical decisions, and provides solutions to individual and organizational problems.

Resilience. The employee deals effectively with pressure, maintains focus and intensity, remains optimistic and persistent despite adversity, recovers quickly from setbacks, and effectively balances personal life and work.

Service motivation. The employee creates and sustains an organizational culture that encourages others to provide the quality of service essential to high performance, enables others to acquire the tools and support they need to perform well, shows a commitment to public service, and influences others toward a spirit of service and meaningful contributions to mission accomplishment.

Strategic thinking. The employee formulates effective strategies consistent with the business and competitive strategy of the organization in a global economy, examines policy issues and strategic planning with a long-term perspective, determines objectives and sets priorities, and anticipates potential threats or opportunities.

Team building. The employee inspires, motivates and guides others toward goal accomplishments, consistently develops and sustains cooperative working relationships, encourages and facilitates cooperation within the organization and with customer groups, fosters commitment, team spirit, pride and trust, and develops leadership in others through coaching, mentoring, rewarding and guiding employees.

Technical credibility. The employee understands and appropriately applies procedures, requirements, regulations and policies related to specialized expertise, is able to make sound hiring and capital resource decisions, addresses training and development needs, and understands linkages between administrative competencies and mission needs.

Technology management. The employee uses efficient and cost-effective approaches to integrate technology into the workplace and to improve program effectiveness, develops strategies using new technology to enhance decision making, and understands the impact of technological changes on the organization.

Vision. The employee takes a long-term view and acts as a catalyst for organizational change, builds a shared vision with others, and influences others to translate vision into action.

Written communication. The employee expresses facts and ideas in writing in a clear, convincing and organized manner.

Developing a Plan for Workforce Continuity and Leadership Succession: A Challenge for Agencies and Universities

Steve L. McMullin
Virginia Tech, Department of Fisheries and Wildlife Sciences
Blacksburg, Virginia

Ryan M. Colker
Renewable Natural Resources Foundation
Bethesda, Maryland

John R. (Rick) Lemon
U.S. Fish and Wildlife Service, National Conservation Training Center
Shepherdstown, West Virginia

David L. Trauger
Virginia Tech
Alexandria, Virginia

Billy W. DeLany, Jr.
McNeese State University,
Harold and Pearl Dripps Department of Agricultural Sciences
Lake Charles, Louisiana

Gene Stout
Gene Stout and Associates
Loveland, Colorado

Peter E. De Michele
Responsive Management
Harrisonburg, Virginia

Brian N. Kertson
University of Washington, College of Forest Resources
Seattle, Washington

The individual papers contributed by each of the authors of this paper established the serious nature of the issues facing natural resource agencies with respect to workforce continuity and future leadership. McMullin (2005) found that 46 percent of all state fish and wildlife agency personnel and 77 percent of personnel in leadership positions plan to retire by 2015. Colker (2005) found that, in the major federal natural resource agencies, more than 50 percent of senior executive service employees, 46 percent of GS-15 and 34 percent of GS-14 employees will retire between October 2000 and October 2007. Both McMullin (2005) and Colker (2005) found that natural resource agencies had top-heavy age distributions, with high percentages of older employees and much lower percentages of younger employees, compared to the civilian workforce. Trauger and Burks (2005) reported that minorities remain underrepresented in agency workforces, and pending retirements will impact adversely ethnic diversity. The increasing trend toward outsourcing of federal jobs, the hiring of contract employees to manage natural resources on federal lands that is so prevalent in the U.S. Department of Defense (Stout 2005), contributes to loss of institutional memory. Outsourcing of jobs and reduced rates of hiring due to difficult financial times during the first half of this decade have contributed to the top-heavy age distribution by reducing the number of junior employees in our natural resource agencies. Recruitment of future leaders in natural resource agencies will be difficult due to the paucity of current agency employees who are interested in moving up and are willing to relocate to headquarters offices. Apparent declines in enrollments in university natural resource programs, combined with declining interest among today's students in traditional fisheries and wildlife management may also affect recruitment of talented individuals to natural resource agencies.

This body of evidence suggests that the entire fisheries and wildlife profession needs to engage in collaborative succession planning. This succession planning should help to alleviate the effects of retiring baby boomers by more effectively recruiting talented newcomers to the profession and by training those newcomers and existing agency employees to assume positions of leadership in natural resource agencies.

In the remainder of this paper, we present recommendations for dealing with the significant personnel issues that face all natural resource agencies in the next decade. We group those recommendations by the parties that should be responsible for pursuing them—natural resource agencies and university natural resource programs.

What Should Agencies Do?

We make seven recommendations for natural resource agencies to deal with impending personnel issues. Each recommendation is accompanied by a description of potential strategies.

1. Attempt to retain much of the institutional memory that could be lost with the retirement of many senior personnel in the next decade.

   Agencies may be able to retain some of the valuable experience of retiring personnel by offering them part-time positions or status similar to an emeritus university professor. Some states already have programs in place that allow retired employees to be rehired after a break in service. The agency benefits from such programs by keeping experienced employees at reduced cost (lower salaries for part-time employees and reduced benefits). The employees benefit by augmenting retirement income and by staying engaged in the profession.

2. Develop leaders within the agencies.

   Development of leaders within agencies has three components: continuing education, mentorship and opportunities to expand the experience base of employees. Effectively managed agencies maintain a strong commitment to continuing education and personal development of employees, even during times of budgetary stress (McMullin 1993). Many well designed leadership development programs exist in government agencies, higher education and the private sector; however, their scope (audiences reached) is inadequate. Although universities can lay the groundwork for training in leadership and management, many of the concepts of leadership are better understood by students who have gained some experience in the working world, i.e., continuing education of working professionals has a greater impact on learning about leadership than formal university education. However, investing in additional formal education for current employees may be a viable means of upgrading skills. Mentoring facilitates development of new leaders by passing institutional memory and organizational norms from one generation of leaders to the next. Nearly all natural resource professionals can point to a small number of individuals who were important in their professional development. Expansion of employees' experience base may be achieved as individuals proceed through a series of positions within the agency. Relying on that approach, however, is a haphazard method of developing new skills. The most effective leadership development programs place individuals in stretch assignments, or short-term detail positions outside of their normal positions, to learn new skills that will be needed as they move up in the agency hierarchy (e.g., the U.S. Fish and Wildlife Service's Stepping Up to Leadership and Advanced Leadership Development programs, described by Lemon et al. 2005).

3. Develop innovative approaches to overcome the reluctance of agency employees to relocate for leadership positions.

If agencies are going to overcome the reluctance of many employees to move into leadership positions, they must address the key issues associated with relocation that underlie that reluctance: increased cost of living, perceived loss in quality of life and disruption of other family members' lives. Most agencies currently operate in systems where moving up in the organization also requires physical relocation of the employee. Most headquarters offices are located in major cities where the cost of living is high compared to smaller towns where field employees may be located. Increases in salary associated with promotions often are insufficient to offset the higher cost of living and most agencies have limited flexibility in adjusting salaries enough to make administrative positions more financially attractive. Likewise, agencies can do little to address perceived loss in quality of life that many employees associate with moving to larger cities. Most natural resource professionals entered the profession out of love for the outdoors, and few of them aspired to live in larger cities. Agencies may, however, be able to effectively and directly address disruption of family members' lives and, in so doing, indirectly address the cost of living and quality of life issues. Many of the staff functions that traditionally have been housed in headquarters offices could be handled by personnel located elsewhere. Through effective use of electronic communications and slightly larger travel budgets, talented employees may be encouraged to move into staff positions and to perform them from decentralized locations. Thus, employees could telecommute to most staff meetings and travel more frequently when the job demands that they be present in the headquarters office. The extra cost to agencies of enhancing communication capabilities and of paying for additional travel should be offset by the benefit of attracting more talented employees to these jobs. The obvious benefits to employees include maintaining their current residence and improving their financial status without disruption of a spouse's job and changing schools for their children.

4. Maintain or develop strategies to recruit bright, young employees.

Federal agencies have traditionally been more aggressive about recruiting new employees than state agencies. Internship programs, such as the federal government's Student Career and Experience Program (SCEP) have allowed federal agencies to compete more effectively than state agencies for bright, young students and to increase the diversity of their workforces. If state agencies wish to be competitive in attracting the best and brightest of students, they must also offer internships that offer students a chance to experience life in a state agency and to gain an edge in potential future employment. Just as the federal agencies have done, state agencies could use these internships as a means of diversifying their workforces. Internships that target students early in their college careers probably would be more effective in "capturing" students, as many students go on to work for organizations where they gained early experience in the field.

5. Maintain or strengthen ties with university programs to develop future employees with desired knowledge, skills and abilities.

University fisheries and wildlife programs and management agencies should collaborate closely to develop future fish and wildlife professionals. For example, the Utah Division of Wildlife Resources (UDWR) collaborates with Utah State University, the Utah Cooperative Fish and Wildlife Research Unit, and Brigham Young University to recruit bright, young students at both the undergraduate and graduate levels (Allan Clark, Utah Division of Wildlife Resources, Salt Lake City, UT, personal communication 2005). The UDWR cooperates with Utah State University to offer guaranteed summer internships to students selected for specially designated scholarships. The university uses the scholarships and the associated guaranteed jobs to recruit high school students. The UDWR assigns selected employees to mentor the interns through successively more complex jobs throughout the student's undergraduate career. At the graduate level, the UDWR offers one half-time paid position to an outstanding graduating senior. The position is in addition to a funded assistantship and research project that supports a graduate degree for the student. As with the undergraduate internship program, the graduate student is assigned to an employee mentor. Although the agency is not able to guarantee a permanent position upon completion of the graduate degree program, the goal of the program is to hire those students. The UDWR also promotes collaboration between the agency and universities by increasing agency commitment to presenting seminars and lectures at universities and in hosting field days designed to increase students' awareness of the agency and its employment opportunities. This far sighted approach by the UDWR costs only a fraction of 1 percent of the agency's budget, and it increases the likelihood that some of the best students coming out of Utah universities will work for the UDWR. Agencies that opt for reducing expenditures at universities during difficult economic times place themselves at risk of losing the connection that will provide their future employees. University faculty members are largely dependent on contract funding for support of their research programs. If management agencies do not provide that funding, faculty members will get it elsewhere; consequently, they will produce graduate students who are less likely to be interested in management agency jobs.

6. Define key positions as government-in-nature.

The trend toward outsourcing government functions will almost surely continue. The key to successfully managing natural resources on government lands will be in protecting professional management positions by defining them as "government-in-nature," by developing productive relationships between government employees and contractors, and by using contractors for appropriate tasks. Professional managers should be government employees because they have significant public trust responsibilities that should not be delegated to contract employees (including oversight of contractors to ensure that they do high quality work). Productive relationships between government employees and contract employees are more likely to develop when the two types of employees are nearly indistinguishable. Contractors are best suited to performing clearly defined tasks or those tasks that require expertise not found in the government workforce, rather than policy-level decisions or professional decisions that are required to manage natural resources.

7. Make effective use of volunteers.

   Volunteers can augment agency workforces for some carefully chosen tasks. Tasks that require substantial technical expertise may not be well suited to volunteer workforces unless the agency is willing to commit substantial resources to training and monitoring of performance. Nevertheless, volunteers with varying amounts of expertise may be found among retired natural resource professionals and in organizations related to the natural resources (e.g., birding clubs). Kertson et al. (2005) suggested that quality control guidelines are especially important if volunteers will be involved in collecting data.

What Should Universities Do?

Universities also play a critical role in recruiting and preparing future natural resource professionals. We offer three recommendations and associated strategies for universities who wish to contribute to addressing the personnel issue.

1. Increase awareness among high school students and undecided underclassmen of fisheries and wildlife as fields of study and possible careers.

   Fisheries and wildlife programs tend to be small in comparison to biology programs on most university campuses and a surprisingly large number of students who might otherwise be interested in fisheries and wildlife are unaware that such programs exist. While outreach to high schools is an obvious strategy to increase awareness of entering students, fisheries and wildlife programs should not ignore outreach within their own university campuses (e.g., major fairs for undecided students, collaboration with other life sciences to fully inform entering students of the range of choices available to them). Greater outreach to minority populations should also be a high priority for colleges and universities (Trauger and Burks 2005).
2. Improve students' awareness of career tracks in fisheries and wildlife. Once students are enrolled in fisheries and wildlife programs, a surprising number of them remain blissfully unaware of the variety of potential

career tracks available to them. In many cases, they are unaware of how a fisheries or wildlife biologist's job in the U.S. Fish and Wildlife Service differs from one in the U.S. Department of Agriculture, Forest Service or a state fish and wildlife agency. University faculty, through a combination of classes and advising, should strive to improve students' understanding of how these agencies and the jobs they offer differ. This information should be placed in a larger context of the roles of fisheries and wildlife professionals in nongovernmental organizations and educational institutions as well as management agencies. The information presented by McMullin (2005) and Colker (2005) regarding the demographics of retirement (and presumably, high demand for fisheries and wildlife professionals in management agencies) should be persuasive to career-oriented students.

3. Maintain or increase the focus on human dimensions and communications aspects of the management of fisheries and wildlife.

It is a rare conversation between a fish and wildlife agency professional and an academician that includes no mention of the need for improving the people skills and communication skills of graduates entering the profession. Although more attention is being paid to the human dimension of natural resource management in today's university curricula, the social, political and economic aspects of resource management usually are treated as minor components of the overall curriculum. This is particularly true at the graduate level. Despite the need for greater specialization at the graduate level, no student should leave our university programs without at least one class that focuses primarily on the human dimension of natural resource conservation. Effective communication skills will always be important to natural resource professionals. As DeLany (2005) suggested, those skills should be integrated throughout undergraduate curricula and honed at the graduate level. Communication skills should address the wide variety of methods by which present and future natural resource professionals will convey information to each other and to their stakeholders. This includes writing for professional and nonprofessional audiences, speaking to a variety of audiences, and using the ever changing variety of electronic means of communication.

Conclusions

Although there is room for debate regarding whether or not the natural resource professions face a personnel crisis, there should be no doubt about the need to prepare for a changing of the guard in our management agencies. Nearly every agency's workforce has a top-heavy age distribution consisting largely of white males. Between one-half and three-quarters of those personnel, depending on which demographic group is the focus of analysis, will retire in the next ten years—many of them from positions of senior leadership. Agencies, universities, nongovernmental organizations and the private sector all have a stake in addressing this issue. The time to start is now. The recommendations we present here should be just a beginning in a continuing discussion—and action—to prepare our natural resource institutions for the future.

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Session Two.
The Sage-grouse Dilemma: A Case Study of Long-term Landscape Use and Abuse

Chair
Rollin D. Sparrowe
Daniel, Wyoming

Cochair
Len H. Carpenter
Wildlife Management Institute
Fort Collins, Colorado

Climate Change Implications for Sagebrush Ecosystems

Ronald P. Neilson
U.S. Department of Agriculture, Forest Service
Corvallis, Oregon

James M. Lenihan
U.S. Department of Agriculture, Forest Service
Corvallis, Oregon

Dominique Bachelet
Oregon State University, Department of Bioengineering
Corvallis, Oregon

Raymond J. Drapek
U.S. Department of Agriculture, Forest Service
Corvallis, Oregon

Introduction

The sagebrush biome in the Great Basin of the western United States is among the three largest in the country (approximately 243,000 square miles [630,000 km^2]), comparable to the Great Plains and the eastern deciduous forest (Barbour and Billings 1988). However, the area has recently been reevaluated to 66,000 square miles (430,000 km^2)(Miller and Eddleman 2000, Wisdom et al. 2005). There are several defining climatic features of the sagebrush ecosystem that are vulnerable to change under rapid climate change. The system is continental, being very hot in the summer and subject to recurrent hard frost every winter. It is "Mediterranean," being wet in the winter and dry in the summer but remains a generally semiarid ecosystem. One of the more fascinating features of the Great Basin is its relative flatness, being around 4,000 feet (ca. 1,200 m) in elevation, punctuated by numerous north-south mountain ranges. As a consequence of the cold, Mediterranean climate, the plants tend to be very frost tolerant and dependent on deep soil water, recharged from winter precipitation, to supply their summer transpiration demands. The natural perennial grasses flourish in the spring but struggle through the long, dry summer and support a relatively meager fire regime. Frequent fires take out the vulnerable shrubs, as is apparent under the rapidly invading annual cheatgrass, which increases the fire frequency.

The cold-temperate sagebrush ecosystem is immediately bounded on the south by the hot, southwest deserts. There is about a 2,000-foot (600-m) scarp separating the higher Great Basin from the much warmer southwest deserts. Thus, much of the vegetation in the Southwest is extremely frost sensitive and supports a high diversity of cacti, as well as frost-sensitive evergreen broadleaf trees and shrubs and many other plant groups. The frost line separating these two broad biomes, hot and cold semideserts, is currently locked on the steep elevational scarp separating the two biomes. Two of the three southwest deserts, the Chihuahuan and Sonoran, also differ from the Great Basin by virtue of a well-defined midsummer rainfall regime, the Arizona monsoon, which can supply as much as 40 percent of the annual precipitation. During the middle Holocene thermal maximum, perhaps 4,000 to 6,000 years ago, much of this hot-desert diversity must have penetrated into the Great Basin, as indicated by the 250- mile (400-km) northward advance of at least one frost-sensitive species, shrub live oak (*Quercus turbinella*), implying a northward march of both the frost line and the summer rainfall regime (Cottam et al. 1959, Neilson and Wullstein 1983). This suggests things to come.

Another prominent feature in the sagebrush ecosystem is the widespread range expansion and in-filling of woody species, primarily pinion-juniper and ponderosa pine over the past several decades. It is widely accepted that this woody expansion is largely due to both fire suppression and fire exclusion via grazing of fine fuels. We hope to demonstrate that climate variability has also contributed to this woody expansion and that it may well continue into the future, regardless of the best intentions to reduce inland fuel loads. So, the sagebrush ecosystem is currently under threat of reduction in size from two immediate sources, invasion of nonnative annual grasses (possibly as much as 25% of its area, [West 2000]), altering the fire cycle, and expansion of native woody species. We will suggest that climate change could add a third dimension to the risk of a waning sagebrush ecosystem and that it could occur rapidly. We will also suggest, through process-based modeling, that there are synergistic interactions among these various stressors.

There is also a certain irony with respect to two large-scale policy concerns within the United States. On the one hand, we wish to reduce fuel loads in the West in order to reduce the risk of catastrophic fire and to restore natural ecosystems. On the other hand, we wish to foster the sequestration (storage) of large amounts of carbon in natural ecosystems as an offset to carbon dioxide emissions from fossil fuel combustion. It has been estimated that the United States is currently sequestering about 0.3 petagram of carbon per year in ecosystems and that fully a third to a half of that is going into the expansion of woody vegetation in the western United States (Hurtt et al. 2002). How can these two policy streams be reconciled, reducing fuels (and hence carbon) while increasing carbon storage in general?

Most of the following discussion regarding the ecological impacts of climate change on the sagebrush ecosystem is based on simulations, which were published in Bachelet et al. (2001) and which were produced for the recent U.S. national assessment of the impacts of global warming (National Assessment Synthesis Team 2000). However, for ease of presentation, the discussion in Bachelet et al. was simplified to a small number of highly aggregated ecosystem classes, even though the ecosystem models actually simulate a larger number of vegetation types. For the current purpose, we have gone back to the original simulations and reanalyzed some of the output using the full suite of vegetation types that were simulated. Since the many vegetation maps do not readily translate to a noncolor gray-scale, the reader is referred to Bachelet et al. for a visual presentation of all the future climate vegetation simulations (aggregated classification), as well as a listing of the various vegetation types simulated by the models.

Simulating Vegetation Change under Climate Change

Vegetation Models

The Mapped Atmospheric-Plant-Soil System (MAPSS) Team uses two different process-based models to forecast possible changes to ecosystems under rapid climate change: MAPSS, a steady-state vegetation distribution model (biogeography) and MC1, a dynamic general vegetation model (DGVM).

MAPSS is a model that was developed to simulate the potential natural vegetation that could exist on any upland site in the world under present, past or future climate (Neilson 1995). It is an equilibrium, or steady-state biogeography model. That is, it simulates the distribution of vegetation under any average climate but does not simulate the dynamics of change from one average climate to another. MAPSS operates on the fundamental principle that ecosystems will tend to maximize the leaf area that can be supported at a site by available soil moisture or energy. MAPSS is fully integrated with a continentally-calibrated hydrologic model, linking hydrologic and vegetation processes, and it has been validated over the globe (Neilson et al. 1998). The model calculates the leaf area index (LAI) of both woody and grass life forms (trees or shrubs, but not both) in competition for both light and water while maintaining a site water balance consistent with observed runoff. Water in the surface soil layer is apportioned to the two life forms in relation to their relative LAIs and stomatal conductance, i.e. canopy conductance, while woody vegetation alone has access to deeper soil water. Biomes are not explicitly simulated in MAPSS; rather, the model simulates the distribution of vegetation lifeforms (trees, shrubs, grass), the dominant leaf form (broadleaf, needleleaf), leaf phenology (evergreen, deciduous), thermal tolerances and vegetation density (LAI). These characteristics are then combined into a vegetation classification consistent with the biome level. MAPSS currently simulates 45 unique vegetation types in the conterminous United States, weighted more toward the semiarid, savanna, shrubland, grassland and desert ecosystems. The MAPSS simulation of the sagebrush biome area (approximately 290,000 miles [760,000 km^2]) is closer to the Barbour and Billings (1988) estimate, but the model does not distinguish sagebrush from the widespread salt desert vegetation that populates much of the low-lying areas within the Great Basin.

The DGVM, MC1 (MAPSS-CENTURY, Version 1), is the integration of the MAPSS biogeography model and the CENTURY biogeochemistry model into a new dynamic vegetation model (Daly et al. 2000). Significant changes resulted from this model integration, such as new biogeography rules, changes in the parameterization of CENTURY, use of the simplified CENTURY hydrology (as opposed to the MAPSS hydrology) and a new dynamic fire module developed to simulate the occurrence and impacts of fire events that are relatively infrequent but extreme. The model simulates dynamic vegetation distribution, structure and functional change over continental scales at a monthly time step using climate time series from decades to centuries in length (Daly et al. 2000).

The main functions of the biogeography module are: (1) to predict the composition of deciduous/evergreen trees or shrubs and of C3/C4 grass life form mixtures and (2) to classify the predicted biomass from the biogeochemistry module into different vegetation classes. MC1 currently simulates 22 unique vegetation types.

The biogeochemistry module simulates monthly carbon and nutrient dynamics for a given ecosystem. Above- and below-ground processes are modeled in detail and include plant production, soil organic matter decomposition, and water and nutrient cycling. Parameterization of this module is based on the lifeform composition of the ecosystems, which is updated annually by the biogeography module.

The fire module simulates the occurrence, behavior and effects of severe fire. Allometric equations, keyed to the lifeform composition supplied by the biogeography module, are used to convert above-ground biomass to fuel classes. Fire effects (i.e., plant mortality and live and dead biomass consumption) are estimated as functions of simulated fire behavior (i.e., fire spread and fire line intensity) and vegetation structure. Fire effects feed back to the biogeochemistry module to adjust levels of various carbon and nutrient pools.

Future Climate Scenarios

Seven future climate scenarios generated by general circulation models (GCMs) were used by MAPSS at 10-by-10-kilometer resolution (hereafter 10 km) over the conterminous United States (Kittel et al. 1995, Bachelet et al. 2001), and two of them were used by MC1 and MAPSS at a 0.5-degree latitude/ longitude (approximately 50-by-50-kilometer) resolution. Fine scale features of the climate, related to topographic effects, are better represented in the higher resolution (10 km) datasets and the larger number of equilibrium scenarios provides a greater context to assess possible future changes. However, there are currently no 10-kilometer transient climate datasets.

The scenarios span a range of about 5 to 12 degrees Fahrenheit (2.8-6.6°C) in projected average annual temperature increase over the conterminous United States near the end of the 21st century. Four are equilibrium scenarios (GFDL-R30, GISS, UKMO, OSU) which were included in the first assessment report of the Intergovernmental Panel on Climate Change (IPCC) (Cubasch and Cess 1990). They include a single layered ocean and assume an instantaneous doubling of carbon dioxide. Three scenarios are transient and were included in the second assessment report of the IPCC (Gates et al. 1996). Two transient scenarios come from the Hadley Climate Center (HADCM2GHG and HADCM2SUL, the latter of which includes effects of sulfate aerosols), and one comes from the Canadian Climate Center (CGCM1, also including aerosols). Transient GCMs include a fully dynamic, three-dimensional ocean, and they are run from the 1800s to the present, using observed carbon dioxide increases, and into the future, using IPCC projections of future greenhouse gas concentrations (IS92a, Kattenberg et al. 1996). The last 30 years of the three transient scenarios were averaged to be treated as equilibrium scenarios by the biogeography model, MAPSS. However, the transient scenarios were clearly not at equilibrium, having attained only about half to two-thirds of their eventual temperature change, due to thermal inertia of the oceans (Gates et al. 1996). Only HADCM2SUL and CGCM1 were used to run MC1.

Mechanisms of Change in the Great Basin under Climate Change

The future climate scenarios show two prominent features in the West: increases in temperature, hence a decrease in frosts, as well as increases in precipitation (Bachelet et al. 2001). The increases in precipitation produce a dramatic increase in woody expansion, at the expense of shrubland, throughout much of the interior West, and a corresponding increase in fire, due to the increased fuel load. Apart from the increases in fire, woody expansion still occurs in the future scenarios, because fire does not occur everywhere or all the time and because sufficient fire-free intervals would exist for new woody establishment. The expanded woody vegetation would enhance carbon sequestration but would also challenge our management community to structure ecosystems so as to diminish the risk of fire in the wildland-urban interface (itself expanding rapidly).

However, the West is currently in a massive drought, so how does one reconcile the future scenarios of increased precipitation with the current drought? The answer lies in interannual and interdecadal climate variability. The well-known El Niño-La Niña cycles produce much of the interannual climate variability, but there are also oceanic interdecadal oscillations, such as the Pacific Decadal Oscillation (PDO), the Arctic Oscillation (AO) and the North Atlantic Oscillation (NAO) (Hurrell 1995, Thompson and Wallace 1998, Mantua and Hare 2002). These interannual and interdecadal patterns of climate variability can produce droughts or floods in the near term, even though the longer-term climate may produce a wetter trend. For example, the Canadian model future climate scenario (CGCM1) produces a 22-percent increase in precipitation over the conterminous United States by the end of the 21st century but ironically produces a 4-percent decline in precipitation by mid-21st century via three decadal-length droughts. Thus, while changes in greenhouse gas forcing may drive a long-term trend, internal ocean-atmosphere oscillations provide a large degree of variability about that trend.

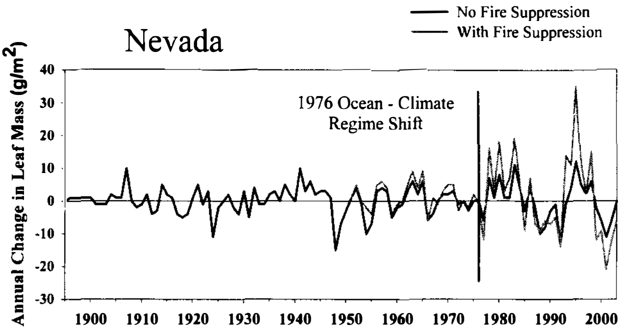
The importance of interdecadal climate variability to Great Basin ecosystem dynamics is quite apparent in a simulation of fire and vegetation dynamics using the MC1 model over the past 100 years. A simulation of leaf mass, a very sensitive indicator of ecosystem processes, averaged over all of Nevada (Figure 1), shows a modest amount of variability until the mid-1970s. However, beginning then, leaf mass is simulated to go through two massive wet-dry cycles. The wet periods are associated with the 1983 and 1998 El Niños with intervening droughts. The leaf mass oscillations increase during these latter cycles. This shift in ecosystem dynamics in the mid-1970s has been related to interdecadal climate variability, specifically a shift in the PDO (Swetnam and Betancourt 1998). Another PDO ocean-climate regime shift had profound effects on interior ecosystems. Notably a shift in the 1940s ended the 1930s drought, produced a favorable climate for expansion of woody vegetation in the West and corresponded with a large increase in the effectiveness of fire suppression. The extreme amplitude in wet-dry cycles since the PDO shift in the 1970s followed a period between the 1940s and 1970s of very low amplitude climate variability, further assisting the expansion of woody vegetation. Grazing reduced competition from grass, thus enhancing the expansion of woody vegetation.

The MC1 model has also been used with fire suppression, whereby only one-eighth of the area that would be simulated to burn is actually allowed to burn. The amount of reduction is based on comparisons of empirical observations to the MC1 simulations where fire is not excluded or reduced. In the absence of fire suppression, the MC1 model accurately simulates fire area over the United States. in the 1920s, 1930s and 1940s. But, after World War II, increases in manpower and equipment vastly improved the effectiveness of fire suppression, resulting in the model-data comparison that suggests we are effective in suppressing about seven-eighths of potential fire area (J. M. Lenihan, unpublished simulation results 2005).

The effect of fire suppression on the Nevada ecosystems is that biomass, notably leaf mass, is then allowed to grow to its water-limited carrying capacity (Figure 1). A fundamental premise used in all large-scale, process-based, biogeographic modeling is that ecosystems will continue to grow until they reach a limiting factor, usually water in temperate regions. Fire naturally keeps the biomass below that water-based carrying capacity, conferring some protection from interannual wet-dry variability. However, in the absence of fire, in the Nevada simulation, the ecosystems (and leaves) grow to larger than normal amounts during the wet periods, rendering them more vulnerable to dieback or decline during the following dry periods because so many leaves transpire too much water (Washington-Allen et al. 2004). The increased amplitude of the leaf mass variation with fire suppression is quite evident in the simulation. Notably, there is currently a massive dieback of woody vegetation occurring throughout much of the Great Basin today (Whitham 2005). Apparently much of the dieback of pinion pines in the pinion-juniper ecosystem in Arizona is due to a beetle infestation, enhanced by the drought (ibid.).

If, as hypothesized by many climate scientists, climate variability increases under rapid global warming, then such wet-dry cycles could interact synergistically with fire, insects, diseases and possibly invasive species to further stress the sagebrush ecosystem.

Figure 1. The temporal variability of leaf mass, averaged over all of Nevada, was simulated by the MC1 dynamic general vegetation model. Simulated leaf mass variability is relatively low from 1895 to about 1976, when there was a major ocean-climate regime shift in the Pacific Decadal Oscillation (see discussion in text). After 1976 the region experienced two major wet-dry cycles, noted as large increases and losses in leaf mass. The MC1 simulations demonstrate the synergistic effects of fire suppression and climate variability on leaf mass. In the absence of fire, the ecosystems rapidly seek their water-limited carrying capacity of leaves. In the wet years, leaf mass increases, which withdraws more soil water than would be transpired if fire had been present and had kept leaf mass in check. The high leaf mass increases the sensitivity of the ecosystem to interannual variability of moisture, resulting in a much larger loss or dieback of leaves (and whole plants) during the following dry years. Thus, the presence of a natural fire regime enhances the resilience of the ecosystem to natural climate variability.



Nevertheless, the uncertainties inherent in future precipitation forecasts must be emphasized. Although the seven future climate scenarios previously examined produced increased precipitation in the 21st century over the western United States, newer scenarios are always being created using improved global climate models and the regional precipitation patterns can vary among these scenarios.

Future Invasion of the Great Basin by Other North American Species

Temperature increases in the Great Basin over the next century carry much more certainty than do precipitation increases. The primary uncertainties regarding temperature are the magnitude and timing of the increases and the effects such increases will have on frequency and intensity of annual frosts.

The MAPSS simulations show a large migration of frost-sensitive vegetation into the Great Basin under all future warming scenarios. Much of the advance is in the form of woody vegetation types, such as xeromorphic subtropical shrubland, a physiognomic depiction of the same kind of vegetation typified by the sclerophyllous shrub live oak that migrated 250 miles (400 km) north during the middle-Holocene thermal maximum (Cottam et al. 1959). As these different kinds of vegetation move into the Great Basin, they displace large areas of sagebrush. We have plotted the area of sagebrush in the West, as simulated by MAPSS under current and all seven future climate scenarios as a function of the GCM's simulated increase in temperature over the conterminous United States (Figure 2). The area of sagebrush simulated at zero temperature change represents the current climate. There is a statistically significant loss of sagebrush area forecast as a function of increasing temperature at a loss rate of about 18,700 square miles per degree Fahrenheit (87,000 km²/°C), or about 12 percent of the present area per degree of temperature increase ($P < 0.01$, where P equals significance level). Under the worst-case scenario (hottest), the area of sagebrush would be reduced to about 20 percent of its current area.

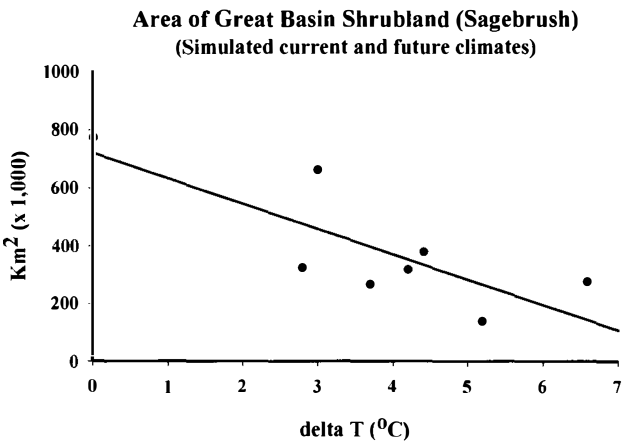


Figure 2. The area of the sagebrush ecosystem is simulated by the MAPSS vegetation distribution model under current climate and seven future climate scenarios, as a function of the temperature change produced by those scenarios over the entire conterminous United States. The area simulated under zero temperature change is the current climate simulation. There is a statistically significant decline in the area of the sagebrush biome due to encroachment of vegetation from southern ecosystems ($r^2 = 0.62$ [where r represents correlation], $P < 0.001$). The sagebrush biome is very frost tolerant and is separated from the southern frost-intolerant ecosystems by a frost line that is currently positioned on the 2,000-foot (600-m) scarp that separates the Great Basin from the southwest deserts. Under global warming, the frost line shifts over the scarp and moves rapidly to the north, opening a window for invasion by southern frost-intolerant vegetation.

The cause of the reduced sagebrush area under increasing temperature is clearly the shift of the frost line over the topographic scarp and its rapid march north through the relatively flat Great Basin terrain. None of the scenarios agree on the precise location or type of vegetation that would displace the sagebrush, largely due to differences in the simulated future precipitation regimes. However, the tendency of displacement from south to north is readily apparent by overlaying all seven of the simulated future distributions of the sagebrush biome, along with the current climate, and by displaying for each location (10 km gridcell) the number of simulations that agree on the occurrence of sagebrush (Figure 3). For

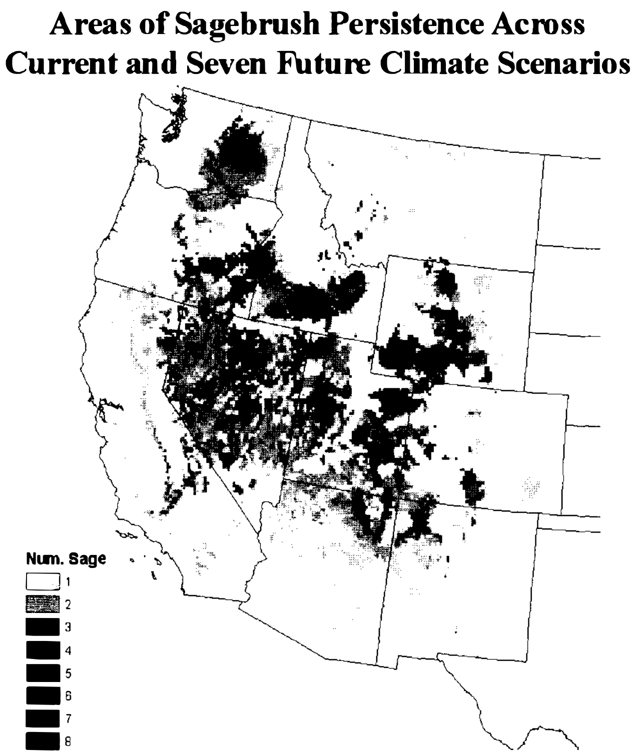


Figure 3. The locations that are simulated to remain sagebrush under each of the seven future scenarios and the current climate are tallied for each site. Those sites which show only one simulation with sagebrush are generally in the southern reaches of the distribution and represent simulations of sagebrush under the current climate that do not remain sagebrush under any future climate simulation. Those sites that show eight simulations with sagebrush are generally in the northern parts of the range and are essentially refuge areas that are simulated to hold sagebrush under the current climate and all seven future scenarios.

example, the areas showing only one simulation are generally the areas simulated to contain sagebrush under the current climate, but they do not support sagebrush under any of the future climates and these tend to be along the southern edges. At the other extreme, those areas showing agreement among eight simulations are where sagebrush is simulated to occur under the current climate and all seven of the possible future climates, and these areas tend to occur along the northern edges. Thus, there are only a few small areas in the Great Basin where sagebrush is simulated to persist under both current and all future climate simulations. The largest is in southern Wyoming in the gap between the northern and central Rocky Mountains, followed by areas along the northern edge of the Snake River Plateau and small areas in Washington, Oregon and Nevada. The model does not differentiate sagebrush from salt-desert vegetation that occupies some of the core basin areas and thus simulates a bit too much sagebrush. The area south of the Uinta Mountains in Utah, which is favored for continued support of sagebrush, may be one such area.

There is some uncertainty about future precipitation changes in the Great Basin. Most of the scenarios show an increase; however, some do show decreases. If there is an increase in precipitation, along with an increase in temperature, then woodland lower elevational boundaries may move down the mountains and out into the sagebrush, displacing the shrubland. A variety of frost-sensitive woodland species from the warmer Southwest will also likely invade but with migrational lags. However, if precipitation decreases along with warming, then elevational woodland ecotones may go up the mountainsides, but frost-sensitive desert shrubs and other southwest species will still likely move into the sagebrush, again displacing the existing shrubland but also with migrational lags. So, the southern reaches of sagebrush appear to be at some risk under most circumstances.

The rate of change or displacement of sagebrush would likely follow three different stages, each with longer time lags. The first change would be physiognomic within the existing community. For example, if moisture conditions were to dramatically improve, sagebrush has the capability to grow to heights of at least two meters, as it currently does in areas on the eastern toe-slope of the Steens Mountain in southeastern Oregon. Secondly, nearby, but perhaps subdominant species might become more dominant and might begin displacing the existing species. The current encroachment of woodlands into the sagebrush may be an example of that. Lastly, the migration of new species from other areas, such as the southwest deserts would require seed dispersal over long distances, establishment and growth in order to displace the sagebrush. This last process could require decades to centuries.

It should also be mentioned that increases in carbon dioxide are the most certain effects of the industrial revolution and that elevated carbon dioxide will directly affect the ability of different plants to invade and to alter sagebrush ecosystems. Most notably, invasive grasses, such as brome (*Bromus* spp.), are favored under elevated carbon dioxide concentrations (Smith et al. 2000).

Conclusions

Sagebrush vegetation in the Great Basin is already at risk of decline in area due to invasive species, notably cheatgrass, and the encroachment of other woody vegetation. Some of the encroachment may be the result of synergistic interactions between fire suppression and climate variability, whereby the suppression allowed a favorable period of climate to be expressed in woody expansion. Future climate scenarios tend to show continued woody expansion due to increased precipitation, given that there may be decadal-length periods of drought intervening. The greater amount of vegetation forecast for the Great Basin also portends more fire, which could augment the shift from shrubland to grassland. Interestingly, the greater vegetation amount would support a U.S. policy of carbon sequestration in ecosystems, even given the greater risk of fires.

The almost certain increases in temperature could have a long-term impact on the species composition and would further displace the sagebrush. The temperature increase is likely to move a frost line over the elevational scarp separating the Southwest and Great Basin regions and move the line rapidly north. The frost line separates the frost-sensitive vegetation in the southwest deserts from the frost-tolerant vegetation in the Great Basin. There would be lags in the response, but many southwest species could move hundreds of miles into the Great Basin, displacing the sagebrush. Thus, there could be major changes ahead for the Great Basin. On the one hand, they may cause reductions or extinctions of many extant species. On the other hand, these changes may also result in a much higher species diversity of a very different character within the Great Basin.

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Greater Sage-grouse Population Response to Natural Gas Development in Western Wyoming: Are Regional Populations Affected by Relatively Localized Disturbances?

Matthew J. Holloran
Wyoming Cooperative Fish and Wildlife Research Unit
Laramie, Wyoming

Stanley H. Anderson
Wyoming Cooperative Fish and Wildlife Research Unit
Laramie, Wyoming

Introduction

Current sage-grouse (*Centrocercus* spp.) breeding populations throughout western North America are approximately two to three times lower than those during the late 1960s, and populations have declined 2 percent annually from 1965 to 2003 (Connelly et al. 2004). In 2000, greater sage-grouse (*Centrocercus urophasianus*) occupied 56 percent of their pre-European settlement distribution (Schroeder et al. 2004). Throughout Wyoming since 1965, greater sage-grouse populations have declined 5.2 percent annually, and the average number of males per lek has declined 49 percent (Connelly et al. 2004). Although no single factor has been responsible for sage-grouse population declines, the discovery and subsequent development of gas and oil fields throughout the western United States beginning in the 1930s and 1940s has been identified as one potential causative agent (Braun 1987, Connelly et al. 2004). Generally, gregarious (e.g., sage-grouse during the breeding season) and hunted species are more severely affected by land-use disturbances than are solitary and unhunted species (PRISM Environmental Management Consultants 1982). Additionally, Braun et al. (2002) indicate that a review of available information suggests that all sagebrush obligate species are negatively influenced by habitat alterations resulting in sagebrush (*Artemesia* spp.) removal and reduced shrub patch size.

Potential impacts of gas and oil development to sage-grouse include direct habitat loss and fragmentation from well, road and pipeline construction and from increased human activity causing the displacement of individuals through avoidance behavior. In addition, these impacts may vary through time in that development may negatively influence sage-grouse populations over the short term (site preparation and drilling), long term (road development and producing well maintenance) and permanently (processing facilities and pumping stations; Braun 1987). Braun et al. (2002) suggested that greater sage-grouse leks within 0.25 miles (0.4 km) of coalbed methane wells in Wyoming had significantly fewer males per lek and lower annual rates of population growth, compared to less disturbed leks. Additionally, the extirpation of three different lek complexes within 220 yards (0.2 km) of oil field infrastructure in Alberta, Canada, was associated with the arrival of oil-field-related disturbance sources (Braun et al. 2002).

Coal-mining activity and oil-field development in North Park, Colorado, resulted in decreased greater sage-grouse lek attendance on leks within 1.2 miles (2 km) of development activities relative to leks located more than 1.2 miles (2 km) from these activities (Braun 1986, 1987; Remington and Braun 1991). Braun (1986) attributed declines to decreased recruitment of juvenile males (i.e., first-year breeders). Failure to recruit juvenile males could have resulted from juvenile male dispersal to different lek sites, from poor nesting success or decreased survival of young resulting in fewer available replacement juveniles, or from acoustical or physical factors that deterred juveniles from becoming established (Schoenburg and Braun 1982; Braun 1986, 1987). Although Remington and Braun (1991) indicated that leks closely associated with mining activity declined relative to control leks, overall greater sage-grouse population trends in the area did not change, suggesting that the distribution rather than the number of breeding grouse was altered.

Greater sage-grouse females disturbed on leks during the breeding season by natural gas field-related activity in western Wyoming exhibited lower nest initiation rates, and those that initiated a nest selected nesting habitats farther from the lek, compared to females breeding on undisturbed leks (Lyon and Anderson 2003). Reduced initiation rates, when combined with inherently low probabilities of reproductive success in sage-grouse (Connelly and Braun 1997), could potentially lower annual productivity rates below sustainable levels. Additionally, if leks are located within or adjacent to potential nesting habitat (Connelly et al. 2000) and gas-field-related activities result in females nesting farther from leks, then these impacted females may use suboptimal nesting sites and thus experience lower nest success. Further, sage-grouse lekking behavior, combined with annual nest site fidelity potentially passed to female offspring (Lyon 2000), could result in relatively clumped nest distributions on a landscape scale. As a result, isolated habitat alterations could impact a relatively large number of nesting individuals.

If declines in the number of males on disturbed leks can be attributed to decreased juvenile male recruitment, what happens to these juvenile males? Remington and Braun (1991) theorize that they disperse to different lek sites. However, Lyon and Anderson's (2003) observation suggest decreased productivity resulting in fewer available replacement juveniles. This paper investigates the response of greater sage-grouse populations to natural gas development in western Wyoming. We examine changes in the number of males on leks relative to the level of activity occurring around those leks, and we use these relative changes to ascertain how individual birds and regional populations might be influenced by natural gas field development.

Greater Sage-grouse Population Response to Gas Development in Western Wyoming

We investigated the potential impacts of gas-field development on greater sage-grouse populations on a study area designated by 3.1-mile (5-km) buffers around known leks in the upper Green River Basin, near the town of Pinedale in western Wyoming. The study area was located primarily within the boundaries of the Pinedale Anticline Project Area (PAPA), but it included portions of the Jonah I and Jonah II gas fields (U.S. Bureau of Land Management 2000). The study area encompassed approximately 421 square miles (1,090 km^2), and it was dominated by big sagebrush *(Artemesia tridentata* spp.) and high-desert vegetation. The first natural gas well was drilled in the PAPA in 1939, but only 23 additional wells had been drilled in the project area by 1997. In May 1998, the U.S. Bureau of Land Management (BLM) approved limited exploratory drilling of 45 wells prior to completion of the environmental impact statement (EIS). The final EIS was approved in July 2000. Full development of the field is expected to continue for the next 10 to 15 years and be concentrated within a 3.1-mile (5-km) buffer around the anticline crest. However, areas designated as "hot spots" outside the buffer may also be developed as the BLM has leased all but 7.3 square miles (19 km^2) of the PAPA (total area approximately 313 square miles [810 km^2]) for potential development. The BLM's record of decision approved the construction of 700 producing well pads with minimum spacing of 40 acres (16 ha) between pads (equivalent to 16 wells per section; U.S. Bureau of Land Management 2000). In the spring of 1999, approximately 75 producing gas wells were situated within the designated study area. By the summer of 2004, the study area contained approximately 450 producing wells.

One of the primary objectives of this study was to determine if increased levels of gas-field development near known greater sage-grouse leks influenced breeding behavior. We categorized each lek based on the total number of producing gas wells located within 3.1 miles (5 km) of the lek (i.e., because gas field development continued through the project, the number of producing wells for each let year was a unique value (n), and we considered leks with less than 5 wells to be controls (minimal gas field-related disturbance; n = 49 lek years), leks with 5 to 15 wells to be lightly impacted (n = 19 lek years) and leks with more than 15 wells to be heavily impacted (n = 31 lek years, where n). We assessed lek attendance as the annual maximum number of males estimated through lek counts (Connelly et al. 2003). Gas-development influences on breeding greater sage-grouse were estimated by calculating either the total change in the maximum number of males attending all leks within a given impact status from the year prior to impact through 2004 or by calculating average annual change in the maximum number of males by lek impact status. In certain instances the impact status of individual leks changed as the field developed (i.e., from lightly to heavily impacted). We calculated overall change in the number of attending males by impact status for these leks using lek counts from the year prior to impact status change.

The total maximum number of males declined 51 percent on heavily impacted leks from the year prior to impact to 2004 (control leks declined 3% during the same time period). Further, the total maximum number of males on three heavily impacted leks situated centrally within the developing field declined 89 percent, and two of the three leks were essentially inactive in 2004 (one male counted on one of the leks on one morning in 2004). Additional anecdotal evidence from southern and western Wyoming has also indicated that leks historically situated within areas developed for natural gas extraction became inactive as well densities increased (Jonah gas fields, K. J. Andrews, personal communication 2001; Great Divide Basin gas fields, G. S. Hiatt, personal communication 2000). The evidence appears to suggest greater sage-grouse are ultimately excluded from breeding within the development boundaries of natural gas fields.

This leads us to a fundamental question associated with the ultimate extirpation and subsequent exclusion of greater sage-grouse leks from a region as the probable result of an anthropogenic disturbance source: are greater sage-grouse displaced from impacted leks to breed on leks away from the disturbance source, or does the disturbance result in the impacted birds not breeding? Braun (1986) hypothesized that adult males (i.e., individuals over 1.5 years old or at least second-year breeders) returned to leks where they had established territories until they died, and juvenile males establishing territories replaced those . The researchers attributed declines on leks influenced by coal mining activity in northern Colorado to decreased juvenile male recruitment. Our results generally support Braun's (1986) hypothesis. Zablan et al. (2003) used band return rates over 18 years in Colorado to estimate adult male annual survival and found that survival varied from 35 to 45 percent (95% confidence interval). Following inclusion in the heavy impact category, average annual declines on the three leks located centrally within the developing anticline field was 48 percent (±SE; ±9%). Further, using maximum male lek counts from the year prior to inclusion in the heavily impacted category as a starting value and assuming 37 percent adult male annual survival (Zablan et al. 2003), we were able to reproduce observed overall declines on these leks with 15.6 percent annual recruitment (approximately 55 to 65% annual recruitment required for stability). These observations suggest that declines on the three centrally situated leks resulted from adult male tenacity with minimal juvenile male recruitment.

Are Regional Populations Affected?

Average annual declines in the maximum number of males differed relative to impact status (heavy 16% [excluding the three centrally situated leks discussed above], light 19%, control 2%), suggesting that juvenile males were being displaced by gas-field-related disturbance. This leads to an amendment of the fundamental question: are displaced juvenile males establishing territories on less-impacted leks, or are they not breeding?

To investigate this question, an annual male population growth rate estimate is needed to compare with annual changes in the number of strutting males throughout the region. We assessed average annual change in the regional number of strutting males by combining annual estimates (from 2000 to 2004) of the maximum number of males from 20 leks with consistently accurate counts

(Connelly et al. 2003) situated within the study area. Annual male population growth was estimated using average demographic information from 190 radio-equipped females captured (Wakkinen et al. 1992) throughout the study area between 1999 and 2003 in the following equation:

$$8 = [(\text{initiate} \times \text{success} \times \text{brood}) \times \text{male chick}] + (\text{male annual survival})$$

Where 8 is male population growth rate; initiate is annual nest initiation; success is annual nest success; brood is annual brooding period chick survival; male chick is male chicks produced annually (based on average August brood size, a brood sex ratio of 45.4 males to 54.6 females [Swenson 1986] and 75% chick winter survival [J. W. Connelly, personal communication 1998]); male annual survival is adult and juvenile male annual survival (56.4%, survival estimate is average from Schroeder et al. 1999 and Zablan et al. 2003). Demographic values derived from our data were apparent values.

The regional number of strutting males counted on leks declined annually by an average of 13 percent (±5%). Using the demographic information, male population growth rates declined 8 percent (±4%) annually. The interval estimates for population growth and annual change in the number of strutting males overlapped, suggesting that a proportion of the displaced juveniles were establishing territories on leks somewhere within the study area. However, the 5-percent difference in the annual estimates and the population growth rate interval being skewed to the left of the male count interval further implies that a proportion of the juvenile males were not counted on leks, suggesting that these individuals were not establishing breeding territories.

Two potential alternative explanations to the conclusion that a proportion of the juvenile population was not breeding exist. These birds may have established territories on leks beyond the spatial scope of the study area. The subsample of leks used to formulate the estimate for the regional change in the number of males included eight leks that we had designated as controls. The average distance between these control leks and heavily impacted leks was 15.5 miles (25 km), and average distance from control to closest heavily impacted lek was 6.2 miles (10 km [± 0.5 miles [0.8 km]]). In Colorado, juvenile males typically established on natal leks (63%), with the remaining juveniles establishing on leks within 8.1 miles [13 km] of their natal lek (Dunn and Braun 1985). Additionally, 82 percent of interlek movements (i.e., movement of individual males between different leks during the breeding season) were between leks separated by less than 5 miles (8 km) (Dunn and Braun 1985). These results suggest that the scope of our study area was sufficient to encompass the area typically exploited by juvenile males searching for lek establishment sites. The second possibility is that these birds were breeding without visiting a lek. Because sage-grouse males provide neither resources nor parental care to their mates, mate choice does not provide direct benefits to the females, suggesting that indirect benefits may be the main evolutionary force behind females' mate selection (Gibson 1990). The ability of females to recognize high fitness in individual males potentially requires a venue for direct comparison (i.e., the lek; Beehler and Foster 1988), and the possibility that off-lek breeding was occurring would constitute a significant change in breeding behavior. We cannot be certain that a proportion of the displaced population abstained from breeding, but the alternatives would represent unlikely deviations from normal behavior.

Concluding Comments

Although it is difficult, if not impossible, to implicate a single factor or group of factors responsible for recent range-wide sage-grouse population declines, Braun (1998) suggests that complexities of factors related to human-caused habitat changes are responsible. Changes rendered across the landscape include habitat loss (e.g., agricultural conversion, mineral and energy development, community building, roads, reservoirs), fragmentation (e.g., fences, power lines, roads) and degradation (e.g., sagebrush treatments, grazing, exotic plant species introduction) with other factors, such as drought, hunting and predation, playing contributory roles. Greater sage-grouse populations in southern and western Wyoming appear to be ultimately displaced to surrounding areas by the development of natural gas fields. A proportion of the displaced birds appeared to establish on leks adjacent to the developed area. However, a proportion of the displaced population apparently did not breed. These conclusions suggest that natural gas field development contributes to localized greater sage-grouse extirpations, but that regional population levels, although negatively impacted, are not as severely influenced.

Research investigating juvenile responses to a developing gas field would improve our understanding of specifics. For example, what proportion of the juvenile male population does not breed? What is the spatial extent of the area searched by disturbed juvenile males prior to establishing a territory on a lek (spatial extent of gas field influence)? Is territorial establishment timing of juvenile males influenced by displacement? What are the well densities within a given distance from an active lek when juvenile male establishment probabilities become negatively influenced? Do increased rates of dispersal influence juvenile male survival? Future research should address potential impacts to the juvenile female cohort. In addition to the questions asked concerning juvenile males, information relative to female seasonal habitat selection and productivity is needed. What is the proportion of the juvenile female population displaced from their natal nesting or natal brooding areas, and are vital rates (i.e., survival, nesting initiation and success probabilities, and chick productivity rates) of the juvenile females displaced from their natal lek, nesting or brooding areas negatively influenced? These and additional questions are currently (from 2005 to 2006) being investigated by researchers at the University of Wyoming with assistance from the BLM, U.S. Department of Energy, and Wyoming Game and Fish Department.

Braun et al. (2002) suggest that the oil and gas industry should mitigate for habitat and population decreases associated with mineral extraction activities, considering potential cumulative effects (e.g., livestock impacts to surrounding landscapes [Kuipers 2004] and habitat treatment consequences [Slater 2003]). Additionally, mitigation measures aimed at increasing not only productivity in but carrying capacity of surrounding areas could be important because of potential density-dependent difficulties (i.e., nest spacing influences on nest success probabilities; M. J. Holloran, unpublished information 2005) arising from artificially high populations caused by the shifting of some of the juvenile cohort. Mitigation measures aimed at minimizing the negative numerical consequences of gas development to regional sage-grouse populations imply a refugia approach to species conservation. By protecting and enhancing these reservoir populations surrounding the developing gas field, mitigation theoretically ensures that sage-grouse will be present to recolonize the field following reclamation. However, this approach requires lengthening the time frame between the development of additional gas fields surrounding the one currently under construction to the life expectancy of the original field thus ensuring that surrounding refugia are maintained (individual gas well life-expectancy estimated at 25 to 40 years for the types of formations encountered in the Pinedale Anticline area; Wyoming Oil and Gas Conservation Commission, personal communication 2005). Following reclamation of the existing field, the area then potentially becomes a refuge for reservoir populations associated with the next gas field slated for development.

The current energy situation in the United States will likely encourage the development of natural gas reserves in many western states harboring substantial sage-grouse populations. According to the American Gas Association (http://www.aga.org), natural gas consumption in the United States is expected to increase between 50 and 60 percent over the next 20 years and, to ensure economic stability and energy security, the United States must reduce its dependence on unstable imports of foreign petroleum. However, the environmentally safe development of the United States' natural gas reserves is of equal importance to the strength and perseverance of this country. Sage-grouse population maintenance initially requires a recognition of the intrinsic value of sagebrush dominated landscapes, followed by the development of a comprehensive approach to sagebrush habitat conservation that involves commitments and partnerships between state and federal agencies, academia, industry, private organizations, and landowners: "only through this concerted effort and commitment can we afford to be optimistic about the future of sagebrush ecosystems and their avifauna" (Knick et al. 2003:627).

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The Generation Gap Between Recent Sage-grouse Research and Integration of New Knowledge for Management of Sage-grouse Habitat

Michael A. Gregg
U.S. Fish and Wildlife Service
Richland, Washington

John A. Crawford
Oregon State University
Corvallis

Greater sage-grouse (*Centrocercus urophasianus*) were recently evaluated for protection under the Endangered Species Act because populations declined significantly rangewide during the past 50 years (Crawford and Lutz 1985, Connelly and Braun 1997, Connelly et al. 2004). Sage-grouse population declines were attributed to loss and fragmentation of sagebrush (*Artemisia* spp.) habitats (Dalke et al. 1963, Braun 1998) and habitat deterioration that caused reduced sage-grouse productivity (Connelly and Braun 1997). Although sage-grouse were not listed as threatened or endangered (U.S. Fish and Wildlife Service 2005), the heightened interest in sage-grouse resulted in a greater emphasis on understanding habitat needs and management of sagebrush habitats. Sage-grouse conservation plans have been initiated or have been completed in all 11 states with extant sage-grouse populations (Connelly et al. 2004).

Because of the close relationship between sage-grouse and sagebrush, protection of sagebrush habitats has been the primary focus for management of sage-grouse populations (Patterson 1952, Braun et al. 1977, Autenrieth et al. 1982). Management recommendations in the first sage-grouse management guidelines (Braun et al. 1977) focused entirely on protection of sagebrush habitats. Previous authors identified herbaceous vegetation as an important component of sage-grouse habitat (Klebenow and Gray 1968, Peterson 1970, Pyrah 1971, Autenrieth 1981). However, only recently was the critical nature of the herbaceous understory for successful reproduction documented (Barnett and Crawford 1994; Drut et al. 1994a, 1994b; Gregg et al. 1994; DeLong et al. 1995; Coggins 1998; Sveum et al.1998a, 1998b; Aldridge and Brigham 2002). Improvement of sage-grouse reproductive success by restoration of understory vegetation may likely be the key to recovery of many populations (Dobkin 1995, Connelly and Braun 1997). Although state (Hemker 1997, Stinson et al. 2004) and federal (U.S. Bureau of Land Management 2000) sage-grouse conservation plans identified restoration of herbaceous vegetation as a conservation measure, the focus on sagebrush for management of sage-grouse habitat has changed little since publication of the original management guidelines (Braun et al. 1977). We suggest there is a generation gap between recent sage-grouse research and the application of new knowledge in management of sage-grouse habitat. The purpose of this paper is to present a hierarchical view of sage-grouse habitat relationships, to identify causes for the generation gap and to propose solutions to integrate current knowledge of sage-grouse habitat requirements into effective management strategies.

Are Sage-grouse Sagebrush Obligates?

Sage-grouse are classified as sagebrush obligates because of their dependence on sagebrush habitats for survival and reproduction; the link between sage-grouse and sagebrush has been well documented (Braun et al. 1976, Roberson 1986). Sagebrush provides the primary source of food and cover for sage-grouse during winter (Patterson 1952, Wallestad et al. 1975, Roberson 1986) and may be the only vegetative component necessary to describe winter habitat at multiple scales (Beck 1977, Hupp and Braun 1989, Homer et al. 1993). Nests typically are located under sagebrush (Patterson 1952, Wallestad and Pyrah 1974, Autenrieth 1981, Gregg et al. 1994), and nest success declines when nests are located under other shrubs (Connelly et al. 1991). Primary brood-rearing areas are sagebrush uplands (Klebenow 1969, Martin 1970, Wallestad 1971, Drut et al. 1994a, Sveum et al. 1998a). However, herbaceous vegetation and the associated arthropods in sagebrush stands play an equally critical role for reproduction and survival of sage-grouse, particularly from the prelaying to the late brood-rearing periods (Barnett and Crawford 1994, Drut et al. 1994a, Gregg et al. 1994).

The Role of Herbaceous Vegetation

There are three distinct phases during reproduction where forbs and grasses are essential components of sage-grouse habitat: prelaying, nesting and brood-rearing. The prelaying period encompasses approximately the 5-week period that immediately precedes incubation (Barnett and Crawford 1994). Dietary protein is important during this period for egg production and chick survival (Beckerton and Middleton 1982, Carey 1996) because grouse generally do not have high endogenous protein reserves to use for reproduction (Carey 1996). In Oregon and Nevada, forbs were an important food for female sage-grouse during spring because they contributed more crude protein to the diet than sagebrush (Barnett and Crawford 1994; M. A. Gregg, unpublished data 2004). Consumption of high protein foods during the prelaying period prepared the hen physiologically for reproduction (Barnett and Crawford 1994). Sage-grouse nest initiation (Barnett and Crawford 1994) and renesting (Gregg et al. 2006) rates may be enhanced when hens consume forbs before incubation.

Herbaceous vegetation in sagebrush stands, particularly in tall (more than 7 inches [18 cm]), residual, native bunchgrasses, provides a critical component of sage-grouse nesting habitat (Gregg et al. 1994, DeLong et al. 1995, Sveum et al. 1998b). Tall herbaceous vegetation surrounding sage-grouse nests increased the likelihood of nest success (Gregg et al. 1994, Sveum et al. 1998b). Sage-grouse nests located in areas with inadequate tall herbaceous cover were predisposed to high rates of nest predation by ravens (*Corvus corax*), coyotes (*Canis latrans*) and other mammals (Gregg 1992, DeLong 1994, Gregg et al. 1994, Sveum et al. 1998b). Tall, dense herbaceous cover may provide scent, visual and physical barriers between nesting hens and predators (DeLong 1994, Gregg et al. 1994). Although tall herbaceous cover typically is composed of native bunchgrass, other types of herbaceous vegetation (e.g., forbs) can provide the necessary cover to conceal sage-grouse nests (Sveum et al. 1998b, Aldridge and Brigham 2002). Exotic grasses, such as cheatgrass (*Bromus tectorum*) and medusahead (*Taeniatherum asperum*) do not provide adequate cover for nesting hens.

Insects and forbs are critical dietary components of juvenile sage-grouse and influence growth and survival (Johnson and Boyce 1990; Drut et al. 1994a, 1994b). Insects are consumed almost exclusively during the first few days after hatching; forbs become a common dietary component thereafter (Klebenow and Gray 1968; M A. Gregg, unpublished data 2004). Chicks deprived of insects exhibited reduced growth rates and low survival (Johnson and Boyce 1990). In Oregon, sage-grouse productivity was enhanced when forbs and insects were the primary dietary components (Drut et al. 1994b). In areas where forb availability was low, chicks transitioned to a sagebrush diet at a younger age (6 weeks) and exhibited reduced survival (Drut et al. 1994b). Lower survivability was attributed to reduced nutrient intake (Drut 1993). Low forb availability could have indirectly reduced survival by increasing home range size for hens with broods, which increased exposure of chicks to predation, accident and other mortality factors (Drut 1993).

Hierarchical View of Sage-grouse Habitat

Sage-grouse habitat relationships are far more complex than the obligatory sage-grouse/sagebrush relationship implies because grouse select habitat factors at different scales. The habitat selection process presented by Johnson (1980) provides the framework to understand the hierarchical nature of sage-grouse habitat selection. Johnson (1980) presented four levels of selection that identified multiple spatial scales of habitat selection. First order selection represented selection of the geographical range of a species. Second order selection identified home ranges of individuals or groups within the geographical range. Third order selection described use of habitat types within home ranges. Finally, fourth order selection delineated the important habitat components within each habitat type. The complexity of sage-grouse habitat relationships increases as the scale of selection decreases (i.e., first order to fourth order selection). For example, the geographical distribution (first order selection) of sage-grouse is inherently related to the distribution of sagebrush (Johnsgard 1983). The presence of sagebrush is the primary habitat factor that determines the occurrence of sage-grouse at the geographic or landscape scale. Landscapes that are not predominately covered with sagebrush will not provide all habitat components needed to support a self-sustaining population of sage-grouse. On the other extreme, use of a habitat within a home range (third order selection) may depend on habitat components other than sagebrush, particularly during the reproductive phases. Hens with broods typically use areas where forbs are abundant (Klebenow 1969, Drut et al. 1994a, Apa 1998, Sveum et al. 1998a) and alter habitat use in response to changes in forb availability (Klebenow 1969, Peterson 1970, Wallestad 1971, Dunn and Braun 1986, Drut 1993, Drut et al. 1994a). Availability of forbs differs depending on cover type, moisture and elevation. When dessication reduces forb availability in sagebrush uplands, hens with broods move to areas with greater forb abundance, including bottoms and grassland cover types (Peterson 1970, Wallestad 1971) and meadows and lakebeds (Drut 1993), which typically have little or no sagebrush cover. Hence, sage-grouse may at times select areas without sagebrush cover.

At the fourth order level (habitat components within habitat types), sage-grouse are dependent on understory vegetation and the associated insects for successful reproduction. At this level of selection, herbaceous plants fulfill a key role throughout the reproductive period and ultimately determine sage-grouse reproductive success. Sage-grouse could be viewed as forb or insect obligates at this scale (both temporal and spatial) of habitat use because consumption of forbs and insects by chicks is required for survival. Thus, the answer to the question "are sage-grouse sagebrush obligates?" ultimately depends on the scale or level of habitat use and the life-history trait under consideration.

The Generation Gap

Management procedures for sage-grouse habitat have not changed substantially since publication of the 1977 guidelines (Braun et al. 1977) despite increased knowledge of sage-grouse habitat relationships from recent research. Conservation measures have been identified for most key sage-grouse habitat components, but management activities have typically focused on mapping and protection of sagebrush stands, not restoration of understory vegetation. We suggest that the herbaceous component of sage-grouse habitat is not integrated into sage-grouse management activities because of differences in the spatial scale at which sage-grouse habitat research has been conducted and conservation measures have been applied.

Sage-grouse are a landscape species because they require large (thousands of hectares), continuous patches of sagebrush habitat for reproduction and survival. Some sage-grouse populations are migratory and move considerable distances among nesting, brood-rearing and wintering areas (Connelly et al. 2000). Movements more than 78 miles (125 km) between seasonal-use areas and annual home ranges of 1,727 square miles (2,764 km^2) have been reported (Leonard et al. 2000). Movements within seasonal ranges can be substantial. Movements more than 25 miles (40 km) for hens with chicks fewer than three weeks old have been documented (M. Gregg, unpublished data 2004). Therefore, management of sage-grouse habitat must occur at the landscape scale (first or second order), but research that identified key habitat components required for reproduction (i.e., herbaceous vegetation) has largely been conducted at a much smaller spatial scale (third and fourth order levels). Methods are available to quantify distribution of sagebrush at large scales

(Wisdom et al. 2000, Comer et al. 2002) but not to evaluate composition of understory vegetation (Knick et al. 1997, Wisdom et al. 2000). The importance of herbaceous vegetation as a component of sage-grouse habitat has been recognized (Connelly et al. 2000, 2004; Hockett 2002; Wambolt et al. 2002; Crawford et al. 2004), but this knowledge has not been used to quantify and to qualify sage-grouse habitat at the scale necessary for effective restoration and management of sage-grouse habitat.

Because of limitations for large-scale evaluations of the herbaceous understory, the focus has remained on the extent and density of sagebrush as the primary habitat factor that controls sage-grouse populations. Sagebrush has been the single habitat component used to quantify sage-grouse habitat at the landscape scale (Patterson 1952, Johnsgard 1983, Beck et al. 2003, Schroeder 2004). These landscape habitat maps based on presence of sagebrush are useful for identifying potential sage-grouse habitat and estimating historic and present distribution of sage-grouse, but they would perform poorly as predictors of sage-grouse population persistence, densities or trends. Estimating the extent of sage-grouse habitat over large geographic areas based solely on the presence of sagebrush is deceptive and provides a false sense of security because composition of understory vegetation is largely unknown (Knick et al. 2003). Assessment of sage-grouse habitat must include all critical habitat components (e.g., sagebrush overstory and herbaceous understory). Sage-grouse populations cannot persist in large, homogenous stands of a single cover type because of their reliance on the herbaceous understory during reproduction and their seasonal use of areas dominated by different types of sagebrush and other vegetation (Crawford et al. 2004). Sage-grouse habitat quantified solely on the presence of sagebrush would likely overestimate potential habitat and would include areas devoid of sage-grouse populations.

Before European settlement, management of sage-grouse habitat based on presence of sagebrush would likely have been sufficient. A diverse herbaceous understory, composed of native forbs and grasses, is thought to have been characteristic of most undisturbed sagebrush communities (Miller and Eddleman 2000). However, there has been a notable reduction in herbaceous vegetation throughout a large portion of sagebrush-dominated communities since European settlement (Young et al. 1979, Miller and Eddleman 2000, Miller et al. 1994). The reduction of herbaceous understory plants has been attributed to changes in species composition of woody plants, to displacement by exotic annuals and alteration of soil characteristics because of historically unregulated livestock grazing, to altered fire regimes, and to introduction of nonnative plants (Young et al. 1979, Miller et al. 1994, Gruell 1996, Miller and Eddleman 2000). Current conditions in sagebrush stands range from areas containing adequate native herbaceous plants, areas dominated by exotic annuals or areas with a near complete lack of understory vegetation. Those areas with altered or depleted understories have few or no sage-grouse.

Bridging the Generation Gap

For effective management and restoration of sage-grouse habitat, we believe that it is imperative to bridge this generation gap between our current state of knowledge of sage-grouse habitat relationships and of management of sage-grouse habitat. However, there are no simple solutions that will integrate all key habitat components into a successful management strategy for sage-grouse habitat. There have been recent attempts to incorporate understory composition, in addition to distribution of sagebrush, into landscape models of sage-grouse habitat in the interior Columbia Basin (Hemstrom et al. 2002; Wisdom et al. 2002a, 2002b) and regional assessments of sage-grouse habitat in the sagebrush ecosystem (Wisdom et al. 2003). These landscape models used differences between historic and current levels of livestock grazing, and they used the departure of disturbance regimes and composition, structure and patterns of vegetation from historic conditions as an index of herbaceous understory composition (Hemstrom et al. 2002, Wisdom et al. 2002b). They provided insight on the restoration potential of sagebrush habitat (Hemstrom et al. 2002) and effects of habitat restoration on sage-grouse populations (Wisdom et al. 2002a), and they performed well at differentiating areas where grouse were present or extirpated (Wisdom et al. 2002b). Procedures for regional assessments of sage-grouse habitat provided methods to estimate and map habitats that may be at-risk of degradation from invasion of exotic annual grasses and encroachment of juniper (Wisdom et al. 2003). Delineation of at-risk habitats enhances our ability to manage sage-grouse habitats at landscape scales by identifying potential areas in need of restoration.

These recent landscape models and habitat assessment procedures provide an appropriate starting point for management and restoration of sage-grouse habitat and are a step in the right direction for bridging the generation gap.

However, the applicability of these models is limited because they do not adequately quantify composition of understory vegetation (Wisdom et al. 2003). Potential habitat is based on dominant overstory plants and does not reflect composition of understory vegetation and, therefore, does not enhance our ability to predict persistence, densities or trends of sage-grouse populations. An accurate estimate of extant sagebrush communities that are in optimum or tolerable condition for sage-grouse is currently unknown (Crawford et al. 2004). Technological advances have increased our ability to quantify landscape patterns and change (Wisdom et al. 2003, Crawford et al. 2004), but the inability to quantify composition of understory vegetation at large scales limits our ability to manage and restore sagebrush habitat and to affect sage-grouse populations. Current methods employed to quantify understory vegetation in sage-grouse habitat are not practical for use at large scales. A new technique to estimate cover in sagebrush communities using ultra light aircraft has been developed (Seefeldt and Booth 2005) and may have potential to quantify understory vegetation at much larger scales than current methods. Continued development of techniques to quantify sage-grouse habitat at the landscape scale will be essential to fully evaluate habitat condition, to determine status of sage-grouse populations and to prioritize areas in need of restoration.

We suggest three additional areas of research to integrate current knowledge of sage-grouse habitat relationships with management of sage-grouse habitat. First, we must identify the appropriate spatial scales for management of sage-grouse habitat. The need to manage sage-grouse at the landscape scale has been recognized (Connelly et al. 2000, Wisdom et al. 2003, Crawford et al. 2004), but sage-grouse management units are often arbitrarily identified based on agency, political or geographic boundaries. The appropriate spatial scale for habitat management to affect sage-grouse populations is unknown. Management of landscapes between 625,000 to 6.25 million acres (250,000 to 2.5 million ha) has been recommended because improvement of only a portion of year-around habitat may be offset by degradation of habitat used at other times (Crawford et al. 2004). However, these landscape recommendations were not supported by any quantified information on structure of sage-grouse populations. Although migratory and nonmigratory sage-grouse populations have been identified (Connelly et al. 2000), we know very little about the spatial structure of sage-grouse populations. Sage-grouse populations could exist as one continuous population, a metapopulation, a set of isolated populations or some combination

(Wisdom et al. 2002b). Understanding what constitutes a population of sage-grouse would help to determine the spatial scale at which habitat management must occur to affect populations. The appropriate scale may differ from population to population across the range of the species. An understanding of the spatial structure of sage-grouse populations is a fundamental question that must be addressed to successfully manage habitat or to evaluate management actions, and it is a critical step for bridging the gap between sage-grouse research and management of sage-grouse habitat.

Second, research is needed to identify landscape characteristics that influence sage-grouse habitat use, productivity and survival. Sage-grouse research conducted at fine scales was instrumental for understanding sage-grouse habitat relationships and identification of key habitat components. However, these studies were not designed to identify optimum cover values for key habitat components at the landscape scale. Cover and juxtaposition of sagebrush and herbaceous vegetation are highly variable across the landscape (Miller and Eddleman 2000). For example, landscape patterns of sagebrush can range from large, homogenous communities to heterogenous stands that are mosaics of sagebrush patches interspersed among areas with no sagebrush cover. Because selection for habitat components by sage-grouse likely occurs at the fourth order level (Drut et al. 1994a, Gregg et al. 1994, Sveum et al. 1998a, Aldridge and Brigham 2002), vegetative characteristics measured at fine scales (e.g., nest sites, brood sites) could be similar irrespective of the variation in cover and juxtaposition of sagebrush and other habitat components at the landscape scale. However, the variation in landscape patterns of sagebrush communities could be important for sage-grouse habitat use, reproduction and survival, but these relationships have not been investigated. Fuhlendorf et al. (2002) found that response of lesser prairie chickens (*Tympanuchus pallidicinctus*) to landscape characteristics was scale-dependent, which supported the importance of multiscale analyses of habitat use. Understanding the influence of the variation in cover and juxtaposition of habitat components at the landscape scale on sage-grouse populations would link our understanding of fine-scale habitat relationships with landscape management of sage-grouse habitat.

Finally, we need to identify direct relationships between pervasive land management practices and key sage-grouse habitat components identified from fine-scale research. The principal land use practices in sagebrush habitat that influence herbaceous understory vegetation include livestock grazing (cattle and feral horses), prescribed fire and restoration activities following wildfire (Rowland and Wisdom 2002). Identification of direct relationships between these practices and key sage-grouse habitat components would facilitate large-scale management of sage-grouse habitat. For example, livestock grazing is a widespread land use that effects fine-scale sage-grouse habitat components virtually throughout the range of the species (Braun 1998). Livestock grazing is also the principal land use practice that land managers can control by manipulating timing and intensity of use. Hence, understanding the effect of livestock grazing on key sage-grouse habitat components could help bridge the gap between current knowledge of sage-grouse habitat relationships and management of sage-grouse habitat. There is indirect evidence that domestic livestock grazing influences (both positively and negatively) sage-grouse habitat, but direct effects of livestock on sage-grouse habitat and reproduction are largely unknown (Connelly and Braun 1997, Beck and Mitchell 2000, Hockett 2002, Crawford et al. 2004). Research on effects of grazing, including timing and intensity of use, on sage-grouse critical habitat components and reproduction could potentially lead to management actions that could be applied to sage-grouse habitat at the landscape scale. However, we caution that adjustments of current grazing practices alone may not result in range-wide increases in sage-grouse populations. Sagebrush habitats dominated by woody plants, exotic grasses or by significant soil loss will remain in poor condition for long periods because many have crossed thresholds and are in irreversible, steady states (Laycock 1991) without active restoration.

Conclusions

Sagebrush is a critical component of sage-grouse habitat. Removal of sagebrush has been found to negatively impact sage-grouse populations as areas devoid of sagebrush do not support sage-grouse (Patterson 1952, Braun et al. 1977, Call and Maser 1985). Loss and fragmentation of sagebrush habitats have been implicated in the reduced distribution and abundance of sage-grouse populations rangewide (Dalke et al. 1963, Braun 1998). However, sage-grouse habitat relationships are complex, and sagebrush is only one of several critical habitat components necessary for reproduction and survival (Connelly et al. 2000, Crawford et al. 2004). A deficiency in any one habitat variable could lead to impaired productivity or to reduced survival and depressed sage-grouse populations. Management of sage-grouse habitat must include all critical habitat components, and management will be most effective at the landscape scale.

The characterization of the sage-grouse/sagebrush relationship as obligate has perpetuated an overly simplistic view of sage-grouse habitat relationships. Management of sage-grouse habitat is considerably more complicated than previously recognized. First order habitat models based on overstory vegetation should be used only for identification of potential sage-grouse habitat and estimating distribution of sage-grouse. Landscape models that incorporate all habitat components will be required before land managers can prioritize areas for restoration, can predict population persistence, densities and trends, and can fully implement habitat conservation measures that benefit sage-grouse populations. Development, validation and applicability of these models will be greatly enhanced with a better understanding of sage-grouse population structure; landscape characteristics that influence sage-grouse habitat use, productivity and survival, and the effects of land-use practices on key sage-grouse habitat components. A multidisciplinary approach that includes wildlife biologists and range and landscape ecologists will be required to solve these complex problems before effective management strategies can be implemented to benefit sage-grouse habitat and, ultimately, to enhance sage-grouse populations.

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Sagebrush, Sage-grouse and Ranching: A Holistic Approach

Rick E. Danvir
Deseret Land and Livestock Ranch
Woodruff, Utah

William J. Hopkin
Deseret Cattle and Citrus
St. Cloud, Florida

Gregg E. Simonds
Open Range Consulting
Park City, Utah

Burke Teichert
Deseret Land and Livestock Ranch
Woodruff, Utah

Steven L. Kearl
Foundation for Quality Resource Management
Montpelier, Idaho

John F. Kimball, Jr.
Foundation for Quality Resource Management
Huntsville, Utah

Robert M. Welch
Foundation for Quality Resource Management
West Hooper, Utah

Anis Aoude
Utah Division of Wildlife Resources, Central Region Office
Springville, Utah

John Haskell
Diamond J Consulting
Woodruff, Utah

Introduction

Livestock grazing discussions can be polarized affairs. Depending on point of view, livestock are alternately considered the bane or the bread and butter of intermountain rangelands. While many rural families consider livestock grazing essential to maintaining income, lifestyle and open space values, others link livestock grazing practices to undesirable ecological conditions in sagebrush rangelands (Fleishner 1994, West 1999).

Concerns have resulted in numerous symposia, studies and listing petitions for many wildlife species of the sagebrush steppe, most notably sage-grouse (*Centrocercus urophasianus*). Many individuals and organizations question the wisdom of grazing or otherwise managing sagebrush rangelands. Others, particularly ranchers, argue that grazing is a sustainable use of sagebrush range, that many wildlife species benefit from ranching and that working ranches may be the most practical hope for maintaining open space and rural economies in the West. A rift exists between those who feel these rangelands and their obligate species would be better served by managing for desired rangeland conditions and those who favor removing livestock and grazing land improvements and letting nature reign.

While focusing on greater sage-grouse and sagebrush, the following discussion more broadly chronicles a 25-year effort to manage a large ranching operation—Deseret Land and Livestock Ranch (DLL)—for multiple economic, wildlife conservation, land health and community-based goals. This ongoing effort has required cooperation between multiple landowners, conservation organizations and government resource management agencies, working together toward the mutually beneficial goals of maintaining healthy watersheds, agricultural values and wildlife populations, using monitoring and management, now and for future generations.

Landscape Description

DLL encompasses approximately 213,000 acres (87,000 ha) of private and public land in northeastern Utah. The eastern half of the ranch is predominantly flat to rolling sagebrush-steppe.

Elevations range from 6,500 to 7,000 feet (1,980–2,130 m), and annual precipitation averages 10 inches (25 cm) (National Oceanic and Atmospheric Administration [NOAA]). Dominant sagebrush-steppe vegetation includes Wyoming big sagebrush (*Artemesia tridentata yaominizensis*), Basin big sagebrush (*A. t. tridentata*) and an understory dominated by crested wheatgrass (*Agropyron cristatum*) (planted in the 1960s) or mixed native herbaceous species (Danvir 2002).

The western half of the ranch is more mountainous terrain, with elevations ranging from 6,200 to 8,700 feet (1,890–2,650 m) and rainfall increasing from 15 to 35 inches (38–89 cm) from east to west. Vegetation includes a diverse and interspersed mix of aspen (*Populus tremuloides*), conifers, mountain meadows, mountain big sagebrush (*Artemesia tridentata vaseyana*) and diverse other plant species (Danvir 2002). The majority of the DLL sage-grouse and sagebrush range occurs in Rich County, Utah, with fewer acreages located in Morgan County, Utah, and Uintah County, Wyoming.

Historical Management

Written accounts (Russell 1965, Rawley 1985) and archeological evidence (Shields 1968) indicate that large ungulates including elk (*Cervus elaphus*), mule deer (*Odocoileus hemionus*), bighorn sheep (*Ovis canadensis*), pronghorn (*Antilocapra americana*) and bison (*Bison bison*) historically foraged on DLL and in its vicinity.

DLL has been privately owned since its formation in 1891. Initially the ranch was managed for sheep and wool production, accommodating upwards of 60,000 ewes annually (McMurrin 1989). Since the 1950s, cattle have replaced sheep as the principal livestock on DLL. DLL currently grazes cattle on approximately 100,000 acres (40,800 ha) of private lands and 13,000 acres (5,300 ha) of U.S. Bureau of Land Management (BLM) sagebrush-steppe range.

Initially, DLL pastures were grazed season-long by cattle from April through October. Cattle relied heavily on stockpiled hay during November through March, and calving occurred in March. By the late 1970s, cattle production, range health and ranch profitability were judged less than desirable, forcing the ranch owners to consider economic alternatives for the ranch, including commercial and residential development (Wolfe et al. 1996). After assessing the production capabilities of the various irrigated range and forested lands on the ranch, the decision was made to implement changes to the overall cattle, range and wildlife management philosophy of the ranch. In so doing, we hoped to maintain an ecologically and economically productive working ranch, generating income while maintaining or enhancing watershed, wildlife and open space values (Wolfe et al. 1996).

Fundamental Management Changes

In the late 1970s, a holistic management strategy began emerging on the ranch (Savory 1988). This approach involved viewing the ranch as a whole and adopting an adaptive management approach by which management practices were evaluated according to their effectiveness in achieving range condition, wildlife abundance, wildlife diversity, livestock production and ranch economic goals.

Wildlife Management

In cooperation with the Utah Division of Wildlife Resources (DWR) the ranch began managing native ungulates for sustainable fee-hunting (Wolfe et al. 1996). This involved managing the age structure for mature male deer, elk, pronghorn and moose (*Alces alces*) populations, coupled with appropriate removal of females to maintain population size. Ranch wildlife management was further improved through enrollment in the Utah Cooperative Wildlife Management Unit Program (CWMU). We believed a mix of wild and domestic ungulates would best turn forage into dollars (by multispecies grazing) while maintaining ecosystem stability (Ritchie and Wolfe 1994, Danvir and Kearl 1996). Wildlife revenue generating enterprises eventually grew to include fee-fishing and guided bird-watching programs.

Livestock Production and Irrigated Lands Management

Cattle production practices were modified to develop a better fit between DLL's cattle and climate. Calving was begun later, in April, mirroring the reproductive cycle of the native grazing ungulates (elk and bison) and aligning nutritional requirements of pregnancy, lactation and breeding with peak range forage values (Simonds 1995, Wolfe et al. 1996). Again taking direction from the wild ungulates, we identified and selected for smaller-bodied cattle having low birth rates but fast-growing calves, aiming for earlier weaning dates and lower calf costs.

Changes were also made to the management of irrigated lands. While comprising only 5 percent of the ranch acreage, irrigated lands produce 55 percent of the cattle forage. Cost and tonnage of hay production was evaluated by pasture, and irrigation expenses were focused on the most productive pastures, reducing winter forage production costs.

Range Management

Grazing management. Range grazing practices changed significantly. Years of season-long grazing had reduced ground cover, particularly near water sources. Time-controlled grazing (Savory 1988) was implemented to improve livestock distribution, plant recovery and land health. This strategy was implemented in cooperation with BLM and with monitoring assistance from the Natural Resources Conservation Service (NRCS).

As with traditional grazing strategies, DLL's cattle stocking rate is determined based on available forage resources, livestock and wildlife performance goals, and desired range condition. Time-controlled grazing differs, however, from other strategies for the way livestock are moved and are distributed across the landscape. Time-controlled management plans focus foremost on providing adequate periods of rest for recovery between grazing bouts. Observations indicated sagebrush-steppe pastures should generally be rested a minimum of 1 year to ensure plant recovery (G. Simonds, B. Hopkin and B. Teichert, personal communication 2004). Once recovery periods have been established, grazing schedules are developed based on the principles of time and timing. Time refers to the length of time plants are exposed to grazing, and timing refers to the season of use and the stage of plant phenological development (Savory 1988). In practice, this entails alternating rather short periods of herbivory with adequate recovery periods before livestock return and avoiding grazing the same pasture at the same time each year. The duration of grazing in a pasture (time) is designed to minimize rebiting of individual plants. Ideally, livestock are moved to the next pasture before herbaceous plants have regrown sufficiently to be bitten a second time. On DLL, pastures are grazed for shorter periods (generally fewer than 10 days) from May through June, when herbaceous plants are growing rapidly. Conversely, during seasons when herbaceous plants are dormant or growing slowly, rebiting concerns are minimal, and grazing periods can be longer. Timing goals are best achieved by waiting more than 12 months before cattle return, i.e., varying the time of year individual pastures are grazed.

Shortening grazing periods required more pastures, fewer herds and higher stock densities (a few large herds moving quickly through several pastures in a year). On DLL, cattle are run in two or three herds numbering 1,500 to 3,000 head each. Over 90 percent of the DLL cattle generally occur on less than 10 percent of the landscape at any given time; consequently, 90 percent of the land is recovering from livestock grazing at any given time. Cattle (and other ungulates) at higher densities tend to be less selective in their food habits and increase their diet breadth to include plant species not grazed or grazed infrequently at lower densities (Savory 1988). Whereas selective herbivory by large ungulates leads to increased dominance of chemically defended, woody plants, intensive herbivory can maintain or increase the dominance of herbaceous plants (Augustine and McNaughton 1998). DLL managers use stock density, range rest, grazing time and timing to influence forage quality, plant density, species composition and structure of the plant community (Savory 1988, Severson 1990, Danvir and Kearl 1996).

Range treatments. In the past 12 years, DLL has also incorporated prescribed burning (cool season burns), chemical (tebuthiron or "Spike") and mechanical (brush-thinning with a Lawson Pasture Aerator or disking and planting seeds) range treatment practices. These practices have been applied at a rate of less than 2 percent of the ranch acreage per year (1,000 to 2,000 acres per year [400–800 ha/year]), and are designed to reduce woody vegetation and to increase herbaceous abundance while maintaining or increasing plant species richness. Treatments range from fewer than 100 acres (40 ha) to more than 1,000 acres (400 ha) in size and are widely distributed throughout the ranch's sagebrush habitat. Treated areas are irregular in shape, having relatively high treatment edge to area ratios; they include islands of untreated sagebrush and are patterned to achieve the structural effects of a cool season sagebrush burn.

Monitoring

Throughout the past 25 years, DLL has monitored selected indicators of livestock performance, wildlife condition, abundance and diversity, range response, and ranch economics. The ranch operates using comprehensive annual and 5-year plans, with ecological and economic goals developed for wildlife, livestock and land. Monitoring results are reviewed and are compared to annual and 5-year goals, and subsequent management practices may be modified based on these findings.

From 1992 to 1998, Ritchie and Wolfe (1994) (and in an unpublished progress report in 1998) monitored the various effects of total rest, of herbivory by wild herbivores (big game and lagomorphs) and of herbivory by both wild and domestic herbivores (controls) in DLL native sagebrush communities using (three) replicated sets of 98-by 98-yard (90- x 90-m) enclosures. Biomass production was clipped in July (generally after one or more sites had been grazed); samples were oven-dried and weighed. Results were compared using paired t-tests. Aoude (2001) compared costs of various treatment methods (burns, plantings and tebuthiron) with returns, in terms of increased herbaceous biomass, plant and wildlife species richness, and abundance.

In 1984, DLL, DWR, BLM and Utah State University (USU) initiated sage-grouse research in Rich County, including repeated lek counts, radio-telemetry studies, unmarked sage-grouse observations, estimates of insect abundance and vegetation condition. Goals included monitoring production and survival, and identifying seasonal grouse distribution and habitat use, foraging behavior and best management practices (Hunnicutt 1992, Homer et al. 1993, Ritchie et al. 1994, Danvir 2002).

Indices of big-game abundance, habitat use, herd composition, production and condition of harvested animals are collected annually on DLL. DLL, DWR and USU have collected some baseline data on small mammal abundance, distribution and ecology (Beck 1994, Moroge 1998, Aoude 2001, A. Koslowski unpublished data 2004). A DLL bird species list has been compiled, and, since 1995, three breeding bird survey routes have been conducted annually. An intensive research effort in Rich County is currently documenting the effects of sagebrush thinning treatments on avian ecology at multiple scales (F. Howe, personal communication 2004).

Results and Discussion

Range and Riparian Results

Between 1980 and 1986, both upland sagebrush-steppe and lowland riparian areas showed increased herbaceous plant cover and decreased bare ground. Based on data collected by NRCS, herbaceous plant ground cover increased by 6 percent 1980 to 1986 (Wolfe et al. 1996). Eroded, poorly vegetated lowland riparian habitats improved markedly. In most cases, near stream vegetation (primarily perennial forbs and sod-forming graminoids) increased, streams narrowed and meanders formed while siltation and bare ground decreased (Wolfe et al. 1996).

Exclosure monitoring studies suggested time-controlled grazing had no significant impact on herbaceous production but significantly reduced shrub biomass production (M.E. Ritchie and M. L. Wolfe, unpublished progress report 1998). Within years, dry-weight herbaceous biomass production did not differ significantly between cattle excluded areas and controls. However, annual shrub biomass production (primarily sagebrush) was significantly greater in cattle exclosures than in controls (890 and 625 pounds per square acre [100 and 70 g/m^2], respectively, $p = 0.95$, where p represents the probability). Between year variation in grass biomass production correlated with prior year (October-July) precipitation ($r^2 = 0.84$, where r represents the regression coefficient).

A remote-sensing evaluation of DLL sagebrush trend suggested increased complexity (increased variation in spectral signatures between adjacent pixels) and a 5- to 8-percent increase in shrub cover from 1970 to 1999 (Washington-Allen 2002). This increasing trend in shrub cover was partially responsible for our implementation of range treatments. Aoude (2001) found that herbaceous biomass increased in sagebrush stands following all range treatments. Herbaceous biomass was generally increased by three to four times in disked plantings and by two to three times in other treatments. Plant species richness (particularly forbs) increased significantly in tebuthiron treatments, disked plantings and higher elevation fall burns (Aoude 2001).

Wildlife Results

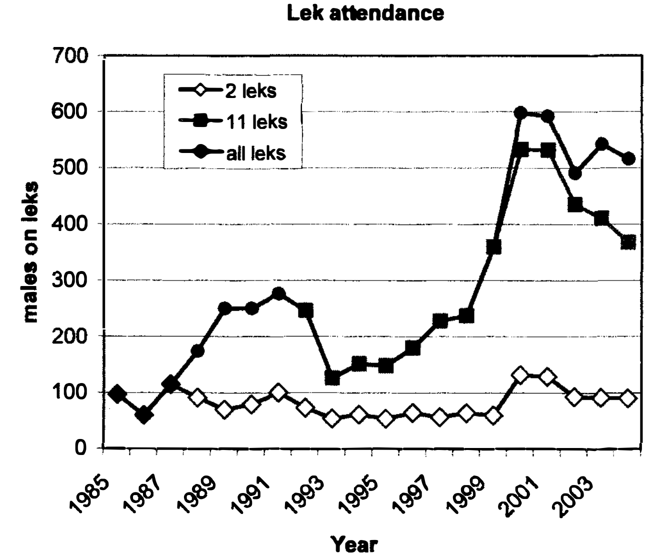
Sage-grouse. Management practices for sage-grouse at DLL evolved from monitoring results. Homer et al. (1993) determined sage-grouse in Rich County selected sagebrush of moderate height (16 to 24 inches [40–60 cm]) and 20- to 30-percent cover in most winters. However, grouse on DLL concentrated in less available, taller (more than 24 inches [60 cm]) sagebrush when snow depth exceeded 14 inches (35 cm) (Danvir 2002). Hunnicutt (1992) determined sage-grouse preferred sagebrush cover greater than 17 percent and herbaceous cover less than 8 percent during April through June but sagebrush cover less than 17 percent and herbaceous cover greater than 20 percent during July through September. While nesting hens selected monotypic dense sagebrush stands, broods selected more diverse areas, having sagebrush stands interspersed with grassy openings and meadows (Hunnicutt 1992). Arthropod biomass generally increased with herbaceous biomass (Danvir 2002).

Weather and habitat availability apparently interacted to limit grouse survival. We found lek attendance stable to declining following dry summers and declining steeply following deep-snow winters (Danvir 2002). It appeared grouse survival declined when birds were concentrated by extreme weather events into limited habitat patches (i.e., riparian meadows in dry summers and exceptionally tall sagebrush in deep snow).

DLL sage-grouse and pronghorn production ratios (chick:hen and fawn:doe) were each three times greater in native sagebrush or grassland habitats (8 percent or greater forb cover) than in crested wheatgrass habitats (less than 3 percent forb cover). We hypothesized that grouse were alternately limited by lack of forb-rich areas (for brood rearing and drought survival) and tall, mature sagebrush at low elevations (for winter survival). Since much of the ranch is both summer and winter habitat for grouse, we implemented range treatments to produce an interspersion of mature, early and midseral sagebrush stands scattered throughout the landscape, providing opportunities for nesting, brood rearing and wintering grouse within pastures. We had observed numerous sage-grouse foraging in dry-land alfalfa (*Medicago sativa*) on reclaimed oil-pad sites, particularly in dry summers (the deep-rooted alfalfa remained green while most other forbs became desiccated). We began planting mixed species forb patches in crested wheatgrass stands and thinning patches of sagebrush (increasing herbaceous biomass) in select mature, native, sagebrush stands. Treatments were located and designed to simultaneously improve habitat for wintering elk, grouse broods, pronghorn fawns and cattle.

Densities of both leks and sage-grouse on DLL-managed rangelands are currently estimated to be 12 times the densities of traditionally grazed sagebrush-steppe habitats in northern Rich County (Mitchell 2003). Although DLL manages only 20 percent of the sagebrush range in Rich County, 80 percent of the males and two thirds of the active leks occur on the ranch (Mitchell 2003). DLL sage-grouse lek counts, from 1985 to 2004, are presented in Figure 1. The multiple trend lines track the increasing number of leks found through the years. The two declines in male attendance (1986 and 1993) follow deep snow winters. Male attendance on leks increased from 1994 to 2004, correlating positively with cumulative acres treated ($r^2 = 0.55$, $p = 0.01$). Surveys revealed grouse densities were seven times greater in forb-rich burned or planted treatment areas than in paired controls (Danvir 2002). Birds flushed in treatments were primarily hens with broods. Eighty percent of grouse observed in treatments were within 180

Figure 1. Number of male sage-grouse counted on two leks (1985–2004), 11 leks (1992–2004) and all leks, Deseret Land & Livestock Ranch, Woodruff, Utah.



feet (60 m) of sagebrush, either sagebrush "islands" or the treatment edge. Alfalfa was the most consistently occurring plant species at grouse feeding sites (Danvir 2002). However brood use increased both in burned and planted treatments in native sagebrush, as well as in forb patches planted in old crested wheatgrass stands.

Big game. Our experience suggests cattle and big game abundance are not mutually exclusive. From 1983 to 2004, both the number of mother cows and the number of combined big game animal-unit-month (AUM) equivalents increased on DLL. Summer adult elk abundance increased from an estimated population of 1,000 to over 2,000. Mule deer and moose abundance averaged 3,500 and 100 adults, respectively. In sagebrush-steppe range, the estimated pronghorn population increased from 100 to 800 adults, while cattle numbers were increased from 2,500 to 5,000 breeding cows. Big game production, body weights and antler mass generally remained at or above desired levels (Danvir, unpublished report 2004). Five to ten percent of the big game population is harvested annually. Danvir and Kearl (1996), comparing AUMs harvested by wildlife and livestock in the Morgan-South Rich DWR big game management unit, past and present, concluded more AUMs are now being harvested and range is in better condition with multispecies herbivory (cattle, sheep, elk, mule deer, moose and pronghorn) than occurred with essentially single-species grazing by sheep in the early 1920s.

Pronghorn responded favorably to 18 burned or planted treatments that increased forbs and decreased brush on DLL during 1995 to 2001 (Aoude and Danvir 2002). While pretreatment fawn production correlated negatively with population size ($r^2 = 0.89$, $p = 0.0001$), suggesting density dependent production, fawn production correlated positively with population size posttreatment ($r^2 = 0.70$, $p = 0.04$) suggesting increased habitat quality and carrying capacity (Aoude and Danvir 2002). Both fawn production and population size correlated positively with cumulative acres treated ($r = 0.81$, $p = 0.005$ and 0.65, $p = 0.03$, respectively, where r represents the correlation coefficient). Burned or planted areas were the only habitat types used preferentially by doe-fawn groups posttreatment.

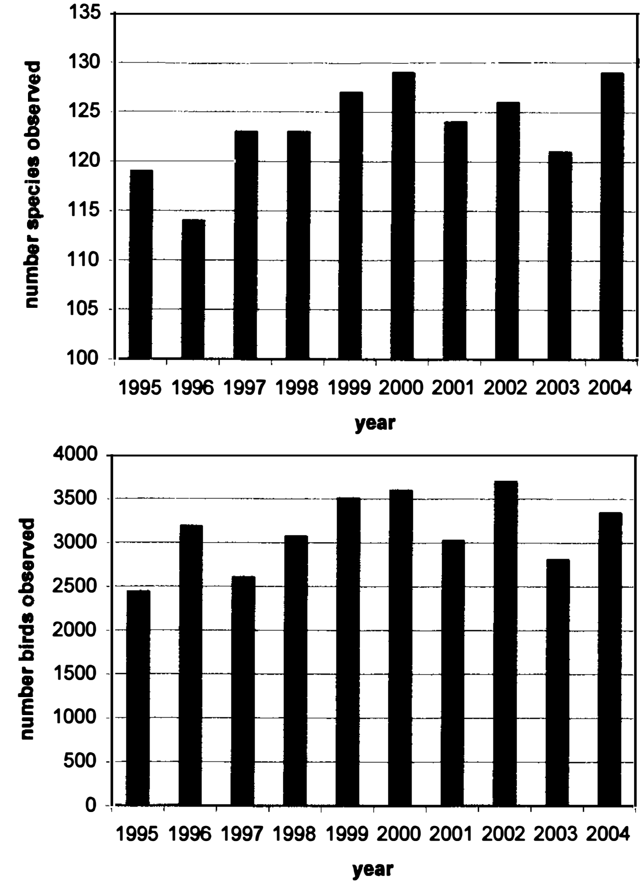
Small mammals. Moroge (1998), studying the relationship between small mammal diversity and sagebrush island patch size following a wildfire burn on DLL, found highest diversity in burned areas where brushy cover was interspersed with herbaceous seed-producing areas. Aoude (2001) found reduced small mammal species richness and abundance on large DLL fall burns. He found no significant difference in richness or abundance on spring burns or disked and planted treatments and observed increased richness and abundance in areas chemically brush-thinned with tebuthiron.

The DLL whitetail prairie dog (*Cynomys leucurus*) population appears stable and is distributed across approximately 10,000 acres (4,050 ha) of DLL sagebrush steppe. This population occurs primarily in 40-year-old crested wheatgrass plantings on relatively flat, deeper soils with less than 10 percent sagebrush cover (Beck 1994; A. Koslowski, personal communication 2004). DWR data suggests the number of occupied acres does not appear to have decreased in the last 15 years (A. Koslowski, personal communication 2004).

Initial monitoring suggests pygmy rabbits (*Brachylagus idahoensis*) are widely distributed throughout the ranch in deep-soiled sagebrush habitats, including at least one sagebrush patch thinned with tebuthiron and one patch thinned with a Lawson Pasture Aerator (R. Danvir, unpublished data 2004).

Other avifauna. Over 275 species of birds have been recorded on DLL. In 2002, the ranch was designated by the Utah Audubon Society as a Utah Important Bird Area. Combined species richness (mean 124) and number of individuals (mean 3,249) counted annually on three breeding bird surveys exhibited stable trends from 1995 through 2004 (Figure 2). Aoude (2001) found no difference in avian diversity between treatments types (burns, plantings and tebuthiron treatments) or their respective controls.

Figure 2. Combinednumber of species and birds observed annually (1985–2004) on three breeding bird surveys conducted on Deseret Land and Livestock Ranch, Woodruff, Utah.



Economic Results

DLL has remained profitable since adopting this approach. By developing cattle better suited to the environment, cattle pregnancy rates, growth rates and weaning weights increased (Wolfe et al. 1996). In combination, the changes made to irrigated land and cattle development decreased winter hay costs (by half), decreased calf production costs and significantly increased cattle profitability. Wildlife recreation revenues, although generally less than 30 percent of ranch net revenue, are invaluable in years of poor cattle prices and provide DLL managers means and motivation to manage for wildlife. Costs of treatments varied by method, ranging from under $10.00 per acre for spring burns, $15.00 to $25.00 per acre for tebuthiron and Lawson Aerator brush-thinnings, and $45.00 per acre for disked plantings (cost does not include archeological surveys). However, cost per additional AUM produced was similar among treatments, ranging from $1.50 per AUM for spring burns to $2.50 per AUM for disked plantings.

DLL, like many western ranches, depends on income from private and public range in order to effectively manage these lands. Agriculture is still a principal land-use and business in the rural west, e.g., over 90 percent of privately owned land in Wyoming is agricultural ground (Taylor 2003). Fifty percent of essential riparian and shrubsteppe habitats in Utah (D. Mitchell, personal communication 2003) and of year-round big-game habitats and at-risk migration corridors in Wyoming are privately owned agricultural land (Coupal et al. 2004, Feeney et al. 2004). Conversion of agricultural to residential land can negatively affect wildlife and rural economies. A summary of 83 studies by the American Farmland Trust in 2001, comparing the cost of community services (i.e., fire, police, schools and other services), found that residential use cost counties an average of $1.15 for every $1.00 in county revenue collected; while, agricultural land cost under $0.50 per $1.00 in revenue collected (Coupal et al. 2002).

Formation of Working Groups

Foundation for Quality Resource Management

By the 1990s DLL and other landowners in the Morgan-South Rich Area were managing for both wildlife and livestock. DWR wildlife managers and landowners alike felt a need to coordinate management efforts. Through a series of discussions, landowners realized that the management practices on one ranch could influence wildlife distribution and abundance on adjacent lands. From this awareness of interdependence arose the Foundation for Quality Resource Management (FQRM). The FQRM mission statement is simply to manage for healthy watersheds, healthy wildlife populations and agricultural values, using sound science and management, now and for future generations. This landowner-driven process increased understanding and cooperation between DWR and landowners and has resulted in coordinated management of wildlife populations and habitat. FQRM meetings provide an opportunity for DWR and other agency personnel to form relationships with landowners in a nonhostile environment.

Depredation issues, once a serious problem in the Morgan-South Rich Area, greatly diminished as landowners began working together to solve common problems. Landowners owning big game summer range began to realize that their wildlife programs depended on the economic survival of the winter range landowners—to whom big game could be a liability. Landowners realized that if the winter ranges were converted from agricultural to residential land, wildlife and many landowners would suffer negative consequences.

Landowners began assessing themselves a fee and identified priority management projects, such as sagebrush range restoration. FQRM members then partnered with conservation groups and agencies having similar missions to fund and implement projects. FQRM currently has three chapters in parts of four Utah counties, involving hundreds of thousands of acres of privately owned sagebrush range. To date, over $500,000 have been raised through these partnerships and have been used to implement restoration projects on over 20,000 treated acres (8,095 ha), thus positively impacting wildlife populations on thousands more adjacent acres.

Cooperative Wildlife Management Unit Association

The Cooperative Wildlife Management Unit (CWMU) Association includes landowners, operators and outfitters enrolled in Utah's CWMU program for big game management. This organization, landowner led and supported by USU Wildlife Extension and DWR, was formed to help landowners and CWMU operators manage wildlife resources. The group has developed a code of ethics, hosted numerous member meetings and tours, and worked with DWR and the Utah legislature to better manage the 1.6 million acres (65,000 ha) of privately owned rangelands enrolled in Utah's CWMU program.

Rich County Coordinated Resource Management Planning Committee

The Rich County Coordinated Resource Management Planning Committee was formed in 2002, in part responding to a legal challenge to managers of livestock grazing on BLM rangelands. The committee is sanctioned by the Rich County government, and it includes private citizens, representatives of conservation and environmental groups, county government, and state and federal resource management agencies. The group developed a county-wide vision to manage for healthy range, wildlife populations and a vibrant rural economy. They developed plans, obtained funding and began sagebrush-steppe restoration efforts on a demonstration project in northern Rich County—the 30,000 acre (12,000 ha) Duck Creek allotment. This allotment includes privately, BLM- and state-owned lands. It is a multistate deer wintering area, provides summer range for migratory avian species, and offers year-round habitat for sage-grouse and pygmy rabbits. Initial surveys suggest high populations of pygmy rabbits but low sage-grouse abundance. Most of the allotment is dominated by mature sagebrush stands. The committee recommended that BLM adopt a management strategy that includes implementing time-controlled grazing management and creates early- to midseral sagebrush patches. Duck Creek allotment project implementation and monitoring have begun, and the committee is currently assisting BLM with environmental assessments and is developing county-wide plans based on the vision statement and adaptive management.

Conclusions

Based on our management and monitoring experience at DLL, we believe that time-controlled grazing and periodic creation of forb-rich, early-seral conditions in appropriate areas (i.e., brood and fawn-rearing areas) has increased sage-grouse and pronghorn populations. We believe we have maintained an abundance of other plant and wildlife species in the sagebrush steppe as well. By generating revenues from wildlife recreation and livestock production, we have paid the learning and management costs of this program. However the accomplishments described here would not have been possible without the cooperation and coordinated activities of numerous agencies and adjoining landowners—striving to understand each others' needs and to manage for shared goals. We believe this success can be duplicated elsewhere, on both publicly and privately owned lands, if grazing and behavioral principles are understood and applied properly. There is a need for further research into economically and ecologically cost-effective ways of generating revenues from rangelands in order to fund the land management activities, e.g., teaching livestock to forage on invasive weeds and brush as is being demonstrated by the BEHAVE consortium (http://www.behave.net, Provenza 2003). Sage-grouse and sagebrush-steppe management is a process, not an event; therefore, we believe the ecosystem management principles discussed here will need to be continued and be improved in perpetuity to sustain the lifestyle, biodiversity, open space, water and soil quality values owed to generations unborn.

Intermittent herbivory, by herding ungulates, and fire have likely maintained herbaceous plant dominance and reduced the abundance of chemically defended woody plants in rangelands (worldwide) for millennia (Augustine and McNaughton 1998). The current condition of sagebrush rangelands in North America, in part, results from human management of fire and native and domestic herbivores (West 1999, Bonnicksen 2000). Our experience suggests wild and domestic herbivores can coexist on and can sustain healthy sagebrush range, if properly managed. We suggest undesirable range conditions on sagebrush rangelands generally result from undesirable management practices. To be successful, this means defining broadly supported, mutually agreed upon watershed goals and developing management strategies incorporating multispecies grazing to manage herbivory and succession. We have found that energy spent vilifying domestic livestock or wild ungulates is better invested in understanding and implementing the behavioral principles responsible for the functioning of humans, animals, vegetation and ecosystems (Savory 1988, Provenza 2003).

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Effective Management Strategies for Sage-grouse and Sagebrush: A Question of Triage?

Michael J. Wisdom
U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station
La Grande, Oregon

Mary M. Rowland
U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station
La Grande, Oregon

Robin J. Tausch
U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station
Reno, Nevada

Sagebrush: An Ecosystem Gone Wrong

The sagebrush (*Artemisia* spp.) ecosystem once occupied over 150 million acres (60 million ha) of western North America (Barbour and Billings 1988). The ecosystem still occupies over 100 million acres (40 million ha) (Connelly et al. 2004, Wisdom et al. 2005), but the abundance and condition of sagebrush communities are declining rapidly in response to a variety of detrimental land uses and undesirable ecological processes (Knick et al. 2003). The ecosystem has been reduced in area by 40 to 50 percent since pre-European settlement (Connelly et al. 2004), and less than 10 percent remains in a condition unaltered by human disturbances (West 1999).

The ills of the sagebrush ecosystem are well documented. Millions of acres have been converted to agriculture, cities, roads, transmission lines, energy developments, exotic plants and woodlands (Connelly et al. 2004). Moreover, the loss appears to be accelerating, and management intervention thus far has been ineffective in abating the rate of loss, let alone reversing it (Hemstrom et al. 2002). Millions of acres of remaining sagebrush are threatened by the continued and widespread invasion of cheatgrass (*Bromus tectorum*) and other exotic plants, as well as by expansive encroachment of pinyon pine (*Pinus* spp.) and juniper (*Juniperus* spp.) woodlands (Billings 1994, Tausch et al. 1995, Wisdom et al. 2005). Finally, up to 80 percent of remaining sagebrush communities could be lost to the direct and indirect effects of global warming (Neilson et al. 2005). Direct effects are a result of substantially elevated levels of carbon dioxide from human activities (Vitousek et al. 1997). Indirect effects include the increased competitive ability of exotic annual grasses and arid vegetation of the southwestern United States, both of which are projected to invade and replace vast areas of existing sagebrush (Smith et al. 2000, Neilson et al. 2005).

Despite overwhelming evidence regarding the demise of the sagebrush ecosystem and the many causes for decline, the specific effects on many sagebrush-associated species are not well documented. Populations of many sagebrush-associated species, however, are declining (e.g., Wisdom et al. 2000, Dobkin and Sauder 2004), and approximately 20 percent of the ecosystem's native flora and fauna are considered imperiled (Center for Science, Economics and Environment 2002). Moreover, Raphael et al. (2001) found that the estimated risks of regional extirpation for sagebrush-associated vertebrates, under current management of public lands, were similar to risks for species in other ecosystems that were already listed as federally threatened or endangered under the U.S. Endangered Species Act. These high extirpation risks are exemplified by status and trends of greater sage-grouse (*Centrocercus urophasianus*); its populations have declined steadily over the latter half of the 20th century, the same time period in which human activities have substantially reduced the quantity and quality of sagebrush (Connelly and Braun 1997, Connelly et al. 2004, Rowland 2004). Similar population trends in response to detrimental land-use effects have been documented for the smaller populations of Gunnison sage-grouse (*Centrocercus minimus*) (Oyler-McCance et al. 2001, Schroeder et al. 2004).

Although status and trends of many sagebrush-associated species may be uncertain, it is clear that the ecosystem, as a whole, is in serious trouble. The sagebrush ecosystem is considered one of the most imperiled of all ecosystems in the United States (Noss et al. 1995, Stein et al. 2000), and recent assessments of sagebrush habitats at regional scales substantiate this view (e.g., Nachlinger et al. 2001, Connelly et al. 2004, Wisdom et al. 2005). The ecosystem's native vertebrates not only face high risks of extirpation at regional scales, but major ecological processes, such as fire and hydrologic regimes, have been substantially altered (Billings 1994; Tausch et al. 1995; Bunting et al. 2002; Pierson et al. 2002, 2003). Adding to the view of ecosystem imperilment is the lack of effective management to reverse undesirable trends in vegetation dynamics and fire regimes (Hemstrom et al. 2002). Consequently, we may not understand the specific mechanisms by which many sagebrush-associated species respond to habitat loss and fragmentation, but the evidence thus far suggests that the entire ecosystem faces an array of threats that appear to be accelerating in effect and extent.

The plethora of detrimental effects on the sagebrush ecosystem is illustrated by the long list of anthropogenic threats that have reduced the ecosystem's abundance, quality and contiguity. Wisdom et al. (2005) identified 26 threats to sagebrush habitats and species that operate at regional scales and thus affect, or have potential to affect, areas the size of a county, multiple counties, or even a state (Table 1). The varied range of threats—from climate change to exotic plant invasions, from roads to transmission lines and from urban development to overgrazing by feral horses—illustrates the point that no single factor or process is responsible for the ecosystem's problems. This is perhaps the most challenging aspect of future management; no particular solution is apparent, easy, quick or straightforward.

Table 1. Potential threats, associated effects and specific examples of the effects on habitats and species in the sagebrush ecosystem (adapted from Wisdom et al. [2005]). See Wisdom et al. (2005) for supporting references included in the original table.

Potential Threat	Associated Effects	Examples
Weather, climate change and catastrophes	*Environmental–* habitat loss or degradation	Gradually increasing temperatures have contributed to drought and more severe and frequent wildfires, escalating the spread of invasive plants, such as cheatgrass in sagebrush ecosystems. Drought years in close succession can lead to losses of key forbs used by sagebrush-associated species.
	Population– stochastic events	Catastrophic events, such as floods and severe drought, can lead to extirpation of small populations.
Roads and highways	*Environmental–* habitat loss	Creation of roads and highways and their associated rights-of-way result in direct loss of habitat.
	Environmental– habitat fragmentation and degradation	Creation of roads and highways and their associated rights-of-way fragments sagebrush habitats; roads may accelerate the spread of invasive plants.
	Population– barrier to migration or road	Roads may serve as movement or migration barriers to less mobile species; animals may avoid traffic or other activities associated with roads.

Table 1 continued. Potential threats, associated effects and specific examples of the effects on habitats and species in the sagebrush ecosystem (adapted from Wisdom et al. [2005]). See Wisdom et al. (2005) for supporting references included in the original table.

Roads and highways (continued)	*Population*–direct and indirect mortality	Death or injury from collisions with vehicles and increased mortality from poaching due to improved access may occur.
Intensive livestock grazing	*Environmental*–habitat degradation	Ecologically inappropriate grazing by domestic stock, especially cattle and sheep, leads to loss of native perennial grasses and forbs in the understory (changes in composition and structure), with resulting declines in forage and other habitat components for species of concern and their prey (e.g., invertebrates) or facilitation of spread and establishment of exotic plants; trampling may destroy burrows used by some species. such as burrowing owls or pygmy rabbits.
	Population– direct mortality	Mortality from trampling of nests may occur.
Oil and natural gas field development	*Environmental*–habitat loss and fragmentation	Pipelines, roads, well pads and associated collection facilities fragment habitats; outright loss of habitat also occurs from roads and well pads and other facilities constructed for field development
	Population–disturbance	Disturbance and potential abandonment of habitat due to vehicular traffic, other noise (e.g., compressor stations), and related human activity at well sites may occur.
	Environmental–habitat degradation	Disturbed sites (e.g., roadsides and well pads) may become infested with invasive species.
Fences	*Environmental*–habitat fragmentation	Construction of fences in sagebrush ecosystems can fragment habitats and interfere with animal movement (e.g., pronghorn).
	Population–direct mortality	Animals can collide with fences or become entangled, leading to injury or death.
Expansion of juniper and other woodland species in sagebrush communities	*Environmental*–habitat loss and degradation	Changes in climate and fire suppression have led to expansion of pinyon pine and juniper woodlands into sites previously occupied by sagebrush, especially in mountain big sagebrush and Wyoming big sagebrush.
Invasions of exotic plants	*Environmental*–habitat loss and degradation	Altered fire regimes and habitat degradation (e.g., from intensive livestock grazing) have led to increases in exotic plants (e.g., cheatgrass) in sagebrush ecosystems; noxious weeds can also be accidentally introduced during reclamation of oil and gas well sites
Reservoirs, dams and other water developments	*Environmental*–habitat loss	Outright loss of habitat from establishment of reservoirs in sagebrush habitat may occur.
	Environmental–habitat degradation	Altered stream flows and hydrological regimes may degrade or change habitat for aquatic and riparian species.

Table 1 continued. Potential threats, associated effects and specific examples of the effects on habitats and species in the sagebrush ecosystem (adapted from Wisdom et al. [2005]). See Wisdom et al. (2005) for supporting references included in the original table.

Herbicides	*Environmental–* habitat loss and fragmentation	Herbicides used extensively prior to the 1980s for conversion and removal of sagebrush, especially if native understory vegetation was in relatively good condition may cause loss and fragmentation.
Transmission lines	*Environmental–* habitat degradation	Disturbance of vegetation and soils in corridors can lead to increased invasion of exotic species in these areas.
	Population– increased rates of predation	Poles and towers for transmission lines may serve as additional perches or nest sites for corvids and raptors, increasing the potential for predation on sagebrush-associated species
	Population–direct mortality	Birds may collide with transmission lines, resulting in injury or death; electrocution of perching raptors and other birds also occurs.
Altered fire regimes	*Environmental–* habitat loss	Increases in catastrophic wildfires, often related to invasions of cheatgrass, have resulted in complete removal of sagebrush cover (i.e., type conversion), especially in Wyoming big sagebrush communities.
	Environmental– habitat degradation	Fire suppression has led to altered fire cycles in sagebrush ecosystems, resulting in changes in vegetation composition and structure, e.g. encroachment of woodlands into sagebrush.
Urban development	*Environmental–* habitat loss	Development of urban areas and "ranchettes" surrounding urban sites results in direct loss of sagebrush habitats.
	Population– human	Increases in human activities in urban and exurban areas may negatively affect populations of disturbance-associated sagebrush species by displacement or abandonment. Predation rates on wildlife in sagebrush habitats also may increase from domestic dogs and cats in urban and rural settings, as well as from increased populations of predators, such as corvids, due to increased availability of food and to resources associated with human waste (e.g., garbage dumps, trash in campgrounds).
Herbivory effects from wild ungulates	*Environmental–* habitat degradation	Localized, excessive herbivory by native ungulates can lead to degraded understories in sagebrush ecosystems (e.g., changes in species composition and structure) and reductions in sagebrush densities and canopy cover
Disease transmission	*Population*–direct mortality	Disturbance from oil and gas development may lead to. concentrations of native ungulates on winter ranges, exacerbating disease transmission during the stressful winter season. In addition, human-made water sources, particularly those whose status has changed from ephemeral to permanent from human activities, may lead to increased transmission of mosquito-borne diseases, such as West Nile virus.

Table 1 continued. Potential threats, associated effects and specific examples of the effects on habitats and species in the sagebrush ecosystem (adapted from Wisdom et al. [2005]). See Wisdom et al. (2005) for supporting references included in the original table.

Brood parasitism by brown-headed cowbirds	*Population–* direct mortality	Populations of some avian species (e.g., lark and vesper sparrows) in the sagebrush ecosystem may be affected by parasitism from brown-headed cowbirds, a species which may increase in human-altered environments, such as livestock feedlots and overgrazed pastureland.
Recreation	*Environmental–* habitat degradation	Off-road vehicle use can degrade habitats in the sagebrush ecosystem, e.g., by increasing presence of exotic annual grasses like cheatgrass.
	*Population–*human disturbance	Recreational activities, such as off-road vehicle use in sagebrush habitats, may affect species of concern, e.g., displacement or nest abandonment. Recreational shooting of small mammals also can directly affect populations.
Conversion of sagebrush to cropland or tame pasture for livestock	*Environmental–* habitat loss	Removal of sagebrush cover (e.g., via brush-beating, chaining, disking or burning) and planting with crops, such as alfalfa, or with nonnative perennial grasses (e.g., crested wheatgrass) for livestock forage; examples of affected species are greater sage-grouse, swift fox and ferruginous hawk.
	Environmental– habitat fragmentation	Removal of sagebrush may lead to fragmentation of remaining sagebrush habitats, resulting in interference with animal movements, dispersal or population fragmentation.
	*Population–*direct mortality	Nest and egg destruction, or direct mortality of animals, from mechanical or other methods used to remove sagebrush or to cultivate lands adjacent to sagebrush may occur.
Mine development	*Environmental–* habitat loss and fragmentation	Fragmentation and outright loss of habitat to surface mines and associated mine tailings and roads, especially coal mines may occur.
	Population– disturbance	Disturbance and potential abandonment of habitat due to traffic, noise and related human activity at mine site may occur; examples of affected species are bats and greater sage-grouse.
Pesticides	*Environmental–* habitat degradation	Decrease in forage base by killing of insects used as prey by sagebrush-associated species may occur.
	Population– mortality	Direct mortality of birds and other vertebrates exposed to pesticides, and indirect mortality through consumption of contaminated insects may occur.
Saline-sodic water	*Environmental–* habitat degradation	The disposal of millions of barrels of water produced during coal-bed methane (CBM) extraction can lead to salinization of surrounding soils and aquatic systems into which these waters may be dumped. In addition, sodic water discharged from wells can lead to high mortality rates (up to 100%) in vegetation exposed to such discharge.

Table 1 continued. Potential threats, associated effects and specific examples of the effects on habitats and species in the sagebrush ecosystem (adapted from Wisdom et al. [2005]). See Wisdom et al. (2005) for supporting references included in the original table.

Wind energy development	*Environmental*–habitat degradation	Increase of noxious weeds in areas around turbines or along roads needed to access turbines and a loss of habitat from road construction and turbine installation may occur. In addition, some species may avoid the area near turbines due to the association of such structures with nests or perches of avian predators such as corvids.
	Population–mortality	Deaths and injuries of birds and bats from collisions with wind turbines
Collection of specimens for personal, commercial or scientific uses	*Population*–loss of individuals from the wild	Collection of rare plants and animals, especially herptiles, may pose unknown risks to populations of these species; an example is the midget faded rattlesnake.
Groundwater depletion	*Environmental*–habitat degradation	The pumping of water for CBM may lead to excessive groundwater withdrawal in the well sites.
Grazing by feral horses	*Environmental*–habitat degradation	Loss of native perennial grasses and forbs in the understory may occur.
Selenium and other environmental contaminants	*Population*–direct threat of mortality	Poisoning of animals from uptake of selenium in contaminated aquifers, primarily from agricultural runoff may occur.
Military training	*Environmental*–habitat fragmentation	Training exercises in sagebrush habitats may result in loss of shrubs from both wildfire and destruction from tracked vehicles, and they may lead to habitat fragmentation.

What to Do?

To further belabor the many ills of the sagebrush ecosystem is to ignore the real question of importance. And that is, what can be done to improve the situation? In addressing this question, two primary objectives are likely to drive future management of public lands in the sagebrush ecosystem: (1) the desire to maintain current sagebrush habitats and associated flora and fauna and (2) the desire to restore at least a portion of sagebrush habitats that have been lost.

To meet these objectives, managers are confronted with three related problems: (1) a high probability of threshold effects that are difficult or impossible to avoid or overcome, (2) a lack of resistance in most sagebrush communities to changes caused by human-associated disturbances and (3) a lack of resiliency in most sagebrush communities to return to former native states once a community change occurs.

We define a threshold effect as any transition from one vegetative state to another that results in a new steady state that is extremely difficult or impossible to change, regardless of the transition agents that may be implemented in an attempt to move to a more desired state. We define resistance as the degree to which a given vegetative state can maintain itself in the face of disturbance. We define resiliency as the degree to which a given vegetative state returns to its former state when changed by a disturbance.

All three concepts are based on state and transition models of vegetation development (Tausch et al. 1993; Figures 1, 2) as used in arid and semiarid rangelands in many areas of the world (Westoby et al. 1989, Laycock 1991). All three concepts are interrelated and integral in the maintenance and restoration of sagebrush habitats and, thus, are central paradigms for management. For example, overgrazing by ungulates in a Wyoming big sagebrush (*A. tridentata wyomingensis*) community with low resistance to invasion by cheatgrass may cause a transition from an understory of native, perennial grasses to one of codominance of native grasses and cheatgrass (Figure 1). At this point, a threshold has been crossed, in turn, setting up an eventual threshold effect that is facilitated by subsequent fires. The subsequent fires progressively change the codominance of native grasses and cheatgrass in the understory to one of dominance by cheatgrass. Eventually, a series of high-intensity, frequent fire events transform the sagebrush community to a homogenous stand of cheatgrass, which is highly resistant to change and highly resilient to further disturbance events. Eventually, if a transition from cheatgrass does occur, the most likely change is to other undesired, exotic perennial grasses that can dominate a site with still higher resistance and resiliency (Nancy Shaw, personal communication 2004).

The vegetation dynamics described above are typical of Wyoming big sagebrush communities occurring in warmer, drier portions of the sagebrush ecosystem (West 1999). The Wyoming big sagebrush community in this example has low resistance and resiliency in the face of ungulate grazing, invasion by cheatgrass and fire (see Hemstrom et al. 2002 for details about these dynamics).

Notably, the three disturbance agents work together in a synergistic manner to transform the Wyoming big sagebrush community to cheatgrass. In addition, other disturbance agents could function in the same manner as ungulate grazing, such as off-road vehicle use, in facilitating the initial invasion of cheatgrass. Consequently, no single disturbance agent contributes solely to the

Figure 1. Example of a state-and-transition model for a Wyoming big sagebrush community with very low resistance and resiliency, such as might occur at sites that are extremely dry (e.g., less than 10 inches annual precipitation) and warm (e.g., less than 3,000 feet in elevation). Boxes represent vegetation states, and arrows are transitions caused by disturbance agents shown next to each arrow. Dashed arrows represent transitions that may be difficult to achieve, owing to threshold effects that have occurred.

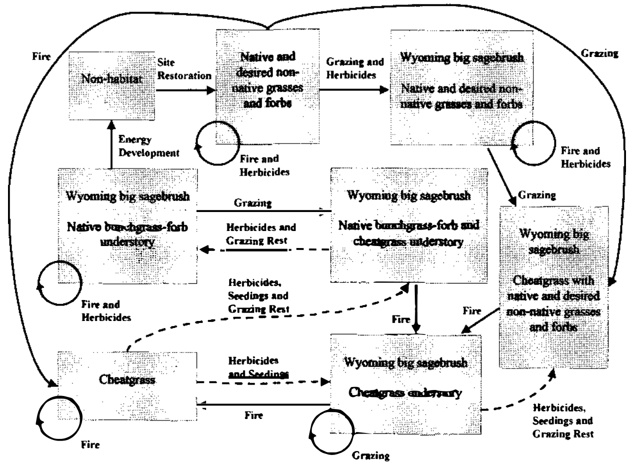
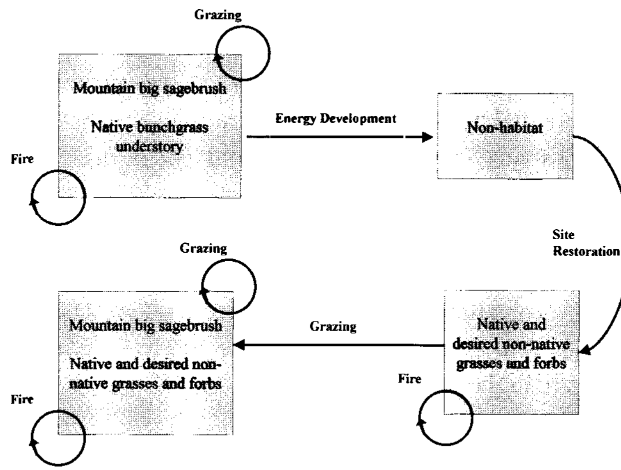


Figure 2. Example of a state-and-transition model for a mountain big sagebrush community with high resistance and resiliency at sites, such as might occur at sites that are very wet (e.g., over 14 inches annual precipitation) and cold (e.g., over 6,500 feet in elevation). Boxes represent vegetation states, and arrows are transitions caused by disturbance agents shown next to each arrow.



new steady state. Instead, a chronic disturbance (ungulate grazing or off-road vehicle use) initially weakens the community, allowing cheatgrass to spread, in turn providing sufficient fuels to carry progressively hotter and more expansive fires with each subsequent fire event. Thus, the cumulative effect of all disturbance agents causes the transition to the new steady state.

These concepts of threshold effects, resistance and resiliency are further illustrated in a conceptual state and transition model in the mountain big sagebrush (*A. t. vaseyana*) community (Figure 2). In this example, the community is highly resistant to change in the face of chronic disturbances, such as ungulate grazing or off-road recreation use, and fire events are less intense and typically invigorate the native flora inherent to the site (per descriptions by Miller and Eddelman 2001). Moreover, efforts to restore the community after land uses that intentionally transform the area to nonhabitat, such as from energy development, have a higher potential for success. By contrast, restoration of the Wyoming big sagebrush community following a land transformation, such as energy development, is substantially more complicated and uncertain (Figure 1).

The disparity of responses among different sagebrush communities, like those described above, suggests that the most challenging aspect of current management is to correctly decipher which sagebrush communities, under which site conditions, are resistant and resilient, versus communities of low resistance and resilience, as well as those with characteristics intermediate to these extremes. Current knowledge suggests that little can be done to restore vast areas of sagebrush that have already been lost and have experienced threshold effects that are impossible, or highly improbable, to reverse (Bunting et al. 2002). On the other hand, many areas of existing sagebrush may be close to transitioning to new steady states that may be difficult to reverse, but these transitions might be prevented through management intervention. Still other areas of sagebrush are highly resistant and resilient to most human disturbances, and they currently demand less management intervention to retain native components and processes.

Given this array of conditions, managers need a systematic way of prioritizing sites, across the entire ecosystem, for application of best management practices that provide the greatest return on investment (i.e., provide the highest probability of maintaining current sagebrush communities or of restoring extirpated communities). We assume that prioritization would be designed to meet the primary objective of maintaining current sagebrush communities and their native flora and fauna. We further assume that a secondary objective would be to restore a targeted portion of sagebrush communities when such restoration would best serve goals of enhancing current habitat conditions. Without new, strategic, and comprehensive methods of spatial prioritization for management, a continuing trend of expansive sagebrush loss and degradation is likely to continue (Hemstrom et al. 2002, Wisdom et al. 2002).

Accordingly, we suggest that sagebrush managers adopt a strategic process that addresses the sagebrush ecosystem as a whole and that provides explicit rationale for spatial prioritization of best management practices to meet the above-stated objectives. The process could include the following ecological concepts and analytical considerations to increase its effectiveness.

1. *Develop a new paradigm of holistic management of all human-associated disturbances.* The 26 factors listed in Table 1 all pose threats to sagebrush habitats at some time and place, and many affect vast areas of the ecosystem in undesirable ways. If all human-associated disturbances were effectively managed, many existing sagebrush communities might be maintained, and some of the former communities would have a better chance of being restored. To focus mitigation on some threats but to ignore many other threats (Table 1) is a strategy likely to fail when applied across expansive areas that typically experience a wide variety of disturbances.
2. *Establish spatial priorities across the entire ecosystem for best uses of limited resources for maintenance of current, desirable conditions.* It is a myth to believe that small refinements in current management practices will maintain existing, desirable conditions in areas where sagebrush communities have low resistance and resiliency (Hemstrom et al. 2002). By contrast, sagebrush communities with high resistance and resiliency are likely to require less management attention. Finally, the many sagebrush communities that have intermediate levels of resistance and resiliency may require most of the limited resources available for best management practices, so as to prevent undesirable transitions that are likely to occur without improvements to current management. As stated above, preventing undesirable transitions across thresholds requires comprehensive and effective management of all human-associated disturbances that operate at broad scales in the sagebrush ecosystem, such as the threats listed in Table 1.
3. *Evaluate the anticipated responses of sagebrush communities to human-associated disturbances, across the entire ecosystem, as the basis for spatial prioritization of management.* Establishing spatial priorities for management could use maps of the estimated resistance and resiliency of sagebrush communities as part of the priority-setting process. Communities with low or high resistance and resiliency would, in turn, have low or high potential for maintenance of current habitats. Spatial priorities for restoration of former habitats could also employ a similar process based on site conditions.

As an example of such a process, we estimated and mapped the potential to maintain current sagebrush communities, and to restore former communities across the historical range of greater and Gunnison sage-grouse (see Schroeder et al. [2004] for derivation of range map). We used precipitation and elevation as proxies, or indicators, of community resistance and resiliency and, by extension, the potential to maintain or restore sagebrush. In general, resistance and resiliency decline with decreasing precipitation and elevation, which index a gradient of increasingly dry (low precipitation) and warm (low elevation) conditions (West 1999). As sagebrush sites become increasingly dry and warm, the probability of maintenance of sagebrush overstories and native grass understories declines in the presence of human-associated disturbances (Hemstrom et al. 2002). For example, road construction through a sagebrush site with high precipitation (e.g., over 14 inches [36 cm] mean annual precipitation) at colder, higher elevation (e.g., over 6,500 feet [1,980 m]) would have a lower likelihood of facilitating the establishment and spread of nonnative, invasive plants. By contrast, the same road construction through a sagebrush site with low precipitation (e.g., less than 10 inches [25 cm] mean annual precipitation) at warmer, lower elevation (e.g., less than 3,000 feet [914 m]) would have a higher likelihood of successfully establishing and spreading invasive plants.

Based on these relations, we developed spatial rules for estimating and mapping the potential to maintain existing sagebrush or to restore former sagebrush sites under varying combinations of precipitation and elevation classes (Table 2). We then applied the rules to existing cover types of sagebrush (Comer et al. 2002) to estimate the potential to maintain existing sagebrush (Figure 3). We also applied the rules to sites currently not occupied by sagebrush but identified by Küchler (1970) as potential sagebrush sites; these latter areas were mapped as a means of estimating restoration potential of sites that were likely to support sagebrush in the past.

The results of such a mapping process (Figures 3, 4) appear to provide helpful insights about spatial patterns regarding the potential to maintain and restore sagebrush communities. In general, most areas with high potential to maintain or restore sagebrush communities are concentrated in Wyoming, eastern Idaho and northern Nevada. Areas

Table 2. Spatial rules for estimating the potential to maintain existing sagebrush cover types or to restore former sagebrush cover types, using combinations of mean annual precipitation and elevation classes as proxy variables that index resistance and resiliency of sagebrush communities.

Elevation (feet)[a]	Precipitation (inches)[b]	Potential for maintenance or restoration
< 3,281	All values	Very low
3,281–6,562	< 10	Very low
3,281–6,562	10–12	Low
3,281–6,562	> 12–14	Moderate
3,281–6,562	> 14	High
> 6,562	All values	High

[a] Based on the National Elevation Dataset (NED), derived by the U.S. Geological Survey (1999) and summarized to a 98.4-yard grid. Estimates of elevation were then overlaid on 98.4-yard grid estimates of existing sagebrush cover types derived by Comer et al. (2002) or potential sagebrush sites (Küchler 1970) summarized by U.S. Department of Agriculture, Forest Service (2000).

[b] Based on mean annual precipitation, summarized for the period 1961 to 1990, as derived by (Taylor 2000), and summarized to a 98.4-yard grid. Estimates of precipitation were then overlaid on 98.4-yard grid estimates of existing sagebrush cover types derived by (Comer et al. 2002) or potential sagebrush sites (Küchler 1970).

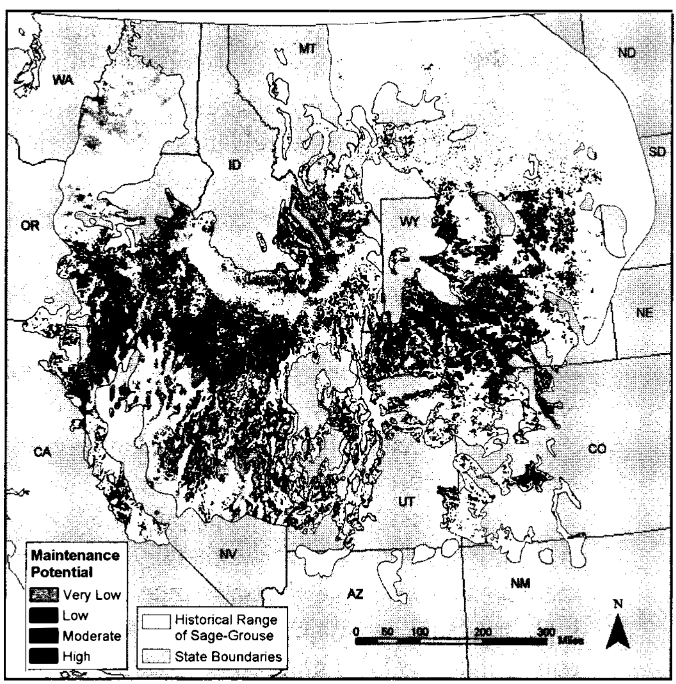
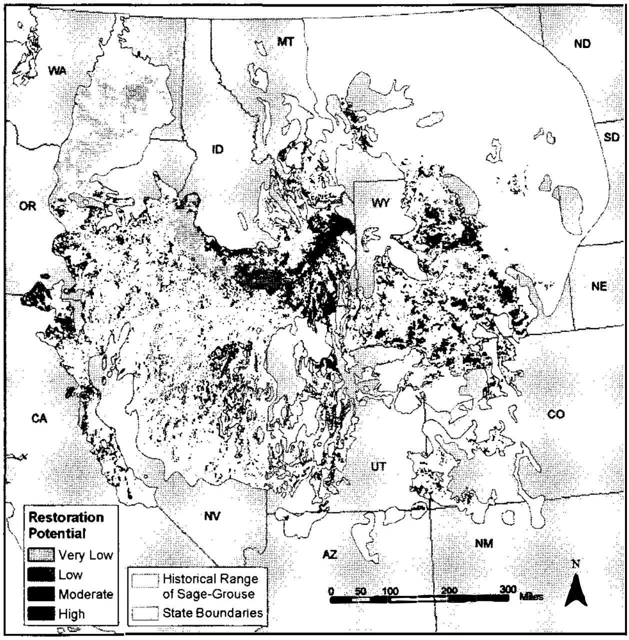


Figure 3. Estimated potential to maintain existing sagebrush communities that ar within the historical ranges of greater and Gunnison sage-grouse, based on the estimated resistance and resiliency of the communities.

Figure 4. Estimated potential to restore former sagebrush communities within the historical ranges of Greater and Gunnison Sage-grouse, based on the estimated resistance and resiliency provided by the sites.



with very low, low or moderate potential to maintain or restore sagebrush are concentrated in Washington, Oregon, western Idaho and much of Nevada. These patterns (Figures 3, 4) appear to closely match the geographic variation in habitat losses due to exotic plant invasions and agricultural development across the sagebrush ecosystem (Connelly et al. 2004). We also believe these patterns match the general sensitivity of sagebrush areas to human-associated disturbances. That is, sagebrush communities with high maintenance potential would be more resistant to change in the face of disturbances, such as grazing, road construction and recreation. Similarly, while land uses that transform sagebrush habitats to nonhabitats have the same immediate effect, the sagebrush sites with higher potential for restoration have higher resiliency and, thus, have a higher probability to bounce back from the transformation, once restoration is initiated (e.g., compare Figure 1 with Figure 2).

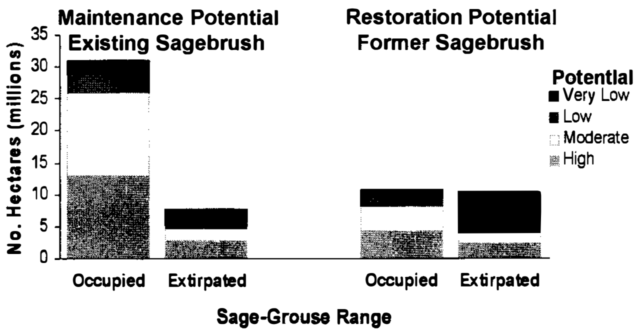
Our maps and results are not definitive, but instead they demonstrate a conceptual process of characterizing the potential for sagebrush maintenance and restoration across the ecosystem. The mapping process shown here could be substantially refined and enhanced with the inclusion of additional variables, such as temperature, slope, aspect, species and subspecies of sagebrush, drought indices, soil characteristics, and human activities, each of which are likely to improve the characterization of the potential to maintain or restore sagebrush communities.

4. *Estimate the resources and budgets required over time and space to fully address all spatial priorities.* The maps, like those shown in Figures 3 and 4, can be used to develop broad-scale management prescriptions for maintenance and restoration. Funds needed to fully implement all prescriptions on high-priority sites then could be estimated, independent of the considerations of current budgets or political influences. Without identification of the full level of funding needed to meet objectives for maintenance and restoration, there is no opportunity for policies to change in recognition of funding shortfalls.

5. *Adopt the concept of triage throughout the process.* Unless budgets substantially increase for public land managers of sagebrush, there simply are not enough resources to maintain all current sagebrush communities, let alone recover a portion of communities lost. In the Interior Columbia Basin, Hemstrom et al. (2002) and Wisdom et al. (2002) found that a six-fold increase in the budgets of the U.S. Department of Interior, Bureau of Land Management (BLM) and the U.S. Department of Agriculture, Forest Service for sagebrush maintenance and restoration reduced the rate of decline in habitat loss and quality but did not reverse the decline. Notably, Hemstrom et al. (2002) and Wisdom et al. (2002) focused their management scenarios on restoration of former sagebrush sites, with less emphasis on maintenance of existing communities; increased emphasis on maintenance would likely have resulted in more effective outcomes. Regardless, the findings of these authors demonstrate that a dramatic funding increase is required to realistically expect a reversal in the accelerating loss and quality of sagebrush habitats. Consequently, the concept of triage, defined in the medical profession as the allocation of treatment to patients, especially battle and disaster victims, according to a system of priorities designed to maximize the number of survivors, is appropriate in sorting through the sagebrush communities to allocate resources to maximize the number, size, type and distribution of communities that survive.

While the actual priority-setting process is beyond the scope of our paper and is driven by legal, policy and socioeconomic criteria in combination with the ecological considerations we discuss here, the investment of resources at sites and landscapes deemed to provide the greatest return is critical. An example is the question of how best to manage and restore habitats for sage-grouse. To illustrate the choices, we summarized the area of existing and former sagebrush communities, by levels of potential to maintain or restore sagebrush (Figures 3, 4), within areas currently occupied by greater and Gunnison sage-grouse versus areas where extirpation has occurred (Figure 5). From the viewpoint of triage, assuming budgets remain inadequate to maintain and restore all habitats for the species, the following areas and sagebrush communities are likely to receive high management attention:

Figure 5. Area of sagebrush cover types estimated as very low, low, moderate and high potential for maintenance and for restoration, summarized by occupied versus extirpated ranges of Greater and Gunnison sage-grouse.



1. *All remaining sagebrush habitats that exist in occupied greater sage-grouse range in Washington, as well as all sites of former sagebrush in occupied range or adjacent to occupied range in Washington.* These areas and habitats are essential to persistence of the small populations of greater sage-grouse in Washington, which have been designated as warranted but precluded for listing under the under the federal Endangered Species Act. Unfortunately, these areas and habitats appear to have lower potential for maintenance or restoration in contrast to other areas of occupied range (Figures 3, 4) and thus will demand substantial resources for successful management.
2. *Existing habitats, in occupied sage-grouse range, that have moderate or high potential to be maintained.* These areas occur within the innermost portions of occupied range (Figure 3), where populations of greater sage-grouse appear to be largest and declining

least (Connelly et al. 2004). Moreover, these areas also are common throughout much of the remaining sagebrush in occupied range of Gunnison sage-grouse. Finally, these areas are most likely to be maintained under current budget and resource constraints.

3. *Former habitats, in occupied sage-grouse range, that have moderate or high potential to be restored and that are adjacent to or close to areas identified under number 2.* These sites have a higher probability of successful restoration and would block up sage-grouse habitats, resulting in lower fragmentation, larger patch sizes and increased abundance of sagebrush in the innermost portions of occupied ranges. The result would likely increase the probability of persistence for the largest populations of greater sage-grouse.
4. *Existing habitats, in occupied sage-grouse range, that have low potential to be maintained.* These habitats largely are found along the boundaries of currently occupied range of sage-grouse, and their maintenance would reduce further contraction in occupied range. However, these habitats would likely demand exponentially higher funds and resources for maintenance than habitats in occupied range that have moderate or high potential to be maintained. Consequently, a careful analysis of trade-offs appears warranted to understand the consequences of giving management attention to this set of habitats over other habitats with higher probabilities of maintenance.

Cause for Hope or More of the Same?

Most or all of these concepts and analytical considerations are not new and currently are being used, to varying degrees, at local administrative units of federal land management agencies, such as from general guidance provided by the BLM (2002; 2004a, b). However, these approaches have not been explicitly recognized and adopted as national policy within or among any federal agencies that have management responsibilities in the sagebrush ecosystem. Nor have any national strategies been explicitly developed based on these concepts.

Despite the challenging outlook, a framework for planning strategically across the ecosystem, using spatially explicit, prioritized management to address maintenance needs of existing sagebrush communities, could substantially improve the odds of successfully minimizing further loss and degradation.

Whether conditions improve, however, depends not only on adoption of concepts and processes like those suggested here. The sheer will of managers to collectively focus on the problems will do little to help the situation if budgets are inadequate to effectively manage the plethora of human-associated disturbances that pervade the ecosystem.

Beyond the severe budgetary constraints faced by public land managers of sagebrush, there is an ecologically driven urgency to start now, owing to threshold effects that continue to occur, over vast areas, and that are far easier to prevent than mitigate. Although populations of species like greater sage-grouse may currently be large, it is an illusion to think that such populations can withstand additional habitat loss and degradation at the scales now occurring (Connelly et al. 2004) and projected (Wisdom et al. 2002). The concept of threshold effects applies to the situation faced by this species, as it does to the sagebrush communities on which sage-grouse and other species depend. Strategic planning and spatial prioritization of management, in a holistic manner across the entire sagebrush ecosystem, employing the concept of triage, are key ingredients for successful maintenance of remaining sagebrush communities and associated species.

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CHARLES W
SCHWARTZ

Session Three.
Conservation across Borders: A Continental Perspective

Chair
Winifred B. Kessler
U.S. Department of Agriculture, Forest Service, Alaska Region
Juneau

Cochair
Lynda Maltby
Canadian Wildlife Service
Gatineau, Quebec

History and Evolution of Cross-border Conservation

Greg Schildwachter
Office of Senator Mike Crapo
Washington, DC

Shauna Hanisch
U.S. Fish and Wildlife Service, Division of Migratory Bird Management
Arlington, Virginia

Introduction

What we now call the North American Wildlife and Natural Resources Conference began within a few decades of the first conservation policies in Canada, Mexico and the United States. This development followed logically from the evident facts that wild animals move across borders and that people excel through cooperation. Wildlife conservation in the early decades of cross-border cooperation (and this conference) is reasonably summarized by Aldo Leopold's (1933) sequence of controls in wildlife conservation (Table 1). His pattern is a useful, but not exact, outline for the story, allowing for specific differences in conservation policies and practices and in political, cultural and economic developments. Specific comparisons and contrasts are outside the scope of this paper.

Table 1. Leopold's sequence of controls in wildlife conservation (Leopold 1933:4–5).

1.	Restriction of hunting.
2.	Predator control
3.	Reservation of game lands (parks, forests, refuges, etc.)
4.	Artificial replenishment (restocking and game farming)
5.	Environmental controls (control of food, cover, special factors and disease)

As we review this history, we are sensitive of glossing over many details and intriguing propositions. We expect that many who have particular knowledge of the many specific events, people and situations of this tale could fill out the history of North American conservation in its many facets. We welcome such improvements to our work. Similarly, we cannot resist hazarding some arguments about why events have proceeded as they have. We expect others to have views as well, especially about the future as conservation continues to develop within the globalizing economy. We hope the exchange of these views will propel continuous improvement in conservation.

Beginnings

The beginnings of game management, true to Leopold's (1933) sequence of controls (Table 1), were in controls on hunting. In North America, regulations on harvest of wildlife began at the state and provincial levels in the United States and Canada (Burnett 1999, Leopold 1933); in Mexico, it began in the federal government. In the United States, all of the states had game laws by 1880, and, in 1900, the first federal wildlife law, the Lacey Act (16 United States Code §701), was established; its purpose was to prohibit interstate commerce in game taken in violation of state law. In Mexico, it was an 1894 forestry law that contained the first general provisions for the conservation of wildlife and allowed federal authorities to place certain restrictions on hunting and fishing (Simonian 1995). The earliest federal conservation law in Canada was the Fisheries Act (in the revised statutes of Canada, Chapter F-14); it was enacted by Parliament in 1868 in order to protect and conserve the sea coast and the inland fisheries. Thus, each nation had independently established legal restrictions on fish and wildlife harvest.

Federal concepts of conservation in Canada, Mexico and the United States extended to habitat protection as well during this period—the late 1800s and turn of the 20th century. The first national park in the United States was Yellowstone, established in 1872. In 1891, at the request of the Secretary of the Interior, Congress authorized the designation of "forest reserves" and, by 1900, about 42 million acres (17 ha) had been set aside (Pisani 1999). In 1887, the Rocky Mountain Parks Act created the first Canadian dominion park (Burnett 1999), and, in 1894, Mexico enacted a forestry law that authorized the government to create forest reserves on national lands (Simonian 1995).

In Leopold's view (1933), President Theodore Roosevelt leveraged United States' conservation thinking into the systems view of ecological thinking. Roosevelt saw that game is not merely a fixed stock that can be perpetuated simplistically by limits on the number of animals taken or augmented by animals raised and stocked. He saw that the stock of game at any time is the net of wild reproduction and loss. This revelation by a future president of the United States connected the ecological principles of habitat and community dynamics with policy. From Leopold's perspective, it was largely the "conservation through wise use" doctrine of Roosevelt that brought the idea of conservation into the mainstream. He wrote, "'Conservation' had until then been a lowly word, sleeping obscurely in the back of the dictionary. The public had never heard it. . . . Overnight it became the label of a national issue" (Leopold 1933:17).

Though the developments in conservation in the three countries resemble each other, the three countries differed socially and politically. Conservation was driven largely by middle and upper class citizens whose ability to engage in recreational activities was greatly broadened by such developments as the automobile, paid vacations and increasing amounts of leisure time. Therefore, the United States, as the wealthiest of North American nations, led the way in becoming a culture that embraced these novel luxuries (Dorsey 1998, Pisani 1999). In Mexico, the early conservation movement struggled, largely because efforts to build a strong proconservation hunting lobby never bore fruit; most Mexicans did not have either the leisure time or the money to become sport hunters (Simonian 1995).

Although all three governments supported federal conservation policy, they did so in varying forms of sovereignty and with different ecological situations. By the mid-1930s, Canada was an independent nation within the British Commonwealth, but it relied on London to run its diplomatic affairs. Mexico had been independent from Spain for decades but European involvement and political instability there continued into the 20th century. The United States had been independent of Great Britain for over 150 years and was emerging as a world power. Ecological problems may have been most evident in the United States, which included the Dust Bowl, the elimination of the passenger pigeon, the near-extinction of the bison and the decline of many other once abundant species.

International Cooperation

With each government having established federal policy, international cooperation followed logically from the evident needs of species that traversed political boundaries (Table 2). One of the earliest examples of cooperation between Canada and the United States came in 1892, when the United States and Great Britain (acting on behalf of Canada) created a joint commission of experts to investigate the fisheries in the contiguous waters of the two nations and to make policy recommendations to conserve those fisheries. This agreement called for the development of regulations to prevent harmful fishing methods, pollution and obstruction of waterways. However, in the end, neither the United States nor the Canadian governments followed the recommendations (Bogue 1993).

Table 2. North American wildlife conservation treaties.

Year	Countries	Title	Purpose
1908	U.S. and Canada	Inland Fisheries Treaty	Fisheries regulation in boundry waters
1911	U.S. and Canada	North Pacific Fur Seal Convention	Fur seal harvest regulation
1916	U.S. and Canada	Migratory Bird Treaty	Migratory bird conservation
1937	U.S. and Mexico	Migratory Bird Treaty	Migratory bird conservation

The Inland Fisheries Treaty of 1908 was the next major diplomatic step between Canada and the United States to conserve fisheries. However, the treaty never became law. The treaty failed "because fisheries conservation had few friends and many enemies" (Dorsey 1998:240). The North Pacific Fur Seal Convention of 1911, again between the United States and Canada, was more successful (both politically and biologically, as it helped save the northern fur seal from extinction). The convention's success was due to having the right combination of factors present, including the aesthetic appeal of seals, the existence of scientific evidence for the harm caused by pelagic sealing and the fact that all parties stood to benefit economically from regulation (Dorsey 1998).

In 1916, the United States and Canada successfully negotiated the signing of a treaty for the protection of migratory birds. Enabling legislation was first passed in Canada, as the Migratory Birds Convention Act in 1917, and the following year in the United States as the Migratory Bird Treaty Act (MBTA) (Dorsey 1998). The United States later signed similar treaties not only with Mexico, but with Japan and Russia as well. Bird conservation remains the most common topic among the shared conservation work of the North American countries.

It is interesting to note that when U.S. conservationists first realized a treaty would be the best means to strengthen bird protection, Mexico was the country they initially looked to as a partner (Dorsey 1998). Although the Mexican revolution took place during these early decades of the 1900s and the country lacked a strong conservation movement, the U.S. Department of State, nonetheless, opted to try to draft a treaty with Mexico rather than Canada. Yet by mid-1913, this plan had been apparently forgotten, and conservationists and administration officials had begun diplomatic negotiations with Great Britain on behalf of Canada. Insufficient trust between the United States and the Mexican governments and a lack of "common ground for cooperation"(Dorsey 1998:244) are viewed as the key reasons behind the failure of a treaty with Mexico.

Fortunately, by the 1930s, Mexico had made considerable strides in the area of conservation achievements (Simonian 1995). The Mexican Committee for the Protection of Wild Birds was established in that decade, and the Mexican government banned armadas (shooting batteries). President Lazaro Cardenas, in 1935, established Mexico's Department of Forestry, Fish and Game and appointed Juan Zinser as the head of the department's game division. Zinser would, in 1936, serve as the official Mexican representative at the North American Wildlife Conference.

While today all three nations can safely be considered stable democracies with good relations among each other, this has not always been so. The Mexican-American War of the mid-1800s may have colored relations fifty years or so later when, in the early 1900s, the idea of a migratory bird treaty was being considered. Relations between the Wilson administration in the United States and the Victoriano Huerto government in Mexico, which came to power after the Mexican Revolution in 1910, were quite unfriendly. This situation, combined with the fact that Mexico was simply unable to invest much political capital in protecting migratory birds, contributed to the decision to pursue a treaty with Canada (Dorsey 1998). The United States and Canada, which had resolved the boundary dispute over the 49th parallel in the mid-1800s, sparred again over the Alaska boundary in the late 1800s, revealing considerable diplomatic tension yet, ultimately and despite being "a low point in U.S.-Canadian-American relations" (Dorsey 1998:8) helping to improve communication between the two countries.

Culturally speaking, the United States and Canada with their shared British origins are the most similar by sharing language (Québec aside), legal, economic and administrative roots. Bogue, in reference to the 1892 United States and Canadian joint fisheries commission, described the similarities as including, "the concept of the common of the fishery, the right of the government to regulate that common to conserve the fisheries, and a body of regulations dating from as early as thirteenth-century England" (1993:1,435). Mexico, having been colonized by the Spanish, did not share the common framework of the United States and Canada. Additionally, conservation efforts in Mexico for many years were focused mainly on economic, not aesthetic, considerations and tended to concentrate on forests rather than wildlife, unlike the conservation movement in the United States and Canada (Simonian 1995, Dorsey 1998).

Cultural differences among the three countries, for example, led to the development of different guidelines for wetland conservation in Mexico (e.g., incorporation of the needs of local people in planning projects) under the North American Waterfowl Management Plan (NAWMP)(Wilson and Ryan 1997). Obstacles to implementation of programs under the North American Wetlands Conservation Act (NAWCA), a funding and partnership arm of the NAWMP, included a "communication gap between United States and Mexican partners" and failure to "understand the very different contexts for conservation on either side of the border" (Wilson and Ryan 1997:63). Dorsey noted that the final choice of Canada with which to negotiate a migratory bird treaty, "reflected the realities of the Anglo-American rapprochement . . . and recognition of a people and government with similar interests" (1998:193).

The North American Wildlife Conference

Called by Roosevelt in 1936, the North American Wildlife Conference embraced the international cooperation underway by expanding the regular meeting of U.S. wildlife professionals. The American Game Conference had been held in New York City each year since 1915 by the American Game Association. In proposing that early conference on conservation, Roosevelt zeroed in on the obvious issue: "It is evident that natural resources are not limited by the boundary lines which separate nations, and that the need for conserving them upon this continent is as wide as the area upon which they exist" (Dorsey 1998:4).

Roosevelt's conference was not particularly successful, but his comments show that he was ready for the logical step of international cooperation (Dorsey 1998). Various titles applied to the conference included, the National Conference on American Game Breeding and, more simply, the National Game Conference, as the program began to address all forms of game conservation and administration. Next, as the geographic scope expanded to all of North America, the conference was titled the American Game Conference, intending for the generic use of "America" to describe its international reach. The meeting in 1936 was called the North American Wildlife Conference, and the costs of holding the event and publishing the proceedings were shared with the newly formed American Wildlife Institute by the federal government. Presumably, the Roosevelt administration contributed something as the president issued the call for the meeting, and the Senate Special Committee on Conservation of Wildlife Resources published the proceedings (U.S. Senate 1936:xvi; Table 2).

Roosevelt and his counterparts in Canada and Mexico, Prime Minister William Mackenzie King and President Lazaro Cardenas, respectively, sent prepared remarks to be read to the assembled. They expressed similar sentiments about international cooperation that would "perpetuate the friendship of the [three] nations," in the words of Cardenas. But, King referred to advancing "the cause of conservation of North American wildlife," and Roosevelt spoke particularly of, "new cooperation between public and private interests leading to "constructive proposals for concrete action" (U.S. Senate 1936:2–4).

The tilt of the United States for specificity became clearer in the opening remarks of Conference Chairman F. A. Silcox, Chief of the U.S. Forest Service. He described the objectives of the conference as "to learn about facts, discoveries and information pertinent to wildlife and the wildlife situation . . . to develop an adequate national and international wildlife program . . . [and] to create one central organization so articulate, so powerful, and so effective that real progress in restoring and conserving the vanishing wildlife resources of a continent can no longer be prevented" (U.S. Senate 1936:2).

From the opening statements of each country and the program for the conference, it appears that the facts and discoveries of the time were consistent with the latter steps of Leopold's (1933) sequence of five controls (Table 1). Reserves for wildlife were featured in the summary of the Mexican situation by Juan Zinser, head of the game division in Mexico's Department of Forestry, Fish and Game. The fourth control, artificial replenishment, was still prominent in the agenda even though the conference title no longer included "game breeding" as it had in the early years (Table 3). Among the titles of papers were the phrases "fish culture," "deer feeding experiments," and the full title, "Breeding Waterfowl for Replacing Wild Stock," by Wallace Grange (U.S. Senate 1936:viii). The conference also thoroughly involved environmental controls, such as "The Relation of Burning to Timber and Wildlife," by Herbert Stoddard, "Food Plantings for Fish," by Carl Hubbs, and "Eel Grass and Other Waterfowl Foods," by Clarence Cottam (U.S. Senate 1936:iv–x).

Table 3. Conference titles preceding the North American Wildlife and Natural Resources Conference.

Year	Title
1915–1935	National Conference on American Game Breeding, also referred to as National Game Conference and American Game Conference
1936	North American Wildlife Conference (after the American Game Association merged into the new American Wildlife Institute), sponsored by President Franklin Roosevelt and U.S. Congress Special Committee on Conservation of Wildlife Resources
1937–1945	North American Wildlife Conference (continues under sponsorship of American Wildife Institute)
1946	North American Wildlife and Natural Resources Conference (Wildlife Management Institute)

Some elements of the organization and administration of wildlife conservation as we know it today were still forming at the time of the conference. The Mexican Department of Forests, Game and Fish had been established only the prior year by the president of Mexico. Hoyes Lloyd, Supervisor of Wildlife for National Parks of Canada, explained that the Migratory Birds Convention Act of 1917 was the beginning of Canada's federal role in wildlife conservation and that dominion and provincial authorities had developed cooperative relationships from that point to coordinate data collection and law enforcement efforts (U.S. Senate 1936:11–3). Ding Darling, whose address was entitled "The Wildlife Crisis" that was interrupted several times by applause, referred to some familiar features of conservation today, such as subscribing to magazines. But, he noted that the congressional committees on wildlife at the time had no official jurisdiction (U.S. Senate 1936). Other evidence of precursors to policies, programs and other institutions familiar today were the session titles "Farmer-sportsman Cooperatives" and "The Problem of Vanishing Species."

Darling's address plainly advocated for a centralized organization of wildlife conservationists and was followed in the second day of the conference with a scheduled "entire day [of] open forum, the purpose of which is the formation of a general federation of wildlife interests" (U.S. Senate 1936:vi). The result that followed in the next year was the National Wildlife Federation. That year, 1937, was fertile for wildlife groups and policy as it was also the founding year of The Wildlife Society and the year that the Federal Aid in Wildlife Restoration Act (the Pittman-Robertson Act) was passed.

Cooperation Since the First Conference

Cooperation increased among Canada, Mexico and the United States in the years following the conference. In 1937, the United States and Mexico signed the Treaty for the Protection of Migratory Birds and Game Mammals. Also that year, the United States and Canada formed the International Pacific Salmon Fisheries Commission to promote sustainable harvest of salmon in the Pacific Northwest. Negotiation and approval of the Pacific Salmon Treaty, however, took the two nations until 1985. In 1999, after the expiration of the original fishing arrangements, the United States and Canada reached a new agreement under the 1985 treaty (Dorsey 1998, Pacific Salmon Commission 2005).

In 1986, in reaction to significant declines in waterfowl populations, Canada and the United States signed a landmark conservation agreement, the NAWMP. Mexico became a signatory to the plan in 1994. As stated in the NAWMP 1998 Update, the plan "gave the wildlife conservation community the daunting task of coordinating and focusing the conservation programs of three nations to measurably increase continental populations of a highly mobile, shared migratory resource—waterfowl" (U.S. Fish and Wildlife Service/Secretaria de Medio Ambiente y Recursos Naturales/Canadian Wildlife Service 1998:1). In 2004, Interior Secretary Gale Norton signed another NAWMP update thus ensuring that the plan (upon final approval from the Canadian and Mexican environmental ministries) will continue to serve as an effective catalyst for continental waterfowl conservation (U.S. Fish and Wildlife Service 2004).

Not only has the NAWMP proved to be a very successful conservation tool, but it has paved the way for other continentwide bird conservation endeavors, such as Partners in Flight and the North American Colonial Waterbird Conservation Plan. In 1999, the North American Bird Conservation Initiative (NABCI) was established as a means of bringing together these, and other, programs to promote integrated bird conservation. NABCI is a coalition of public, private and academic organizations in Canada, the United States and Mexico whose aim is to conserve native bird populations by increased effectiveness and enhanced coordination among the programs and people of the three national governments (North American Bird Conservation Initiative 2005).

Both Partners in Flight and NABCI were created under the auspices of the trilateral Commission for Environmental Cooperation (CEC), part of the North American Free Trade Agreement (NAFTA). The CEC is an international organization created by Canada, Mexico and the United States to address regional environmental concerns, to help prevent conflicts in trade and conservation, and to promote enforcement of environmental law. The mission of the CEC demonstrates the evolution of the cooperation sought by presidents Roosevelt and Cardenas and by Prime Minister King from an annual conference in 1936 to a standing international body with broad responsibilities today.

The trilateral Committee for Wildlife and Ecosystem Conservation and Management is similar to the CEC. As CEC is rooted in NAFTA, the trilateral committee is rooted in the NAWMP. It formed in 1996 in a memorandum of understanding among the heads of the wildlife conservation agencies of Canada, Mexico and the United States. The committee improves interagency coordination and cooperation and promotes partnerships among the agencies and with other entities, all to further the goals of conserving and managing wildlife, plants, biodiversity and ecosystems. Delegations from each nation meet annually (U.S. Fish and Wildlife Service/Secretaria de Medio Ambiente y Recursos Naturales/ Canadian Wildlife Service 2005).

Also since the first North American conference, global cooperation developed. Roughly sketched using autobiographical timelines, this history began in 1948 at an international conference in France where the "IUCN—The World Conservation Union" (formerly known as the International Union for Conservation of Nature and Natural Resources) claims its beginnings (World Conservation Union 2005). By the early 1960s, the World Wildlife Fund had formed and had begun funding projects with precursors to Birdlife International (World Wildlife Foundation 2005). In 1972, the United Nations convened the United Nations Conference on the Environment and months later established the United Nations Environment Programme (United Nations General Assembly Resolution 2997, December, 15, 1972).

Private organizations of birdwatchers, sportsmen and women, and other conservationists were and continue to be involved in North American conservation along with the official relationships among the governments. The Audubon Society, Boone and Crockett Club, and probably others, were involved in the passage of the MBTA (Trefethen 1975); although, the Audubon Society describes its international efforts as beginning in the late 1970s (Audubon Society 2005). Ducks Unlimited, Inc. formed in 1937 and the next year established operations in Canada and, later (1974), in Mexico (Ducks Unlimited, Inc. 2005). This is not a complete list of the groups involved in cross-boundary work, but we speculate that private sector conservation is growing.

The Future

As culture, economics and politics have influenced the conservation partnerships of North American countries in the past, so they are likely to shape the future. In some ways, the interplay of societies is likely to promote opportunities. On the other hand, challenges persist. For example, participants in two recent pilot projects implementing the United Nations Global Programme of Action in North America found, "many unexpected cultural and operational differences in the development and enforcement of environmental policies and legislation" (Commission for Environmental Cooperation 2004:9) and in other areas. One of these initiatives launched by the CEC is between the United States and Canada in the Gulf of Maine and the other is between the United States and Mexico in the Bight of the Californias. The Bight of the Californias project had difficulties with, "basic issues of culture and differing levels of economic, social and political support and simple questions of organizational structure, leadership and legitimacy" (Commission for Environmental Cooperation 2004:17). Fortunately, political relations among the countries are not a major limiting factor in international negotiations today.

The ability of a nation to support conservation economically is always a relevant issue. Wealthier nations generally have stronger resource protection laws and a more adequate infrastructure to administer and enforce those laws. As was the case in 1900, today the United States and Canada, with 2004 per capita gross domestic product (GDP) rates of approximately $37,500 and $29,700, respectively, are stronger economically than is Mexico with a $9,000 per capita rate of GDP (World Bank 2005). Wilson and Ryan observed that, "difficult economic times in Mexico have limited contributions from Mexican sources" (1997:63), thereby delaying NAWCA projects. Also, as was noted earlier in this paper, economics affects public interest in conservation, and, historically, Mexicans did not have either the leisure time or the income that was associated with early U.S. and Canadian conservationists (Simonian 1995, Pisani 1999).

Economic changes on the continent have been most dramatic in Mexico recently, and they may be the most obvious harbinger of developments. In just the last 20 years, by renegotiating its debts, joining NAFTA, and by surviving armed rebellion in Chiapas, assassinations and a devaluation of the peso, Mexico is improving its wildlife and other environmental agendas. Political pressure from the United States and assistance from other countries has played a role both in stabilizing the economy and in advancing conservation. Investment in the country, especially in manufacturing, has risen (Yergin and Stanislaw 2002). This situation tests the question raised in protests over world trade: does a growing economy in the 21st century promote conservation and sustainability or waste and depletion? The answer to the question—which is also relevant in the United States and Canada—may be positive if the cooperation among the three countries enables effective sharing of ideas and resources and if it promotes continued evolution of conservation approaches.

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Political, Social and Economic Considerations for Cross-border Conservation

D. A. (Don) Young
Ducks Unlimited, Incorporated
Memphis, Tennessee

The United States and Canada share many things, including an undefended international border, contiguous ecosystems and a societal commitment to habitat conservation. Despite these commonalities, real political, social and economic differences exist that have influenced and continue to affect natural resources conservation in the two countries. Understanding these similarities and differences, and in particular their historical context, is vital to shape the future of conservation in these countries. Developing funding opportunities, mechanisms for direct conservation program delivery and public policy initiatives must ultimately take into consideration complex societal and political environments if significant conservation objectives are to be attained.

Societal Views toward Wildlife, Wetlands and Conservation

From the earliest days of European settlement of Canada and the United States, both countries grew up with a shared strong connection to the outdoors through hunting and fishing. While the dependence of the countries' respective residents on fish and wildlife for day-to-day sustenance has greatly diminished, both societies still place considerable value on the recreational activities associated with fish and wildlife populations and their habitats.

As recently as 1996, almost 18 percent of Canadians 15 years or older took part in recreational fishing while 5.1 percent hunted (Federal-Provincial-Territorial Task Force on the Importance of Nature to Canadians 1996). Thirty-one percent of Americans 16 or older participated in recreational activities related to fish and wildlife (U.S. Department of the Interior and U.S. Department of Commerce 1997). Among that same age group, 17 percent fished and 7 percent hunted. Migratory bird hunting is much more popular in the United States, with 3 million hunters reported (U.S. Department of the Interior and U.S. Department of Commerce 2002). In Canada, 177,000 migratory bird permits were sold for 2001–2002 season, with a steady decline noted since the late 1970s when approximately 500,000 were sold (Fronczak 2003).

One conservation topic continues to emerge as being of importance to residents of both countries—the value of wetlands. In Canada, when asked in 2003 to identify the most serious problem facing wildlife and its habitat, 33 percent of Canadians identified the disappearance of wetlands (Western Opinion Research, Inc. 2003). This number was significantly higher than the 2 percent reported from a 1998 survey (Angus Reid Group, Inc. 1998). In addition, the awareness of the importance of wetlands to the overall state of the environment increased from 45 percent in 1998 (Angus Reid Group, Inc. 1998) to 61 percent in 2003 (Western Opinion Research, Inc. 2003).

Among U.S. citizens, a survey showed that 46 percent of the general public indicated that there are too few wetlands (Duda et al. 2001). That same survey revealed that 91 percent of the United States thinks it is very important or somewhat important to protect and conserve wetlands. Eighty-seven percent of the United States replied that if they knew that wetlands helped reduce pollution by purifying water, they would be more likely to support waterfowl and wetland conservation (International Association of Fish and Wildlife Agencies 1996).

The reasons for this interest are not certain, but there are some known factors that have contributed to the public's awareness of this issue. For several decades in the United States, there have been many nongovernment organizations that have focused on conserving wetlands. This mobilized public support through organizations, such as Ducks Unlimited, Inc., The Nature Conservancy and Trout Unlimited, to name a few. In contrast, particularly until the past decade, there have been relatively few such organizations in Canada.

Unlike Canada, the United States has a relatively long history of regulatory protection afforded to wetlands. Federal regulatory protection for wetlands in the United States is afforded under the Clean Water Act administered by the Environmental Protection Agency (EPA), with involvement of other federal entities, notably the U.S. Army Corps of Engineers (COE). A recent U.S. Supreme Court decision, regarding the Solid Waste Agency of Northern Cook County (SWANCC), has been interpreted by the EPA and by COE to enable them to remove protection from a significant portion of the remaining wetlands—some that are geographically isolated wetlands—in the United States. This decision has precipitated several high profile lawsuits. This litigation, coupled with other examples such as water use conflicts in the Klamath Basin, has raised public awareness of the value of wetlands in the United States.

There is currently no official federal wetland protection statute in Canada. Each province has legislation (via Water Act and Environment Act) that can be applied to protect specific wetlands. Saskatchewan, Manitoba, Ontario, Prince Edward Island, New Brunswick and Alberta all have wetland policies that encourage sustainable management, conservation and rehabilitation of Canada's wetlands. The absence of Canadian federal regulatory protection for wetlands and limited litigation action has not precluded media attention to the matter of wetlands. In recent years, contamination of public water supplies, most notably in Walkerton, Ontario, has led to a broader public awareness of the importance of wetland protection measures. In the Walkerton case, deaths and illness from bacterial contamination led to a provincial board of inquiry assessing the problem, and this, in turn, led to the establishment of the Watershed-based Source Protection Implementation Committee by the Premier of Ontario. One of the report recommendations focused on wetland protection in Ontario.

Translating Public Interest into Conservation Action

The prominence of hunting and fishing in the formative years of the two nations and the continued recreational and economic importance of these activities strongly influenced the development of state/provincial and federal agencies charged with the protection and enhancement of fish and wildlife populations and their habitats. More recently, residents of both nations have demonstrated a strong interest in nonconsumptive, nature-related activities that include wildlife watching, bird feeding and photography. This, in turn, has provided broader impetus for governmental involvement in habitat conservation initiatives.

For example, in 1996, Canada reported that 44 percent of Canadians participated in nature-related activities and that associated expenditures amounted to almost $12 billion (Canadian dollars [CAD]).

In the United States, the U.S. Department of the Interior and the U.S. Department of Commerce 2002 reported that 80 million people (39 percent of the U.S. population) spent $110 billion in 2001 on fish and wildlife-related activities alone; $70 billion was spent on recreational fishing and $20 billion on hunting.

While there is a shared public view of the importance of wetlands and related wildlife, there is a significant departure between the two countries when it comes to the diversity and scope of funding available for their conservation. At the U.S. federal level, there is a remarkable abundance of funding opportunities for wetlands and migratory bird-related conservation initiatives. Some examples include:

- Sport fish and wildlife restoration acts (i.e., Pittman-Robertson Act [1937; 11-percent excise tax], Dingell-Johnson Act [1950] and Wallop-Breaux Act [1984]) have generated more than $9 billion for fish-and-wildlife-based conservation and recreation since 1937, including more than 5 million acres (2 million ha) of habitat purchased (U.S. Fish and Wildlife Service, N.D.). More than 62 percent of Pittman-Robertson Act funds are used to buy, develop, maintain and operate state wildlife management areas.
- State wildlife grants provided $69 million in fiscal year 2004 to states for wildlife conservation planning and implementation.
- The Migratory Bird Hunting Stamp Act has raised $647 million and has protected more than 5 million acres (2 million ha) (Congressional Sportsman Foundation, N.D.).
- The U.S. Farm Bill, the legislation related to agricultural program delivery, contains within it key conservation provisions related to wetlands and migratory birds. The Conservation Reserve Program (CRP) has 35 million acres (14 million ha) enrolled in permanent cover, with an annual funding appropriation of approximately $1.7 billion. It has been estimated that CRP lands in Montana, North Dakota and South Dakota alone are responsible for annual production of 2.7 million ducks per year (George Vandel, personal communication 2005). The Wetlands Reserve Program (WRP) is directed toward wetland hydrology and vegetation restoration. Funding levels for this conservation program approach $280 million per year.
- The North American Wetlands Conservation Act is U.S. federal legislation designed to provide funding for wetlands conservation throughout North America, providing nonfederal dollars available for matching purposes. Since its inception, over 2,650 partners have participated, with NAWCA funds of $481 million matched multiple times (over $2 billion) toward wetland conservation affecting more than 20 million acres (8 million ha) in North America.
- In 2004, appropriations included: $32 million for U.S. Fish and Wildlife Service migratory bird management, $42 million for wetlands and

adjoining uplands within the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program, $37 million for the Landowner Incentive Program and for private stewardship incentive programs, $391 million for National Wildlife Refuge System operation and management that includes 31 million acres (12 million ha) of wetland, $6 million for the U.S. Department of Agriculture, Forest Service for migratory birds and wetlands, $35 million to the COE for aquatic ecosystem restoration and environmental improvement/project modifications.

At the state government level, the various licenses, fees and taxes on hunting and hunting equipment fund more than 90 percent of the budgets of state fish and wildlife agencies. Since 1923, sales of state hunting licenses, tags and permits have provided more than $10.2 billion for wildlife management, habitat acquisition and enhancement, and conservation law enforcement.

Additional state-level habitat conservation initiatives include state Duck Stamp programs, with funding directed toward wetland restoration and conservation of wetland-associated uplands. Between 2003 and 2004 alone, over $10 million was generated for conservation from these duck stamp sales. Individual states (e.g., Missouri and Arkansas) levy special sales taxes, with those funds directed to habitat conservation activities. Colorado directs funds generated by their Great Outdoors Colorado lottery and gaming cash to conservation, including their wetland initiative.

Unlike the United States, Canadian federal funding opportunities for wetlands conservation are very limited. Environment Canada is the umbrella agency under which federal environmental matters are administered. This includes the wetland conservation and migratory bird management responsibilities of the Canadian Wildlife Service. During the period of 1991 to 2003, the Canadian federal government, provinces, municipal governments and nongovernment organizations, especially Ducks Unlimited Canada, have contributed over $65 million (CAD) to North American Waterfowl Management Plan conservation efforts through the principal delivery organization, Ducks Unlimited Canada (K. Krahn, personal communication 2005). Significantly, during the same period of time, the U.S. federal government contributed almost $234 million (CAD) to wetlands and waterfowl conservation in Canada (National Tracking System 2005). This was coupled with matching U.S. nonfederal dollars (primarily from Ducks Unlimited, Inc. in the United States) in the amount of $242 million (CAD). Cumulatively then, U.S. sources contributed more than $475 million (CAD) towards wetlands and waterfowl conservation in Canada (National Tracking System 2005)

An exciting opportunity has recently emerged via federal support for conservation outside of Environment Canada. Canada's equivalent of the U.S. Department of Agriculture—The Ministry of Agriculture and Agri-Food Canada—launched a progressive initiative in 2003 called the Agricultural Policy Framework (APF). The APF served as a major agricultural policy breakthrough in Canada, much like the 1986 U.S. Farm Bill did in the United States. Ducks Unlimited Canada was at the forefront of the conservation community in helping the federal government develop the environmental components of the APF. With respect to the environment, the APF strives to reduce agricultural risks and to benefit Canada's water, soil, air and biodiversity resources through the newly developed Environmental Farm Plan, which is enabled by cost-shared beneficial management practices (BMPs). The most promising BMP for wildlife managers in the APF is the Greencover Canada Program that enables the conversion of marginal cropland to perennial cover. Unfortunately, at present there are no use restrictions (timing, duration or frequency of use) on this conversion program.

While Greencover Canada and the other suite of BMPs are a good start in protecting the environment, they do not provide substantive benefits to waterfowl and other migratory birds. Simply put, the Canadian government needs to adopt BMPs that are similar to the hugely successful CRP and WRP programs in the United States.

In 2004, Ducks Unlimited Canada submitted two documents to the Ministry of Agriculture and Agri-Food Canada, entitled *Review of Beneficial Management Practices Available within the APF* and *Integration of Watershed Planning and the APF: A Pilot Watershed Approach.* The suggested approaches in these documents would greatly benefit waterfowl and other migratory bird populations and biodiversity in Canada and, thereby, benefit all North Americans.

Nongovernment Support

The Canadian government's financial resources have been supplemented by those of nonprofits and nongovernmental organizations with a conservation or environment-related mission. Overall in Canada, 3 percent of the 161,000 nonprofit and volunteer organizations have environment as their principal focus (Cornerstones of Community 2003). In the United States, there are significantly more nonprofits engaged in conservation and environmental activities but the overall percentage of the almost 1 million registered charities engaged in this type of work is also approximately 3 percent (National Centre for Charitable Statistics 2003, Giving USA Foundation 2004).

The principal wetland and waterfowl conservation delivery organization in both countries is Ducks Unlimited, Inc.. Since its inception in 1937, Ducks Unlimited, Inc. has invested over $2 billion (U.S. dollars) to conserve almost 11.5 million acres (4.7 million ha) of wetland and associated waterfowl habitat across North America.

Challenges and Opportunities

Both nations face challenges with continued degradation of already stressed and diminished wetland resources. In some respects, the United States is better equipped to stem further losses by virtue of federal- and state-level wetland protection legislation, providing these regulations are enforced. Encouragingly, the George W. Bush Administration has placed some priority on the subject of wetlands, with the President going so far as to speak of a desired objective of a net gain in wetlands. The degree to which this objective will be met is still uncertain. In Canada, there are no moves afoot to enact federal wetlands protection legislation. However, a multiagency process is underway in Canada to develop a federal freshwater research agenda. With the essential assistance from academic institutions and nongovernment organizations, one can only hope that this process will finally give Canadian lawmakers overwhelming evidence (evidence that the remainder of the developed world has already embraced and acted on) that continued wetland loss is unacceptable and must be stopped.

Despite the leadership vacuum at the federal level in Canada, individual provinces are independently pursuing wetland protection measures. While these developments are largely based on policy initiatives, rather than on regulatory ones, there is hope that sensible regulations will eventually follow.

The international nature of migratory birds and growing societal interest in bird watching to supplement consumptive recreation holds promise for mobilizing support for the birds and their habitats. Three current initiatives, the North American Waterfowl Management Plan, the North American Wetlands Conservation Act and the North American Bird Conservation Initiative, demonstrate the will and the ability to plan and deliver North American-wide conservation programs. Efforts must continue to sustain and expand these efforts, particularly through informing the public of the multispecies benefits of these international conservation initiatives.

Both countries share a concern over the availability of abundant and high quality water. Water-use conflicts are likely to continue to emerge as one of the most hotly contested issues facing society for the century. The problem of water shortages is more acute in the arid West where, coincidentally, population growth is also higher. Additionally, water quality continues to be a concern. Issues here include not just potable water availability but downstream water quality, including degradation of the Chesapeake Bay, the Great Lakes and St. Lawrence rivers, the Gulf Coast coastal wetland loss, and hypoxia in the Gulf of Mexico.

The potential positive implications of these water concerns include increased societal awareness of the value of wetlands that could, in turn, translate into increased public policy initiatives and direct support for wetlands conservation. Again, the United States is currently better positioned in terms of political will and economic support for wetland conservation through public agencies and nongovernment organizations. There are current indications of Canadian federal government support for landscapewide conservation work through agricultural programs. While still in the formative stages of development, broader implementation holds great promise. The depth and diversity of funding for wetlands conservation in Canada remains relatively weak. In the absence of increased government leadership and funding, direct wetland conservation activities will continue to be led by nongovernment organizations.

Changes in demographics, including increasing urbanization, may have implications for societal support for wetland conservation. Public opinion surveys reveal that hunters are more than three times more likely to financially support habitat conservation efforts than nonhunters (M. D. Duda, personal communication 2002). Should declines in numbers of sportsmen occur, and in the absence of other compensatory societal support for conservation, the political and economic support for wetland conservation could diminish. Clearly then, the challenge for the conservation community is to seek ways to inform and mobilize broad segments of society for the conservation of these valuable places.

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Wildlife Management across Borders

Raymond M. Lee
Foundation for North American Wild Sheep
Cody, Wyoming

I would like to talk with you today about some of the issues involved with working across international borders. To illustrate these issues, and to keep the focus relatively local, I will primarily draw upon my experiences working with wildlife and wildlife biologists in Mexico.

Mexico is widely recognized for its high level of biodiversity that makes it an attractive place to do wildlife management. It has a disproportionately high number of species compared to its land surface. For example, it has 525 species of mammals, or some 12 percent of the known species, in less than 2 percent of the total land surface.

Referring to the United States and Mexico, it has been written: probably nowhere in the world do two neighbors understand each other so little. More than by levels of development, the two countries are separated by language, religion, race, philosophy and history. The following points illustrate the basis for some of this lack of understanding and this separation.

Communications

I am the product of nearly half a century of liberal arts education. In my generation, we did book reports on John Steinbeck's *Of Mice and Men*. We didn't choose this work due to its literary excellence – we read it because it was Steinbeck's shortest story. But, we all read it. Our school play was "Our Town," just like virtually every other school's play. Essentially, if you grew up anywhere in the United States during that period you received a very parallel and consistent education.

My wife is also of that generation. She received the same schooling, and we both pride ourselves on our fluency in the English language. Still, even with this common background, after 25 years of marriage, we have verbal misunderstandings—"but you said; but you know that's not what I meant" and "do you think that this make me look fat"? I am certain that, while some people may achieve a considerable level of fluency in a second language, it does not ensure a total comprehension in that language. This can be caused by regional linguistic nuances or by cultural differences.

Culture

I went to Milan, Italy, for my senior year of high school. I was always a competitive student, and, when I found that my first class was social studies (that amalgam of history, geography, and government), I nearly salivated. Here was my big chance to show those other kids how smart an American was. Man, was I ready—Monroe Doctrine (opposing European intervention in the Americas), 1823; Gadsden Purchase (expanding US territory), 1854; Battle of Gettysburg (turning point of the US Civil War), 1863. Man, I knew it all. My arm was cocked, ready to shoot my hand into the air. The first question was "Which of the Medicis commissioned the statute of David"? Everybody's hand went up, every one, except mine. "In what year was Victor Emanuel declared King of Italy"? Same results. "Which provinces became part of Italy as an outcome of the Austro-Prussian War"? This went on for an hour. I didn't know a single answer. It was like those Italians had a history all their own. It is this difference in culture and history, as much as in language, that sometimes leads to miscommunications.

Education

When you work with someone from another country, you can be pretty sure that you are dealing with someone whose first play was not "Our Town." While they may have eventually read Steinbeck and Hemingway, these weren't the first authors they read.

In wildlife management, the differences in education are quite pronounced. Wildlife management curricula are uncommon in Mexico's universities. For a person with a great interest in animals, the usual course work is in veterinary medicine. This education leads to a very different relationship with animals than does a wildlife management degree from a U.S. University. A U.S.-schooled biologist is more used to seeing animals in the field. If they want blood samples, their first thoughts run to appropriate capture methodologies. For the Mexican biologist, who has been trained with caged animals typically close by, the thought process would be to get out a syringe. It is this type of desired familiarity with animals that has led wildlife managers in Sonora, Mexico, to have reduced nearly 50 percent of their bighorn sheep to enclosures.

Past infractions by visiting researchers have sensitized some biologists in Mexico. As a result, research protocols were developed to ensure that research is conducted under appropriate Mexican animal care and welfare standards with generous sharing of information. These protocols have been revised and made more restrictive by the Mexican Secretary of Environment and Natural Resources (Secretaria de Medio Ambiente y Recursos Naturales [SEMARNAT]) in an attempt to encourage collaborative research. It is this collaboration and sharing of results that is most important to our Mexican counterparts. Publish or perish is alive and well in Mexico's universities. Mexico's participation in Convention on International Trade In Endangered Species (CITES) and the International Union for the Conservation of Nature and Natural Resources (IUCN) has spurred international cooperation to prosecute violations of research protocol, resulting in warrants, publication censures and prohibition of entry into Mexico. It is essential that U.S. citizens working in Mexico respect Mexico's sovereignty of their natural resources.

Continuity

I've heard it said that you just can't keep up with all of the changes in Mexico's government agencies. I've also heard it said that the average tenure of a U.S. game and fish director is about 3 years. For a Mexican biologist, bordered with California, Arizona, New Mexico, and Texas, there is at least one change in state game and fish directors each year.

This continuity issue is being helped by the advent of nongovernmental organizations (NGOs). NGOs are becoming a significant factor in wildlife research and conservation; not only do they serve as a stable employment base for biologists, they also provide essential funding for research. NGOs have been instrumental in developing collaborative research initiatives between U.S. and Mexican biologists. Several of these projects have resulted in the reintroduction and restoration of pronghorn antelope, bighorn sheep, turkeys and aplomado falcons to their native habitats. NGOs are effective players in conservation, having the recognition of governments and the support of society.

Land Ownership and Management

This is a particularly difficult issue. One area in which I worked was the Cabeza Prieta National Wildlife Refuge on the Arizona-Mexico border. On the surface, it seems that this would be a very nonconfrontational place to work, being essentially a desolate wasteland, removed from large human population centers, with only a handful of wildlife species, and those occurring in very small numbers. But, wait. We have the U.S. Fish and Wildlife Service proclaiming management authority over some of the species (in particular pronghorn antelope) and the Arizona Game and Fish Department feels that they have a state mandate to manage. The animals cross adjacent property boundaries quite freely: to the Tohono O'Odam Reservation, where the tribe claims a cultural attachment to the animals; to the Organ Pipe Cactus National Monument, which is managed by the National Park Service; and to Mexico, where it is a federally listed endangered species, bringing into the management picture federal biologists from Mexico City, as well as state biologists from Sonora and the Pinacate Reserve, a protected natural area in Mexico that is managed by yet another federal management agency. You can then add to this Friends of the Cabeza, an environmental citizen's group in Tucson who want to make a bi-national Park out of the whole complex. Add the U.S. Department of Homeland Security to the mix, due to the large volume of illegal traffic across the border. And, over all of that, the U.S. Department of Defense claims the air space over the refuge as an extension of their nearby bombing range, which they say has no impact upon the wildlife.

While the Cabeza Prieta situation may sound difficult, I have found that, in Mexico, land ownership and management is possibly even more complex. In Mexico, land is a unique commodity. It was largely the basis for the Mexican Revolution. Following the revolution, immense landholdings were broken up and given to the people in communal lands termed *ejidos*; the land was supposedly never again to be taken from the people. Mexico's land base is centered on this constitutionally implemented agrarian reform system, initiated in 1911. Landownership was considered to be a privilege and not a right.

By 1940, 44,478,969 acres (18 million ha) had been allocated to approximately one-third of the Mexican population for communal use. Unfortunately, suffering from a "tragedy of the commons," land productivity declined. With *ejidos* failing at a rapid rate, Mexico's rural population began returning to the cities to look for work. This resulted in a new set of problems, including rapid urbanization and a burdened economy.

In 1991, President Carlos Salinas de Gortari made the move to constitutionally nullify social land distribution and to allow privitization of lands. In addition, *ejiditarios* (those with a legal claim within the *ejido* community) gained title to the land currently in their possession, and they were allowed to sell or lease their plots.

Following this change in land ownership, Mexico implemented a nationwide conservation plan, entitled Program for Conservation of Wildlife and Diversification of Production in the Rural Sector. This plan included wildlife production as a socially beneficial use of the land. As a result, landowners and *ejido* communities could diversify their economic options by registering their lands as wildlife management units, or UMAs, if they developed management plans for intensive breeding facilities or for the utilization of free roaming wildlife and habitat.

Further, in Mexico, there are areas designated as natural protected areas, some are listed as biosphere reserves; we are familiar with biosphere reserves in the United States, such as the highly protected Glacier Bay in Alaska. Protected areas, as we know them in the United States, are not common in Mexico. There, federal designations are overlaid upon the *ejidos*. This is not like a private in-holding within federal land, as we are familiar with in the United States. In Mexico, the *ejiditarios* retain their rights to manage their affairs on this land. Registered as UMAs, many of these areas are set up to generate their own revenue. This has led to the sale of butterflies, plants, etc. under this program to conserve wildlife and wildlife habitat by increasing production in the rural sector.

Economics

Typically salary and financial support levels vary greatly. I have had federal Mexican biologists show up at my hotel room at the beginning of a 2-week project with no money for food or lodging. However, I have also seen the loonie-to-dollar ratio change from 0.75 to 1.25 and thepeso-to-dollar ratio change from 10,000 to 1 to the current 11 to 1. So, I don't get too complacent about the current level of finances.

Permits

Even relatively small political changes can often result in significant changes in permit requirements, fees and limitations. Preferably permits are issued on a biological basis. However, with the new international treaties (North Atlantic Free Trade Agreement, etc.), obtaining permits is becoming increasingly a political, or an economic, issue rather than a biological one.

Permits have become a significant factor in wildlife management work. Import/export permits are required from both countries to import or export collected plant and animal material, whether CITES listed or not. Researchers should plan at least a 6-month lead time before attempting to import samples. Reputable import/export border agents can be invaluable in facilitating cross-border shipments. Advances in biotechnology and genetics have made some countries exceedingly protective of genetic materials that are being removed from their country. This can have considerable adverse impacts on obtaining DNA samples for taxonomic work, for example.

All wildlife-related research projects in Mexico must be approved by SEMARNAT. In addition, work permits, or FM-3 permits (our green cards), should be obtained for projects that involve the collection, import or export of samples. These permits, as opposed to the common tourist visa, facilitate border crossings with equipment, vehicles and samples. They are also useful in the case of an accident or a crime due to the assistance that can be offered through the U.S. embassy.

In addition, international travel and financial tracking requirements of many U.S. agencies and universities can make even the simplest trips to Mexico both complicated and expensive. Working with the Mexican government can be quite challenging when routine (to us) purchase orders are not accepted.

Despite the preceding discussion about the many differences and difficulties of working internationally, I actually prefer to consider the similarities and the benefits. There is the similarity to follow the very annoying, and insidiously destructive, tendency of politicizing science. Stop it! The use of "consensus science" to promote a desired sociological goal is anathema to true science. We all have to work to preclude this from happening. Sound science is sound in all countries; bad science is just plain bad.

Wildlife biologists in every country in which I have worked have displayed the desire to do the right thing, a willingness to put up with adverse conditions, a good education and a sense of humor. Working in a foreign country will test you like nothing else, and it will reward you in the same way.

Sonoran Joint Venture: Binational Bird Conservation

Robert Mesta
Sonoran Joint Venture
Tucson, Arizona

What Are Joint Ventures?

Joint ventures are regional-scale, self-directed partnerships involving federal, state and local government agencies, corporations, tribes, individuals and a wide range of nongovernmental organizations. Joint ventures deliver science-based, on-the-ground conservation in support of local, regional, national and international bird conservation plans.

What Is the Sonoran Joint Venture?

The Sonoran Joint Venture (SJV) is a partnership of diverse organizations and individuals from throughout the southwestern United States and northwestern Mexico that share a common commitment to the conservation of all bird species and their habitats.

What Is the Mission of the Sonoran Joint Venture?

The mission of the SJV is to initiate and to sustain a regionally-based biologically-driven, landscape-oriented partnership to protect, conserve, restore and enhance bird populations and their habitats within the boundaries of the SJV.

What Does the Sonoran Joint Venture Do?

- It collaborates with partners to achieve bird conservation goals.
- It coordinates planning and activities to maximize effectiveness of bird conservation efforts.
- It works with a wide range of partners from the United States and Mexico.
- It works to improve public awareness of bird conservation issues.

- It works to increase support for bird conservation projects and programs.
- It bases all of its conservation initiatives on sound science.

Sonoran Joint Venture Structure

The SJV Program structure includes the following.

Management Board

The SJV is guided in policy and planning by a management board (Board). The primary responsibility of the Board is to maintain leadership, guidance, resources and commitment, and to accomplish the goals and objectives of SJV.

Coordinator

The primary responsibility of the JV Coordinator is to facilitate the execution of the SJV Strategic Plan.

Science Coordinator

The primary responsibility of the Science Coordinator is to maintain the biological foundation of the SJV.

Education and Outreach Committee

The primary responsibility of the Education and Outreach Committee is to support the goals and objectives of the SJV through its education and outreach projects, programs and activities.

Technical Committee

The primary responsibility of the Technical Committee is to provide the Board and joint venture staff with technical expertise regarding biological planning, recommendations, prioritization and evaluation.

Sonoran Joint Venture Boundaries

In the United States, the SJV includes southern Arizona and southern California. In Mexico, it includes Baja California and Baja California Sur, Sonora, Sinaloa, and the Gulf of California.

Conservation Importance of the Sonoran Joint Venture Region

- The SJV includes 72 important bird areas (IBAs); 20 of the 26 that are in Arizona and 47 of the 150 that are in California.
- The SJV includes all or parts of 60 of the 245 Áreas de Importancia para la Conservación de las Aucs en Mexico (AICAs-Miribas [Mexican IBAs]).
- It includes all or parts of the 10 North American Bird Conservation Initiative (NABCI), bird conservation regions.
- It has 744 documented bird species.
- It has 16 endemic and near-endemic bird species.
- It includes 40 percent of Mexico's conservation areas.
- It includes 9 of the 51 Mexican Ramsar sites.

Sonoran Joint Venture Projects and Partners

The SJV facilitates and supports a wide range of projects including:

- bird habitat restoration, protection and enhancement projects
- training opportunities
- education and outreach initiatives
- avian monitoring and research projects.

Three Examples of Sonoran Joint Venture Projects

Habitat Restoration

Coastal sage scrub habitat restoration and avian monitoring: This Audubon directed project aims to restore many acres of coastal sage scrub habitat and to monitor changes in bird assembly and nesting success over the course of the restoration.

Monitoring

The Natural History Museum of Los Angeles County and Pronatura is working to monitor and to protect important gull-billed royal tern and black skimmer colonies in coastal northwest Mexico and in southern California.***Conservation Planning***

Point Reyes Bird Observatory is writing a desert bird conservation plan to provide land managers, planners and biologists with a cohesive, easy-to-use guide to conserve and to promote bird populations in the Mojave and Colorado deserts of southeastern California.

Leaders' Panel: Priorities for Continental Conservation

Steven A. Williams
U.S. Fish and Wildlife Service
Washington, DC

My task here today is to speak about the future of conservation in North America. It's a pretty daunting assignment. We face so many challenges, not least of which are the limits of our own human and financial resources, that sometimes it's hard to know where to start. But, I am both humbled and encouraged to have this conversation among the gifted conservation leaders assembled at this meeting. And, while thinking about my topic, I realized that all of us here are required to be visionaries every day, whether or not we recognize it. That's because the very essence of our conservation work is focused on the kind of world we want to leave to our children.

Rachel Carson exercised that kind of vision a half century ago when she looked across the North American landscape and saw that the capacity of natural systems to sustain plants and animals was being diminished by pesticides. It was a time when most agronomists, foresters and public health officials regarded pesticides as miracle compounds, capable of increasing production of food and fiber and reducing disease. Over the next two decades, Carson helped the world understand and address an environmental crisis it had been slow to see.

The broader lesson she helped bestow is now part of the fabric of our collective conscience—that environmental actions yield long-term consequences. So, our actions must be responsible. Her story also reminds us that great visions must be acted on cooperatively. Rachel Carson did not end the use of dichlorodiphenyltrichloroethane (DDT). She helped convince scientists, citizens and governments around the world to examine the use of DDT and other chemicals to control unwanted pests. Gradually, they themselves adopted more cautious approaches to producing and using pesticides.

I'm reminded of the seemingly insurmountable odds that Carson faced—and the remarkable results she inspired—when I consider our own increasingly complex world. We must contend with and anticipate the challenges posed by globalization, urbanization, climate change, invasive species and the allocation and use of our water resources, to name just a few continentwide issues. Each of these issues is likely to affect the conservation community for decades to come even as our agencies grapple with increasing workloads and diminishing budgets. These circumstances highlight the fact that responsible and effective stewardship requires cooperative conservation inspired by vision and driven by priorities.

Today, I'd like to talk about some of my priorities for continental conservation. The most crucial challenges we face are continentwide, making international partnerships a *must*. We are fortunate, though, that such partnerships are not a *first*.

As they have in the past, our continuing efforts to manage wildlife on the continent must be based on reliable scientific data. We have a responsibility to the President, Congress and the public to carry out our mission based on the best available science. The U.S. Fish and Wildlife Service (Service) has a proud history of credible science. As the current generation of Service employees, it is our job to carry on that tradition and to pass that credibility on uncompromised to the next generation of employees. To that end, I have made the reliance on sound science a major emphasis.

We are working closely with the U.S. Geological Survey (USGS) to tie our research needs more closely in with their priorities. We are expanding our commitment to cooperative research units that not only perform research and analysis but also provide a pool of talented scientists who can be recruited as future Service and state employees. Together with USGS, we have formed the Future Challenges Team to anticipate events and phenomena that are likely to cause landscape changes capable of reducing the sustainability of natural systems.

The Future Challenges Team has identified four priorities—climate change, invasive species, the drain on our water resources and biotechnology—and is examining ways that we can best use our limited resources to address the management challenges they pose. We believe strongly that these efforts must involve our international partners as well.

More immediately, we're working to strengthen our cross-border research efforts—most notably in regard to the Waterfowl Survey Program.

I'm proud to stand before you in this, the 50th year of the Waterfowl Survey Program, and reemphasize our strong commitment to the program. Together with our partner, the Canadian Wildlife Service, we conduct the largest and most reliable wildlife survey in the world. The scientific benefits provided by 50 years of consistent and reliable data cannot be overstated, and we are committed to ensuring that the surveys incorporate the latest technological and methodological improvements.

As many of you know, escalating budget pressures nearly forced us to scale back the surveys last year. But, our state and Canadian partners stepped up and provided crucial funding that enabled us to preserve the program and the important data needed for proper wildlife management. The President has requested nearly $2.8 million for the surveys next year, funding that will enable us to upgrade some equipment and to maintain the surveys.

We are also working to replicate the phenomenal success of cross-border programs like the North American Waterfowl Management Plan. Responding to long-term declines in waterfowl populations in the 1980s, waterfowl managers in the United States and Canada developed a continental strategy to restore waterfowl populations through habitat protection, restoration, and enhancement. That strategy was documented in the North American Waterfowl Management Plan (Plan), signed in 1986 by Canada's Minister of the Environment and the United States' Secretary of the Interior. Plan updates in 1994 and 1998 included Mexico's Environmental Minister as a third signatory. In keeping with the 1986 Plan's 15-year planning horizon with 5-year updates, the Plan Committee initiated an update process in 200, which has now culminated with signatures by the United States, Canada and Mexico on a new, comprehensive plan that incorporates the principles and vision of the original document with a strategic framework for waterfowl conservation appropriate for the 21st century. Wildlife managers will use the plan's design to launch a new era in wildlife conservation, one based on partnerships to conserve shared natural resources.

As many of you know, the plan has facilitated the restoration and protection of millions of acres of waterfowl habitat across the continent. We believe that initiatives like those fostered by the plan, initiatives that are partnership-driven and that leverage resources, are the future of conservation.

In fact, the North American Waterfowl Management Plan serves as a model for a growing coalition of fisheries professionals and conservation leaders who are championing the National Fish Habitat Initiative. The effort is hoped to achieve for fish what has been accomplished for waterfowl by improving our collective ability to reverse declines in fish habitats around the country, thus stabilizing and even increasing fish populations. The success of locally driven joint ventures in securing wetland habitat gains is being looked at closely by fish habitat initiative proponents as they test various conservation models that might apply on a national scale. The Service is working with the Sport Fishing and Boating Partnership Council, the International Association of Fish and Wildlife Agencies, National Oceanic and Atmospheric Administration (NOAA) Fisheries, and a host of other partners to draft a national fish habitat plan. As this exciting new approach to fish conservation matures, the need to address cross-border issues in some substantive fashion will doubtless arise.

Like the wildlife we manage, our efforts should not—and will not—stop at our borders.

We have a long, and successful, relationship with Canada in addressing some of the major fisheries issues that we share in the Great Lakes Basin. We've worked successfully together to restore lake trout fisheries in Lake Superior. Our joint efforts with the basin states and Canada to control sea lampreys (*Petromyzon marinus*) represent one of the most successful examples of controlling invasive aquatic species in the world. We've got a full slate of control activities, including treatment of streams to reduce larval populations, operation of barriers in Great Lakes tributaries and release of sterile male sea lamprey already underway. Field trials of pheromones to develop alternative control methods are also on that list. We hope that work adds an additional tool to our shared efforts to control invasive species.

David Lodge, chair of the National Invasive Species Advisory Committee and an ecology and biology professor at University of Notre Dame, has called invasive species and their environmental damage the most irreversible form of pollution. A few years ago, Cornell University reported that exotic plants and animals on land and water cost up to $138 billion annually in the United States alone, impacting human health, commercial activities, community infrastructures, natural resources and agriculture production. And, the Federal Interagency Committee for the Management of Noxious and Exotic Weeds has reported that between 200 and 250 invasive plant species are recognized as major problems in world agriculture.

Many invasive species travel as inadvertent byproducts of international trade, coming through intentional imports of plants and animals. Trade with Canada and Mexico accounts for a significant portion of U.S. wildlife imports and exports; this is true of both legitimate commerce (which we hope to facilitate) as well as illegal trafficking (which we are committed to stopping). By sharing intelligence, investigative and forensics assistance and by facilitating coordination among inspection agencies working at the borders, we can prevent the unlawful commercial exploitation of protected species and the inadvertent spread of invasive species. And, we can contribute to the sustainability of North American wildlife and plant resources.

We hope to build on and strengthen the partnerships that already exist on this North American front. For many years now, our officers have worked closely with counterparts in Mexico and Canada to uphold and enforce global and North American protections for wildlife.

For 10 years, the Trilateral Committee—made up of representatives from Canada, Mexico and the United States—has been meeting to discuss conservation issues of international importance. Under the auspices of the Trilateral Committee, the Service has helped to train more than 100 Mexican wildlife law enforcement officers, has reintroduced several species to former ranges—such as black-footed ferrets, condors and pronghorn—and has implemented more than 200 projects in Mexico on capacity building, ecosystem management and information transfer.

In fact, just two weeks ago, the National Wildlife Refuge System hosted a Trilateral Protected Areas Managers Workshop at the National Conservation Training Center. The workshop brought together 30 field managers from the Canadian Wildlife Service, Mexico's National Commission of Natural Protected Areas and the Service's Refuge System to discuss shared management challenges and strategies and to identify opportunities for collaboration and training. Workshop topics included partnerships, invasive species, habitat management, law enforcement and development of a system of transboundary sister protected areas to link land management expertise and habitat conservation efforts among the three countries.

The Trilateral Committee has become a leading biodiversity conservation entity in North America. It provides a unique and effective mechanism to work towards a common vision and to face the challenges of natural resource management on a continental scale by allowing for a better understanding of local constraints and opportunities. We look forward to continuing working through this committee for a sustainable future for North America.

For a sustainable future for North America, international partnership is a *must*. It will always be a *must*! In light of the increasingly complex challenges we face, we can never stop looking for ways to expand our collaborative power. We face major issues. And, as populations increase, so does the intensity of these kinds of issues. Like our wildlife, none recognizes international boundaries, and they are not likely to disappear soon, nor can they be ignored.

Rachel Carson wrote, "Only within the moment of time represented by the present century has one species—humans—acquired significant power to alter the nature of his world."

Let me amend that statement for the 21st century and add that, while the nature of our world continues to become altered, our obligation to chart its course and act responsively, responsibly and collaboratively, is also growing stronger. It *must*! Our children cannot afford the alternative. Thank you.

Session Four.
Addressing Current and Future Wildlife Health Issues

Chair
John R. Fischer
Southeastern Cooperative Wildlife Disease Study College of Veterinary Medicine, The University of Georgia
Athens

Wildlife Disease in a Changing World

Milton Friend
U.S. Geological Survey, National Wildlife Health Center
Madison, Wisconsin

Introduction

The 1st North American Wildlife Conference, held in 1936, was a seminal event for the conservation of North American wildlife because it stimulated an increased and urgently needed interest in wildlife throughout the United States (U.S. Congress. Senate 1937). The current conference theme, Elevating the Priority of Natural Resource Conservation, reflects arrival at another important crossroad for conservation. This 70th conference focuses on achieving renewed and strengthened progress towards shared continentwide conservation goals. The Special Session, Addressing Current and Future Wildlife Health Issues, highlights disease because it has become an increasingly important wildlife conservation issue, an issue that requires disease management to be among the top priorities continentwide. This presentation provides foundation for that need.

In general, the importance of disease as a threat for the long-term sustainability of many wildlife populations has been grossly underappreciated, belies overstatement and has led the conservation community to an unfamiliar crossroad along the path of natural resources conservation. The choices that agencies and society make at this crossroad regarding wildlife health issues have ramifications in our changing world that extend beyond the natural resources community, because of the interrelations with domestic animal and human health, and beyond the added dimensions of homeland security and economic well-being.

An integrated approach to infectious disease for the benefit of all has become imperative rather than optional (Zinsstag and Weiss 2001, Potter 2004, Wildlife Conservation Society 2004). Like the 1st North American Wildlife Conference, let's hope the 70th also will be a seminal event for conservation, this time by serving as a catalyst for investment in the full integration of wildlife health as a shared global conservation goal that is conceptually and functionally addressed from a "one health" orientation. Natural resources conservation and society in general have a great deal to gain from this change.

Connectivity

Our training in the life sciences has taught us that the connectivity between all living things and the physical structure of our environment forms an integrated web of life that must be sustained to retain Earth as we know it. The struggle to maintain this web of life is eternal, and, too often, the connectivity between components is forgotten as we focus on the tasks before us. This has been true in matters of health and disease, and it requires renewed focus. Thus, the similarity between the title for this presentation and that for the National Academy of Sciences publication, *Infectious Disease in an Age of Change* (Roizman 1995), is not coincidental. Similar factors underlie infectious disease emergence and resurgence in humans and wildlife. Therefore, failure to holistically address these factors provides pathways for disease emergence in populations left vulnerable by ecological change and by lack of preemptive actions.

Transitions in Human Disease

The emergence of infectious diseases affecting humans is so common today that many are unaware or have forgotten that during the 1960s and 1970s prominent scientists and public health officials in developed countries declared victory over infectious disease (Burnet 1962, Stewart 1967, Cairnes 1978). At that same time, other notable scientists were vainly attempting to reverse the developing complacency towards infectious disease (Krause 1981, 1993). A consequence of society's failure to heed those warnings and to act preemptively is reflected in the approximately two score of emerging diseases that have appeared globally. Examples in North America, since 1980, include acquired immune deficiency syndrome (AIDS), severe acute respiratory syndrome

(SARS), monkeypox, and West Nile fever (WNF). Note that all of these examples are zoonoses (i.e., disease transmissible between animals and humans). The associated costs to society from these and other diseases that have emerged has been very great and, because of the legacy of infectious disease, will continue to accrue into the future.

Wildlife Disease

With the exception of crisis response to some major wildlife disease events, a laissez-faire attitude towards disease has existed for decades among many within the wildlife conservation community. Similar to human health of the 1970s, the voices of those urging an aggressive approach to disease in free-ranging wildlife have largely gone unheeded until recently. As a result, infectious diseases have been allowed greater opportunities than necessary to emerge, to become established and to spread. All too familiar recent North American examples, from a much longer list (Austin 1999, Daszak et al. 2000, Dobson and Foufopoulos 2001, Friend et al. 2001, Miller et al. 2001), include WNF, chronic wasting disease (CWD), raccoon rabies in the eastern United States, morbillivirus infections of marine mammals, chytrid fungal infections of amphibians, upper respiratory disease of tortoises, spring viremia of carp, Taura syndrome virus infections of shrimp, wasting disease of abalone and coral diseases. These examples illustrate that disease emergence is occurring in all major classes of North American fauna. Further, wildlife is affected to an even greater extent than humans because capabilities for proactively addressing and combating disease events are grossly inadequate.

Disease Patterns

Changes in disease patterns and spread among humans are often associated with transitions in human ecology. These changes span the existence of humanity from prehistoric to current times (Table 1). The intervals between transition periods have decreased on a logarithmic scale over time, while the geographic area of impact has increased by an order of magnitude for each transition period (McMichael 2004). The movement of diseases among human populations and between animal and human populations are both prominent within each transition period and reflect the opportunistic nature of pathogens (McMichael 2004). Because so many emerging diseases are shared by humans and wildlife, we must address the commonality of factors facilitating disease emergence in both, not just who is giving what to whom.

Table 1. Transitions in infectious diseases associated with transitions in human ecology (developed from McMichael 2004).

Era	Social and ecological transitions	Disease outcomes	Scope of impacts
Prehistoric period (several million years ago)	Shift from tree dwelling to savannah habitat	Exposure to mosquitoes and ticks	Individuals
	Increasing reliance on wildlife as food, hides, etc.	Greater exposure to enzootic pathogens and vectors	Individuals and small groups
	Increasing movements into unfamiliar areas	Increased exposure to new pathogens	Individuals and small groups
First historic period (ca. 5,000 to 10,000 years ago)	Early settlements	Enhanced opportunity for pathogens from husbanded animals and urban pests (i.e., rodents and flies) to enter human hosts	Local settlements
Second historic period (ca. 1,500 to 3,000 years ago)	Military and commercial contacts (trade)	Swapping of dominant infectious diseases of humans and animals between Eurasian civilizations (i.e., plague)	Continental
Third historic period (ca. AD 1500 to mid-21st century)	European exploration and imperialism	Transoceanic spread of often-lethal infectious diseases from Europe to the Americas, between Europe and the Asia-Pacific region, Europe and Australia, and with the trans-Atlantic slave trade	Intercontinental
Fourth historic period (today)	Changes occurring on many fronts, including demographics, environmental, social, technological and other rapid changes in human ecology that have destabilized ecosystems	Unprecedented disease emergence and resurgence throughout the world in humans, domestic animals and natural biota	Global

Wildlife Disease Transitions

The historical record for wildlife disease is quite limited, especially for North America; it only spans about 100 years as a wildlife-conservation issue. For many, concern about wildlife disease has been a nonissue until recently; these new concerns represent an important transition in perspective. As noted for human disease, "It cannot be mere chance that there has been an upturn in the tempo of new and spreading infectious diseases in recent decades" (McMichael 2004:1,051). The increased prominence of epizootics from infectious disease in free-ranging wildlife is a striking change of the past three decades. Further, the combined losses from catastrophic die-offs that commonly kill tens of thousands of wildlife, and occasionally even more, and the increased general attrition from disease cannot be sustained by free-ranging wildlife populations. Environmental conditions have reduced the past resiliency of many populations to overcome these losses (Friend et al. 2001), thereby assuring population declines. Thus, there is an urgent need to minimize disease impacts if we hope to provide long-term sustainability for traditional wildlife uses.

Pre-exploration Era

Preexploration North America is the baseline for the seven eras of wildlife-disease transitions that have followed. Data are inadequate to assess the status of disease in North American wildlife prior to European exploration and settlement. However, judgments can be made about some of the zoonotic diseases, based on knowledge about disease in humans at that time (Verano and Ubelaker 1992) and current knowledge of the occurrence of those diseases in wildlife. Sylvatic plague, tularemia and rabies, along with several parasitic diseases, are reported to have been causes of disease in native peoples prior to European exploration of the Americas (Stodder and Martin 1992). All but the internal parasitic diseases would also have caused wildlife epizootics. The most prevalent viral, bacterial and parasitic diseases causing wildlife mortality at that time were probably rabies, tularemia and mange, respectively. Wildlife disease, like human disease, was a part of nature, was not dealt with, and most likely had no lasting importance relative to species abundance and distribution.

Exploration and Early Settlement Era (circa 1500 to 1700)

Native peoples of the Americas were ravaged by new diseases as European explorers, expeditions and settlers, moved across the continent (Verano and Ubelaker 1992). Clearly, disease had a major and lasting impact on the population levels of native peoples and on the demography of people. The dominant diseases of European livestock, poultry and companion animals also were introduced to North America during this era, but their appearance in wildlife either was uncommon or was not documented. Nevertheless, the wildlife disease "seeds of change" were sown with the arrival of the first two "horsemen" of wildlife disease emergence: (1) the intrusion of domestic animals into wildlife habitat and (2) large-scale landscape change associated with agricultural development. The first one facilitated the transfer of microbes and parasites between species that had not evolved together, thereby providing potential opportunities for pathogens to flourish. The second one created ecological instability among established biological communities, thereby creating happy hunting grounds for infectious agents. The first report of a major mortality event involving wild birds appeared during 1656 and involved an extensive loss of pelicans in the West Indies (Bierer 1974).

Exploitation Era (circa 1700 to 1850)

Wildlife was exploited for various purposes, from food and sporting purposes to feathers for the millinery trade to hides for leather and furs; it was a way of life during early settlement of North America. The movement of immigrants and first-generation settlers across the continent, the major landscape changes associated with the ensuing communities that developed and the intrusion of domestic animals into previously natural environments was encouraged by the U.S. government and was carried out with abandon to promote economic growth and to secure the landscape against other interests. Wildlife conservation, and thus wildlife disease, had no major social importance during this era and were of little concern, except for threats to human health from wildlife-associated zoonoses, such as tularemia and rabies. Increasing documentation of wildlife disease began to appear, perhaps due to better reporting, but primarily because of concerns about human and domestic animal health rather than concern about impacts on wildlife populations.

Social Conscience Era (circa 1850 to 1930)

As much of North America's seemingly inexhaustible wildlife populations spiraled downward, the demise corresponded with a reawakening of social conscientiousness around the time the Civil War ended. The economic impacts from wildlife losses helped stimulate a conservation movement; restoring forests was the first national conservation effort. The first federal wildlife conservation agency, the U.S. Bureau of Biological Survey (BBS) was formed within the U.S. Department of Agriculture (USDA) during this period. As wildlife valued for economic and sporting interest declined, captive-propagation activities began to support those interests, introducing the third horseman of wildlife disease emergence. Diseases affecting propagated fur animals, such as fox, mink and rabbit, resulted in Congress directing the BBS to investigate those diseases, in support of the fur industry (U.S. Congress, Senate 1937). Species propagated for food, such as rabbit, pheasant, quail and waterfowl, also became an early focus for BBS disease investigations. Early BBS investigations were not focused on free-ranging wildlife populations because there was no demand for that. Disease was not considered to be a factor influencing the population dynamics of wild species.

The first landmark disease investigation that was focused solely on free-ranging wildlife occurred in the United Kingdom rather than the United States. This "grouse disease" investigation, initiated at the start of the 20th century, resulted in the identification of the round worm (*Trichostrongylus tenuis*) being the cause (Leslie 1911). About that same time, the unprecedented mortalities of water birds in California and on the marshes of the Great Salt Lake, Utah, stimulated the first North American disease investigations in free-ranging wildlife. Millions of birds were dying from what we now know to be avian botulism (*Clostridium botulinum*, type C) while continental waterfowl populations, a major food source for many people, were diminishing. Also, market hunting of these species was continuing despite attempts to stop this practice. The botulism investigations in California provided the impetus for the creation of the California Department of Fish and Game Wildlife Disease Investigations Laboratory. The Bear River Wildlife Disease Station, developed by the BBS in Utah around 1910 to support BBS investigations, persisted as a wildlife disease laboratory for about 70 years. The first station leader completed classic studies on avian botulism and lead poisoning in waterfowl (Wetmore 1918, 1919).

By the mid-1920s, BBS disease investigations had expanded to the extent that the Section of Disease Control was created. In 1927, the BBS undertook a 10-year investigation of disease as a factor in game fluctuations (Schillinger 1937). Those investigations were stimulated by periodic major fluctuations known to occur in the abundance of some game and fur species. Shortages in game-species numbers discouraged hunting, and the lower number of hunting licenses sold reduced revenues for state conservation departments (Schillinger 1937). Tularemia was a major disease investigated relative to its relations with grouse (*Bonasa umbellus*) and hare (*Lepus americanus*) cycles and how those cycles affected carnivore populations and, thus, the livelihood of fur trappers. The general conclusions from the overall investigation were that high wildlife densities facilitated disease transmission, that they increased losses from disease, and that disease and game populations needed to be managed in an integrated manner rather than independently (Schillinger 1937).

Conservation agencies only investigated disease in game and fur species during this era. This reflected the general acceptance of consumptive uses of uses by society during a time of increasing public concern for wildlife. Those uses provided direct linkages for the need to address disease in those species. Little incentive existed to address disease in other wildlife species.

Wildlife Conservation Era (circa 1930 to 1950)

The dismal state of natural resources in the United States during the mid-1930s prompted actions by President Franklin D. Roosevelt that included the 1940 creation of the U.S. Fish and Wildlife Service (FWS) as the federal agency charged with the restoration of the nation's wildlife resources. This new agency was created by the 1939 transfer of both the BBS, from USDA, and the U.S. Bureau of Fisheries, from the U.S. Department of Commerce, to the U.S. Department of the Interior (Gabrielson 1941). Wildlife disease was part of the charge transferred to the FWS. The 1940 Senate Report of the Special Committee on the Conservation of Wildlife Resources states that: "Research on diseases of wildlife must be regarded as an aid to conservation. With the advancement of our biological knowledge there is an increasing recognition of the importance of various infections, parasitic, and nutritional disease that from time to time decimate wild forms" (U.S. Congress. Senate 1940:90).

That 1940 report also notes the need to better understand the movement of disease agents between domestic stock and big game, the growing apprehension about the number of diseases of humans acquired from wildlife, and the concern that wildlife elimination may be pursued to protect human welfare. Funding was requested for studies that could provide the knowledge necessary for the establishment of rational policies for wildlife disease prevention and control (U.S. Congress. Senate 1940).

The teaching and writing of Aldo Leopold advanced wildlife conservation in the United States during this era. His classic treatise, *Game Management* (Leopold 1933), became a foundational philosophy for wildlife conservation. Also, his philosophy, which argued that wildlife disease prevention and control should focus on doctoring the environment not the animal (Leopold

1933), highlighted the importance of human-induced landscape changes as a major factor influencing disease occurrence.

Several state wildlife agencies established internal wildlife disease programs during this era in support of their conservation activities. Game and fur species were the primary focus for those investigations, many of which involved agency wildlife propagation programs. Enhanced collaborative investigations also occurred between public health and agriculture agencies for diseases of high public concern, such as rabies, malaria, various arthropod-borne causes of encephalitis and brucellosis.

Type C avian botulism and tularemia were the dominant wildlife diseases of concern relative to impacts on wildlife populations, and, near the end of this era, they were joined by avian cholera (*Pasturella multocidia*) as a new disease for concern. Avian cholera likely was brought to the New World in poultry (including ducks and geese) from Europe. It first appeared in poultry within the United States in 1867, causing losses of chickens, turkeys and geese in Iowa (Anonymous 1867). Despite the importance avian cholera quickly attained as a disease of poultry, the first North American water bird epizootics did not occur until 1944 (Phillips and Lincoln 1930, Friend 1999). Environmental contamination by poultry carcasses was the likely source of those epizootics in the panhandle of Texas and the San Francisco Bay Area of California.

Wildlife Management Era (circa 1950 to 1970)

Several wildlife disease landmarks appeared in the United States during the two decades following World War II. The first was the development of an interdisciplinary, graduate-level, training program at the University of Wisconsin-Madison that focused on the pathogenesis and ecology of wildlife diseases. That program evolved from veterinary science investigations of domestic animal diseases, including fur-farm species, and the teaching of Aldo Leopold, professor of wildlife ecology at the University of Wisconsin. Professor Leopold advanced the philosophy that wildlife disease had an ecological foundation and that disease impacts were more significant for wildlife populations than generally appreciated (Leopold 1933, McCabe 1987). Therefore, it was fitting that, following his 1948 death, a collaborative graduate training program focused on wildlife disease evolved between the Veterinary Science and the Wildlife Ecology departments.

The 1951 formation and early development of the Wildlife Disease Association (WDA) was a second landmark and reflected increasing interest by the scientific community in wildlife diseases. In 1955, WDA began publication of a newsletter that was the first scientific periodical focused on diseases of free-ranging wildlife. The *Bulletin of Wildlife Diseases* superseded the newsletter a decade later and eventually became the *Journal of Wildlife Diseases*.

The third landmark was the 1957 development of the Southeastern Cooperative Deer Disease Laboratory at the University of Georgia in Athens. This wildlife disease cooperative was founded by the Southeastern Association of Fish and Wildlife Agencies to address large-scale die-offs of white-tailed deer (*Odocoileus virginianus*) in the southeastern states. Epizootic hemorrhagic disease, or EHD, was found to be the cause. This landmark program has since become the Southeastern Cooperative Wildlife Disease Study (SCWDS) and has expanded its activities to serve a larger number of states and other user groups.

By 1960, the environmental movement within the United States was gathering considerable momentum. Rachel Carson's *Silent Spring* was a fourth landmark and a major catalyst for enhanced investigation of the impacts of pesticides and other synthetic chemicals on wildlife health (Carson 1962). Eggshell thinning in birds due to dichlorodiphenyltrichloroethene (DDT) metabolites (Ratcliffe 1967, Hickey and Anderson 1968, Blus et al. 1971) became an environmental movement poster child. Major investments in facility and program development followed for the investigation of organchlorine pesticides, polychlorinated biphenyls (PCBs), and other environmental contaminants. Those investigations resulted in findings leading to bans on the use of DDT and some other compounds. Despite the contributions made, it is unfortunate that wildlife environmental contaminant programs were developed as independent entities rather than being integrated within wildlife disease programs. This separation inhibited investigation of sublethal pesticide exposures on wildlife health (Friend and Trainer 1970a, 1970b, 1974). As a result, there is an important gap in knowledge of what constitutes safe pesticide exposure levels.

The shifting of public and media attention to environmental contaminants also redirected much of the focus away from other causes of wildlife disease. This redirection suppressed the development of wildlife agency infectious disease investigations as a result of operational priorities and associated resource allocations. In addition, organizational and philosophical separations between contaminant and other disease investigations formed barriers that continue to impede wildlife disease control.

The fifth landmark of this era was the activities leading to the development of an oral rabies vaccine for wild foxes (Baer 1975, Steck et al.

1982). This approach was a major shift from existing rabies control methods and policies that involved the killing of foxes and other wildlife to combat rabies epizootics. The importance of the vaccine program extended beyond its efficiency to that of helping to erode the position of those rejecting wildlife disease investigations on the basis that disease in free-ranging wildlife cannot effectively be addressed. More importantly, vaccination was responsive to growing public sentiment within the United States that opposed the killing of wildlife.

Initiation of the FWS Foreign Game Importation Program was a sixth important wildlife disease landmark. That program encouraged the importation of foreign game species to fill vacant game-range niches, thereby enhancing opportunities for sport hunting. The program was terminated after about a decade because of widespread ecological concern about the introduction and establishment of exotic wildlife in the United States (Banks 1981), the fourth horseman for wildlife disease emergence. Enhanced investment in exotic wildlife for sporting purposes on private lands also was stimulated by that program.

Ecosystem Management Era (circa 1970 to 2000)

The 1970s were a decade of paradox in the United States. Public health officials were declaring victory over infectious disease and redirecting their focus to chronic health problems, such as cardiac disease and cancer. At the same time new infectious disease problems, such as Lyme disease, were beginning to emerge. Similar contradictions were occurring in the wildlife conservation community. Despite the decade being ushered in with an avian cholera epizootic killing approximately 80,000 waterfowl on Chesapeake Bay (Friend et al. 2001), an internal 1972 FWS meeting informed agency wildlife disease investigators that their activities were to be terminated with the new fiscal year because of other priorities. However, the January 1973 duck plague outbreak at the Lake Andes National Wildlife Refuge (Friend and Pearson 1973) refocused agency attention on infectious diseases. In response to the recommendations of an external "blue ribbon" committee of disease specialists from other government agencies and the university community, the FWS abandoned its plans to terminate its wildlife disease activities and created a consolidated national program.

The FWS National Wildlife Health Center (NWHC) was initiated in January 1975 on the University of Wisconsin-Madison campus. Since then, permanent off-campus facilities were built to house the expanded program, including the first major biocontainment level-3 facility devoted to wildlife disease investigations. These biocontainment facilities have facilitated NWHC emerging disease investigations, including those for WNF.

Disease emergence in wildlife and humans alike gained momentum during the mid-1970s. It has become a phenomenon of unprecedented scope and the dominant factor influencing wildlife disease investigation since the late 1970s. Disease outbreaks have occurred in some of the most pristine areas of the world in addition to some of the most developed. Marine, freshwater, arctic, tropical, desert, grassland, forest and urban wildlife all have been impacted. The magnitude of what has occurred is both overwhelming and intimidating, relative to the challenges being posed for natural resources.

The predominance of zoonoses among the emerging disease of humans and the crossing of so-called species barriers (Mahy and Brown 2000, Osterhaus 2001) has caused wildlife to again become elevated as a component of human health investigations, for zoonoses can move from humans to wildlife as well as vice versa. The rapid growth of ecotourism has resulted in human diseases affecting great apes and other wildlife (Ferber 2000, Alexander et al. 2002) and poses new challenges for natural resource managers and administrators. Game ranching, or alternative agriculture, and aquaculture also have grown substantially as industries in response to markets created by food preferences, medicinals and other wildlife-based products. The interface between those industry animals and free-ranging wildlife provides opportunities for pathogen transfers that have been realized for several diseases.

Despite the exponential increases in disease within free-ranging wildlife populations during this era, only minimal new investments were made to address wildlife disease. The 1992 development of the Canadian Cooperative Wildlife Health Center is the most significant of those investments. This university-based interagency partnership with components at each of Canada's four colleges of veterinary medicine provides Canada with an integrated national program for wildlife disease investigations. Also, within the United States, CWD resulted in several natural resources agencies adding positions for addressing this disease in their state. Despite these additions, funding and staffing levels are greatly below needs for all North American wildlife disease programs.

Other noteworthy changes were the greatly increased focus on disease in nongame species and the unprecedented speed of disease spread across the United States. For the first time, diseases of nongame species, such as amphibians, songbirds, eagles and marine mammals, began receiving greater attention than those of game species. Media coverage of disease in wildlife also greatly increased. The global phenomenon of disease emergence, the emerging focus on ecosystem health and the connectivity evident between wildlife, humans and domestic animals for such diseases as WNF contributed to a continuum of reportable events.

Avian cholera greatly expanded its geographic area and frequency of occurrence, commonly killing thousands of birds (primarily waterfowl) during individual events. The first major epizootic of duck plague occurred in wild waterfowl; lethal forms of Newcastle disease virus killed tens of thousands of cormorants (*Phalacrocorax* spp.) in Canada and in the United States during epizootics from the Great Lakes to the West Coast. House finch conjunctivitis appeared in the Washington, DC area and subsequently spread across the entire eastern range of the house finch (*Carpodacus mexicanus*). And, a host of other diseases appeared in wild birds, amphibians, reptiles, marine and terrestrial mammals, shellfish, finfish, corals, insects and plants. Many of these events involved new diseases, expanded geographic distribution, or exposed a new species of occurrence. In some instances of recurring disease, such as avian vacuolar myelinopathy (Fischer et al. 2002) and the disease syndrome taking a large toll of eared grebes (*Podiceps nigricollis*) at California's Salton Sea (Friend 2002), the causative agents remain elusive.

Current Era

Our changing world has resulted in two important, and somewhat related, but nontraditional focal areas for wildlife disease investigations as we enter the 21st century. These are disease surveillance and monitoring to help provide homeland security and managing wildlife health in urban-suburban environments. The infamous post-9-11 anthrax letters and other events have elevated concerns about bioterrorism. Wildlife is a potential source of pathogens that might be used by terrorists and also is a potential "delivery system" for the introduction of such agents into human and animal populations. The reality of this potential has been documented in various ways throughout history, most often as accidental disease introductions associated with legal activities involving various types of wildlife releases and as the isolation of lethal and exotic pathogens from smuggled wildlife. Intentional disease introductions, other than the post-9-11 anthrax letters, also have occurred. Biological control involving the release of pathogens to cause disease in animal populations is exemplified by the history of myxomatosis in Australia and Europe (Fenner and Ratcliffe 1965, Hickling 2000) and, more recently, by rabbit hemorrhagic disease (Bomford et al. 1998, Bowen and Reid 1998). People and domestic animals have also been targeted by bioweapons during wartime (Geissler and van Courtland Moon 1989, Harris 2002) and by terrorists pursuing their personal or organizational agendas (Christopher et al. 1997, Kolavick et al. 1997, Takahaski et al. 2004).

Agriculture and wildlife are highly vulnerable targets that may be chosen by terrorists because of their accessibility, the potential economic costs that may be inflicted and the potential for some biological agents to move from animals to people following infection of the animals (Wilson et al. 2000). The closure of international markets until after disease eradication has been achieved extends the economic costs associated with diseases, such as foot and mouth disease, far beyond the disease impacts on infected animal populations. Similarly, curtailment of hunting and closing recreation areas to human use can result from disease introductions in wildlife.

Urban-suburban environments are the second area for focus. These environments have become habitat for an increasing array of wildlife as landscape fragmentation for housing and other human needs continues to encroach upon natural areas (Palumbi 2001, Palmer et al. 2004). This trend is unlikely to change. It presents new challenges and needs relative to wildlife disease management because of zoonoses and because of the potential for disease transfer between the wildlife residents of these environments and the transient wildlife that move freely between different locations. There also is an array of social and jurisdictional issues associated with urban environments that complicate wildlife disease prevention and control. These factors also result in urban-suburban environments being highly vulnerable for bioterrorist attack.

The potential for human exposure to zoonotic disease in urban-suburban environments is enhanced by the close association often present between wildlife and humans. Depending on the species involved, often there is greater tolerance by wildlife for approach by humans. Also, human perspectives that tend to impart companion animal status to wildlife foster the desire for close human approaches. Indirect exposure involving contact with environments contaminated by wildlife body discharges, contact with arthropod disease vectors and contact with companion animals that have interfaced with diseased wildlife and their environments are other potential pathways for human exposure to disease agents in these environments.

Discussion

Disease is an outcome of the combined and increasingly widespread impacts from demographic, environmental, behavioral, technological and other rapid changes in human ecology (McMichael 2004). Pathogens have exploited our indiscretions, lack of sensitivity, ignorance and arrogance to the extent that wildlife, humans and domestic animals all are being impacted globally. It would be easy to feel that we have reached Armageddon. However, the concept of being at war with disease is part of the problem because it obscures our understanding of the eternal self-interested, coevolutionary struggles that microbes and humans are both engaged with in the quest for survival (McMichael 2004).

Unfortunately, these struggles are confounded by those who embrace the use of microbes to cause disease as a means for advancing political and personnel agendas. Because of ecological and political instability and because technological advances facilitate intentional disease introductions and spread, microbes have become greater threats as weapons for attack. Africa serves as an example of the long-term and multispecies consequence that can result from failure to adequately prevent the intentional establishment of an infectious disease. Anthrax appears to have been used as a bioweapon against cattle in Rhodesia (now Zimbabwe) during its war of independence in the 1970s. Disease establishment and spread was aided by the war-associated breakdown of government administration and veterinary services. The ensuing human epidemic resulted in approximately 10,000 cases of illness and hundreds of death. The persistence of anthrax in Zimbabwe since then continues to place a heavy toll on humans, domestic animals and wildlife (Wilson et al. 2000).

Regulatory approaches cannot provide adequate protection against bioterrorism because of the broad spectrum of legal pathways and multiple-agency jurisdictions associated with human-assisted movements of animals and animal products for wildlife trade, scientific investigations, zoological collections, wildlife conservation and other needs. Also, intentional illegal wildlife movements will not be constrained by such regulations. Therefore, enhanced capabilities for early detection of disease introduction and emergence are needed to protect ourselves and our institutions from bioterrorism. Greater collaborative efforts also are needed to address disease introductions.

Truly integrated wildlife, domestic animal and human health programs enhance infectious disease surveillance, thereby facilitating early detection of disease occurrence and the potential for timely intervention and disease containment. In concert with wildlife disease programs, the network of federal and state natural areas, wildlife refuges, other government holdings, and the field force present on those areas could be developed into an early warning grid for disease emergence that would serve national security, public health and wildlife conservation alike. However, integrated wildlife disease monitoring and surveillance has remained outside the scope of biodefense efforts (Pavlin and Kelley 2005). The estimated $7.5 billion in U.S. biodefense funding during the previous year was allocated for the development of new drugs and vaccines, better sensors, new high-security laboratories, genome sequencing of pathogens that might be weaponized, a Bioshield program, and other activities (Anonymous 2004). Indication of potential change is the April 2005 national conference being convened by the U.S. Department of Homeland Security to discuss the establishment of the Academic Network on Foreign Animal and Zoonotic Disease. Hopefully, that conference will enhance appreciation of the values wildlife disease surveillance and monitoring have for national security and human well-being.

Conclusion

In the words of Pogo, "We have met the enemy and he is us." Thus, the good news is that because we as a society are the basic problem, we have the capacity to adjust our behavior and actions in ways that can greatly reduce the potential for disease emergence and the impacts that are occurring. The bad news is that many of the adjustments needed will be very difficult to achieve because of tradition, self-interest and other impediments. Part of the problem is that the population impacts of wildlife disease often are underappreciated in conservation strategies (May 1988, Price 1991, Deem et al. 2001). Also, response to disease is generally crisis-orientated and is seldom focused on a preventive approach. Further, tolerance of disease during periods of noncrisis has suppressed the incorporation of wildlife health management within the mainstream of natural resources conservation, thereby inhibiting disease prevention and control for the benefit of free-ranging wildlife. Each of those impediments must be overcome.

Other changes needed include a greater appreciation that disease is an outcome not a cause. Failure to grasp the importance of this difference remains a fundamental problem that too often results in actions being directed towards symptoms rather than cause. This situation is analogous to general comments by Aldo Leopold about conservation efforts: "Many conservation treatments are obviously superficial. Flood control dams have no relation to the cause of floods. Check dams and terraces do not touch the cause of erosion. Refuges and propagating plants to maintain animals do not explain why the animal fails to maintain itself. In general, the trend of the evidence indicates that in land, just as in the human body, the symptom may lie in one organ and the cause in another. The practices we now call conservation are, to a large extent, local alleviations of biotic pain. They are necessary, but they must not be confused with causes. "The art of land-doctoring is being practiced with vigor, but the science of land-health is a job for the future" (Leopold 1941:3). Typical responses to disease by the conservation community have primarily been local alleviations of biotic pain. This is no longer acceptable if we truly are serious about our wildlife-stewardship role. The science of land health is no longer a job for the future. Instead, it has become a fundamental need for enhanced understanding and application for addressing wildlife, domestic animal and human health alike.

Wildlife health is an indice of land-health. The connectivity that exists with human and domestic animal health strongly supports the wisdom of unified and integrated efforts for addressing disease prevention. The consequences from failure to do so are painfully evident throughout the globe. We have the capability to make a difference by suppressing disease impacts in wildlife. The question is, do we have the will to do so? The choices are ours to make and the consequences of our choices will be bestowed upon future generations.

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Reducing Risk Factors for Disease Problems Involving Wildlife

John R. Fischer
Southeastern Cooperative Wildlife Disease Study
College of Veterinary Medicine, The University of Georgia
Athens

William R. Davidson
Southeastern Cooperative Wildlife Disease Study
College of Veterinary Medicine, The University of Georgia
Athens

Introduction

Many of today's most significant disease issues involving wildlife are associated with highly artificial activities that increase the risk for the introduction, establishment or dissemination of pathogens. Examples of these practices include, but are not limited to, translocation of native or exotic species of wildlife, supplemental feeding and baiting of wildlife, captive propagation of wild species, development and use of biological products, and fenced wildlife enclosures. At times these activities may occur within wildlife or agriculture agency programs, but they typically are more extensive within the private sector, and this is where the more intractable problems usually have occurred. Consequently, appropriate changes in public education, policies, regulations and enforcement are justified to reduce the risks of creating new disease problems and to enhance efforts to control or eliminate existing wildlife health issues.

High profile examples of disease problems associated with these activities include: the expansive outbreak of raccoon rabies after its introduction into the mid-Atlantic region via private sector translocation of animals from the raccoon rabies endemic area in the Southeast; the establishment of bovine tuberculosis in wild white-tailed deer (*Odocoileus virginianus*) in an area of Michigan where massive supplemental feeding and baiting of deer occurred; the dramatic spread of chronic wasting disease among privately owned elk (*Cervus elaphus*) herds in the United States and Canada; and the introduction of exotic ticks, monkeypox virus and other disease agents with imported exotic wildlife.

Some of these examples involved a combination of activities that increased risk. All of these activities, along with other practices that directly contribute to disease problems, represent risks that can be managed.

The issues and authority to address them span wildlife, animal health and public health professions. In accordance with their responsibility for conserving wildlife, state fish and wildlife management agencies should assume a primary role in developing science-based policies and regulations that reduce manageable wildlife disease risks and that justify these actions through effective public outreach programs. Inaction on the part of state fish and wildlife agencies could result in erosion of their traditional authority and responsibility for managing wildlife resources, which may occur when public health or domestic animal health agencies acquire or assume increased responsibility for management actions for disease problems involving wild animals.

Activities That Increase the Risk of Wildlife Health Problems

Several practices have been identified as increasing opportunities for the spread of disease agents, for their introduction into new species or geographic locations, and for their maintenance in free-ranging wildlife populations. However, it would be misleading to categorize all of the resulting problems as wildlife diseases. Although in some cases the diseases occur naturally and primarily in wildlife species, in many cases the diseases are caused by traditional livestock pathogens that have been introduced into susceptible wildlife species. It is essential to recognize that disease transmission between wild and domestic animals is a two-way street. Current examples of livestock diseases in wildlife include bovine tuberculosis and bovine brucellosis in limited areas in the United States and Canada. These European cattle diseases were brought to North America. They spread throughout domestic cattle but also spilled over into native wildlife in limited instances. Now that bovine brucellosis and bovine tuberculosis have been all but eradicated from the domestic livestock industry, native wildlife species have become the remaining reservoirs, and the problems frequently are referred to as wildlife diseases.

Activities that increase disease risks in wildlife have some common denominators. They usually have narrow objectives, they often are incompletely researched and evaluated, and they frequently are implemented or not controlled despite potentially negative consequences. The practices are related to disease because each alters one or more epidemiological risk factors. The risk factors that may be altered include which pathogens are involved, when, where and how exposure occurs, and the magnitude of exposure of native wildlife to the pathogen. The consequences of altering these epidemiological risk factors are real, not just theoretical, and there are many examples of unintended disease consequences from altering them. However, the list of activities and examples of problems that resulted from or were exacerbated by these practices in the following review is far from complete.

Translocation of Native or Exotic Wildlife Species

Perhaps the best example of a large health problem that resulted from translocation of native wildlife is the current raccoon rabies epizootic affecting much of the eastern United States. Prior to the widespread and often illegal private sector translocation of raccoons (*Procyon lotor*) in the 1970s, the raccoon strain of rabies virus was endemic only in the far southeastern corner of the United States. However, capture of raccoons in the endemic area and the subsequent release in the mid-Atlantic region by individuals wishing to increase local raccoon numbers for hunting purposes resulted in one of the largest and most intense epizootics of rabies ever documented (Jenkins and Winkler 1987). Private sector translocation of rabid raccoons was confirmed as the source of the appearance of raccoon rabies hundreds of miles to the north by contemporaneous detection of rabid translocated animals (Nettles et al. 1979) and by subsequent identification of the specific viral strain (Jenkins and Winkler 1987, Smith et al. 1995). To date, millions of dollars have been expended in raccoon rabies surveillance and in management efforts with no end in sight.

Numerous other disease problems have been documented that are attributable to private sector translocation of native wildlife for hunting. Although none of these are as dramatic or publicly recognized as the current raccoon rabies epizootic, they have resulted in the unintentional translocation of important pathogens. Indigenous cases of tularemia had not been recognized in Massachusetts prior to 1937, a year in which more than 26,000 cottontails (*Sylvilagus floridanus*) (that came with health certificates and that originated from tularemia-free areas) were imported and released in the state (Ayres et al. 1948). The first three human cases were diagnosed near a release site during the same year, and tularemia later was confirmed in rabbit shipments from the Midwest (Belding and Merrill 1941). Subsequently, an enzootic focus of tickborne tularemia developed in Massachusetts with wildlife, domestic animal and human cases. Since 1978, two separate clusters of pneumonic tularemia have been documented in humans conducting lawn maintenance and were attributed to aerosolization of the causative bacterium by lawn mowers and other power lawn equipment (Feldman et al. 2001).

In the 1980s and 1990s, state and federal undercover law enforcement operations netted illegal shipments of red foxes (*Vulpes vulpes*) and coyotes (*Canis latrans*) in the Southeast. Shipments contained animals carrying a tapeworm that can cause severe disease and death in humans but which does not occur in the Southeast (Davidson et al. 1992, Lee et al. 1993). The tapeworm, *Echinococcus multilocularis*, is currently widespread in wild canids in the upper Midwest where it also probably was introduced from Alaska or from more northern regions of Canada sometime in the mid-1900s (Schwab 1986). The illegal shipments originated from multiple states, including Illinois, Indiana, Montana and Ohio. However, the precise geographic sources of all of the animals, which were infected with other pathogens, such as canine distemper virus, remained unknown. Subsequent monitoring of several fox pens in Georgia and South Carolina that were known to have links to the confiscated animals failed to detect on site infestations of *E. multilocularis*; however, this study was small in scope and was far from a comprehensive evaluation of whether the tapeworm might have become established in the Southeast (Lee et al. 1993).

Translocation of native and exotic wildlife for sale as pets also has resulted in the introduction of diseases or vectors into new areas. Exotic tick species that are vectors of foreign animal diseases, such as heartwater, were detected on 97 of 349 (28%) of imported African reptiles inspected during a two-month period from 1994 to 1995, in Miami, Florida (Clark and Doten 1995). In 1995, breeding exotic ticks were found in Florida. And, in 1999, some ticks on imported reptiles tested positive for DNA of the heartwater organism (Burridge et al. 2000a, 2000b). Fortunately, heartwater, which is fatal to cattle and to some wildlife including white-tailed deer, has not been recognized in Florida or elsewhere in the United States.

Capture of native prairie dogs (*Cynomys* spp.)and their distribution for sale as pets have been associated with three very significant human pathogens, one of which previously had not been recognized in North America. In 1998, plague was diagnosed as the cause of death in over 200 wild-caught prairie dogs shipped from plague-endemic areas to a Texas broker. The mechanism by which plague was able to occur in this situation, with extensive flea-control efforts in place, was undetermined (Texas Department of Health 1998). In 2002, tularemia was documented among 3,600 wild-caught prairie dogs that were shipped from South Dakota to a Texas broker, where exposed animals subsequently were distributed to 10 other states and to 5 foreign countries (Centers for Disease Control and Prevention 2002). And, in a highly publicized event in 2003, human cases of monkeypox in five states were linked to pet prairie dogs that had been exposed to infected, imported African rodents (Centers for Disease Control and Prevention 2003). Subsequently, the importation, transport and release of certain species of African rodents and of prairie dogs were banned permanently in the United States. However, a population of Gambian giant pouched rats (*Cricetomys gambianus*), one of the African species associated with the introduction of monkeypox, has been found in the wild in the Florida Keys (B. Hanson, personal communication 2004).

Translocation of cervids by state wildlife management agencies and by the private sector has been associated with the introduction and establishment of pathogens into new areas. White-tailed deer are natural hosts and almost never are clinically affected by the meningeal worm, *Parelaphostrongylus tenuis*, which causes neurological disease in all other native North American wildlife, as well as in some domestic animal species. Thus, it is an important consideration in ungulate management. The meningeal worm does not occur throughout North America and is absent from some regions, including the southeastern coastal plain. However, it was introduced in this region via translocation of white-tailed deer from Wisconsin and Pennsylvania. Although the worm was found in the 1960s in a single deer in Florida (Prestwood and Smith 1969), apparently it did not persist or become widely established (Forrester 1992). The origin is believed to be Wisconsin white-tailed deer that were brought to Florida in the 1940s by the state wildlife agency to restore wild deer populations. In 1993, meningeal worms were found in 100 percent of a small sample of deer at Wassaw Island National Wildlife Refuge in coastal Georgia, and its presence was attributed to the introduction of six white-tailed deer in the 1920s by private individuals (Davidson et al. 1996). Risk of *P. tenuis* introduction into regions of North America east of the Great Plains via movement of captive cervids, particularly elk, is an ongoing concern (Samuel et al. 1992)

An exotic louse recently has been associated with a widespread hair-loss syndrome first recognized in 1996 in black-tailed deer (*Odocoileus hemionus* *columbia*) in western Oregon and in Washington (Bildfell et al. 2004). The previously undescribed louse, *Damalinia* (*Cervicola* sp.) is parthenogenetic and can reach densities greater than 1.5 million lice per host animal. Strong evidence suggests that the louse was introduced via importation of exotic deer or of other ruminants because all known members of this genus previously have been recognized only on deer or antelope in the eastern hemisphere. In addition to its presence and cause of the hair loss syndrome in black-tailed deer in Washington and Oregon, an apparently identical louse has been recovered from wild white-tailed deer at multiple locations in the Southeast (Bildfell et al. 2004). Fortunately, infestations on southeastern white-tailed deer have not involved extremely high numbers of lice nor have they been associated with hair-loss syndrome (W. R. Davidson, personal files 2004).

Supplemental Feeding and Baiting of Wildlife

Supplemental feeding and baiting of wildlife have been associated with some high profile health problems in native wildlife, as well as with a few less publicized diseases. And, they have been demonstrated to enhance disease risks in two separate and fundamentally different ways. First, feeding and baiting congregate normally dispersed wild animals, thereby enhancing direct and indirect transmission of infectious disease agents. Consequently, they may be responsible for the establishment, maintenance and spread of a disease within a wildlife population, and they might be looked upon as the accelerators of conflagrations rather than the igniters. Second, supplemental feed and bait may be the source of noninfectious disease agents, such as fungal toxins.

Prior to the 1990s, bovine tuberculosis (TB) never had been known to persist in free-ranging cervid populations in the United States despite a handful of occurrences regarded as spillover of *Mycobacterium bovis* from cattle to deer without subsequent maintenance in the wild. However, in 1994 an infected white-tailed deer was found in the northeastern portion of Michigan's lower peninsula. Subsequent surveillance revealed that bovine TB has become endemic in deer in several counties within this region. Additionally, bovine TB has spread from deer into elk and several native carnivorous species, as well as to more than 30 herds of beef and dairy cattle. To date, two human infections have been associated with the *M. bovis* strain circulating in Michigan wildlife. Michigan has lost its accredited statewide bovine-TB-free status. The costs associated with testing wildlife and livestock, with depopulation of cattle herds, and with other surveillance and management activities are estimated to be more than $25 million annually.

The unusual maintenance of bovine TB in deer in northeastern Michigan has been attributed largely to supplemental feeding and to baiting of deer that occurred on a massive scale for many years prior to identification of the disease problem (Schmitt et al. 1997). It is likely that *M. bovis* spilled over from infected cattle herds in the past when the prevalence of the disease was high among cattle in the region. The affected area of Michigan has soils of marginal quality, and much of the private lands are leased or owned by deer hunting clubs. Supplemental feeding was practiced to increase deer population densities, and baiting was employed to increase chances for hunting success. The net effect was an increase of the deer population to a density that exceeded the carrying capacity of the land. Furthermore, deer gathered at feed or bait piles where *M. bovis* was spread directly from animal to animal, via nose-to-nose contact, and indirectly, via consumption of contaminated feed. Research conducted in the affected area of Michigan documented significant nose-to-nose contact between deer at feed and bait sites (Garner 2001), and it revealed strong relationships between bovine TB cases in deer, feed sites and levels of feeding (Hickling 2002). Consequently, management actions to eradicate bovine TB from Michigan have included stringent regulation or bans on feeding and baiting, as well as liberalization of harvest regulations to reduce deer population densities in the affected area.

Supplemental winter feeding is regarded as a critical factor in the maintenance of bovine brucellosis in elk in the Greater Yellowstone Area (GYA). The disease also occurs in bison (*Bison bison*) in the GYA. And, in 2003 and 2004, apparent spillover of brucellosis from elk to cattle herds resulted in the loss of brucellosis-free status for Wyoming (Linfield 2004). Like the bovine TB situation, millions of dollars have been invested by taxpayers and producers to eliminate brucellosis from domestic cattle, and spillover from these animals to native wildlife likely occurred at some point in the past. Extensive winter feeding of elk has occurred in this area for many years, largely in response to land-use conflicts with livestock grazers. Unfortunately, through this practice the elk are congregated at the time when most brucellosis transmission occurs via contact with calves aborted by infected elk. The complexity of this disease problem involving multiple states, multiple agencies within states and several federal agencies cannot be overstated, nor can the role of public sentiment in determination of the approaches being considered to resolve this issue.

Another location at which infectious disease agents are transmitted among wildlife is at bird feeding stations. Bird feeders have been associated with at least five common diseases of songbirds, including salmonellosis, mycoplasmal conjunctivitis, trichomoniasis, avian pox and aspergillosis. Salmonellosis outbreaks, especially among songbirds that frequent feeders, have increased in number and severity in the last 20 years, especially in some species (Friend et al. 1999). Mycoplasmal conjunctivitis was recognized for the first time in 1994 in suburban Washington, DC, and has since spread across the entire eastern range of house finches (*Carpodacus mexicanus*), as well as to some additional avian species (Fischer et al. 1997). House finches, which are native to the western United States, were introduced into Long Island, New York, in the 1930s and have spread across eastern and midwestern United States and Canada where they often dominate at bird feeding stations. Trichomoniasis occurs primarily in doves (*Zenaida macroura*) and pigeons (*Columba livia*), and in the raptors that prey on them. The causative protozoa may be transmitted directly by crop milk feeding of young or ingestion of infected birds, as well as indirectly at contaminated feeders and bird baths. Avian poxvirus is transmitted primarily via mosquito bites, but direct bird to bird transmission is enhanced by congregation of birds at feeders. Aspergillosis is caused by a fungal organism found nearly everywhere; however, when present on bird feeding stations, the fungus may infect large numbers of birds. Proper bird feeder hygiene can prevent or can reduce many of the infectious disease problems occurring at these sites.

In addition, toxins may be found in bait and supplemental feed for wildlife. Mycotoxins, such as aflatoxin and fumonisin, occur mainly in grain crops and peanuts that have been damaged by drought or other stressors. Aflatoxins are hepatotoxic, teratogenic, mutagenic and carcinogenic, and the U.S. Food and Drug Administration regulates consumption of aflatoxin by humans and animals destined for the human food chain. Typically, grain products contaminated by more than 20 parts per billion (ppb) are banned from human food; whereas, animal feed action levels range from 20 to 300 ppb depending on the animal species, age and products to be consumed from the animal, such as milk or meat. Contaminated grains unsuitable for human or domestic animal consumption may be dumped or may find their way into commercial wildlife feeds, which generally are not as stringently regulated. Additionally, aflatoxin levels can increase after grains are stored or are placed in the field, even in freezing weather. One survey found that 18 of 38 samples of corn from deer bait piles, from bait storage bins and from fields in North Carolina and South Carolina contained aflatoxin levels ranging from 22 to 750 ppb (Fischer et al. 1995). Subsequent feeding trials revealed that wild turkeys consuming feed containing 100 to 400 ppb had decreased weight gains, liver and blood dysfunction, and lower immune function (Quist et al. 2000). Although bait or feed may be placed in the field for some species, such as deer, it is highly likely that nontarget species that may be more susceptible to the toxic effect also will consume the material.

Captive Propagation of Wildlife

Captive propagation of native and exotic wildlife is practiced for a variety of reasons. Some propagated wildlife may never enter the wild. Other animals may be released intentionally to bolster populations for hunting or other purposes while, in some cases, entrance into the wild is by escape. In addition, free-ranging wildlife in the vicinity may be able to enter and leave a fenced facility containing captive wildlife of the same or different species. All of these situations can alter the epidemiological factors that increase the risk of disease problems among free-ranging wildlife in the vicinity of facilities or release sites.

Captive propagation of wild turkeys (*Meleagris gallopavo*) for release formerly was practiced by wildlife management agencies, but it has been abandoned. However, this practice may still occur in the private sector. Although disease risks often were asserted regarding pen-raised turkeys, historically there had been limited circumstantial evidence to support the claims. However, in 1985 the National Wild Turkey Federation purchased pen-raised turkeys and submitted them for diagnostic testing. Findings included avian poxvirus, *Mycoplasma gallisepticum*, *Salmonella typhimurium*, *Histomonas meleagridis* and other pathogens. As a result, the release of pen-raised wild turkeys was considered biologically hazardous, and the recommendation was made that the practice should be discouraged or prohibited (Schorr et al. 1988).

Diseases of domestic animals may become disseminated among captive wildlife propagation facilities, particularly when extensive shipping of animals occurs among the operations and tests for the disease in question are not reliable on an individual basis or in the species being tested. Such was the case in the 1980s and 1990s, when bovine TB spread throughout many captive cervid herds in the United States and Canada. Additionally, bovine TB infections in captive bison herds were traced back to infected commercial elk. Infected captive deer and elk herds subsequently were found in several states and provinces (Thoen et al. 1995). The national eradication program for bovine TB among cattle and bison was expanded to include captive cervids in the United States in the 1990s greatly reducing the problem. However, recent detections of low numbers of infected captive elk indicate that the disease has not been eliminated entirely from the industry.

In addition to disease risks posed by the presence of infected animals, genetics of disease resistance may be an issue with respect to propagation of captive wildlife. For example, orbiviral hemorrhagic disease (HD) occurs from the southeastern to the northwestern United States in wild cervids and is a very significant infectious disease of white-tailed deer. However, the clinical outcome and impacts of HD among wild white-tailed deer populations are highly variable, depending on the geographical location. In the southern United States, particularly in parts of southern Florida and in central and southern Texas, multiple strains of HD viruses (epizootic hemorrhagic disease virus (EHDV) types 1 and 2 and bluetongue virus types 2, 10, 11, 13 and 17) are enzootic. In these locations animals are exposed to HD viruses annually, and deer often show only mild or no clinical signs of infection. In contrast, outbreaks are sporadic in more northern areas where HD occurs and are associated with high mortality rates (Davidson and Doster 1997). Furthermore, it has been observed that white-tailed deer imported from northern states to captive facilities in the South often suffer more severe clinical disease and death during HD outbreaks. This picture suggested some degree of innate resistance among southern deer to HD viruses. This was confirmed experimentally when young deer from Texas (enzootic area) and from Pennsylvania (nonenzootic area) were inoculated with identical doses of either EHDV-1 or EHDV-2. Although the same level of viremia occurred in both Texas and Pennsylvania animals, the Pennsylvania deer developed severe clinical disease, and 100 percent (EHDV-1) and 20 percent (EHDV-2) died. Whereas, the Texas deer had no clinical signs and none died. Because the experiment also included controls for any acquired or maternal antibodies, researchers concluded the results confirmed innate resistance. Furthermore, this work showed that northern deer are genetically maladapted for regions in which HD is enzootic, and it suggested that northern deer genotypes could dilute HD resistance if introduced into resistant southern deer populations (Gaydos et al. 2002).

Development and Use of Biological Products

Development or use of biological products can encompass a broad variety of issues; however, here the use of vaccines or antimicrobials for immunization or treatment of wild animals will be emphasized. Examples of problems arising from vaccine use in wildlife primarily are related to modified-live virus (MLV) vaccines that were administered to species other than those for which the product had been intended. The use of various MLV canine distemper virus (CDV) vaccines provides an excellent example because of the worldwide distribution and broad host range of the virus. In 1974, vaccination of the only known living endangered black-footed ferrets (*Mustela nigripes*) captured from the wild in South Dakota resulted in the deaths of four of the six animals (Carpenter et al. 1976). In multiple instances, gray foxes (*Urocyon cinereoargenteus*), which are highly susceptible to CDV, have died in fox-chasing enclosures following vaccination with canine distemper MLV that was administered by both veterinarians and private citizens (Halbrooks et al. 1981). Additionally, there are reports of vaccine-induced canine distemper among many species of wild animals maintained in zoological collections.

An example of potential hazards associated with treatment of wildlife species with antimicrobials is the rehabilitation of house finches with mycoplasmal conjunctivitis. Two potential issues arose. First, *Mycoplasma gallisepticum* (MG) spread to blue jays (*Cyanocitta cristata*) housed in a cage that had contained infected house finches. Blue jays with mycoplasmal conjunctivitis have not been observed in the wild and this situation emphasizes the potential for spillover into additional species under artificial conditions. Second, despite the resolution of clinical signs in house finches treated for MG, culture of birds indicated that they remained infected with the organism and could be a potential source for other birds if released after resolution of eye lesions (Ley et al. 1997). Suggestions have arisen from the public regarding treatment of affected birds with medicated bird seed or water, and similar thoughts have been given to treating wild deer or other animals with parasiticides. Unfortunately, administration of medications through these methods does not ensure that an effective therapeutic dose will be delivered. Inadequate treatment with antimicrobials and parasiticides is a well-recognized risk factor for the development of drug resistance by bacterial organisms and parasites.

High Fence Enclosures

High fence shooting enclosures have been associated with a variety of problems, many of which have been directly related to stocking of the enclosures with animals from remote locations, i.e., translocation of captive wildlife. The previous example regarding *E. multilocularis* among foxes shipped illegally to stock southern hunting enclosures also could be included in this section. However, additional examples exist for disease problems in hunting enclosures.

In 1993 and in 1994, the coyote/dog strain of rabies virus from an ongoing outbreak in southern Texas was found hundreds of miles away in foxhounds associated with fox pens in Alabama and Florida. In Alabama, infection of a foxhound was linked to the purchase of Texas coyotes and their release in the hound owner's fox-chasing enclosure (Centers for Disease Control and Prevention 1995). In Florida, five foxhounds were found to be rabid, and, although a definitive source of exposure was not confirmed, some of the dogs had been run in fox-chasing enclosures and at foxhound field trials. Quarantines were implemented to control movement of dogs from affected premises, and coyotes, foxes and other wild carnivores were depopulated from the fox-chasing enclosures owned or leased by the dog owners. Additionally in Florida, 24 persons that were exposed to the dogs underwent rabies postexposure prophylaxis (Centers for Disease Control and Prevention 1995).

The spread of bovine TB was cited above as an example of the potential for a disease to spread among captive wildlife propagation facilities. Infection of free-ranging wildlife in the area of the facilities often is feared by wildlife managers, and has been documented in at least one instance. In the winter of 1993 to 1994, bovine TB was found in a wild mule deer (*O. hemionus*) in Montana as a result of surveillance around a game ranch that contained infected elk. The ranch was surrounded by a single high fence and no escapes of captive elk had been reported. Additional surveillance disclosed bovine TB in another mule deer and in a coyote in the vicinity of the ranch (Rhyan et al. 1995). All animals were infected with the same strain of *M. bovis* found in the captive elk herd, as confirmed by DNA testing. Although the owner of the captive elk herd was indemnified for destruction and testing of the privately owned animals, there was no compensation provided for the publicly owned, free-ranging animals in the area that were killed in surveillance efforts.

Chronic Wasting Disease: The Result of a Combination of Altered Risk Factors

The current situation regarding chronic wasting disease (CWD) in North America is the result of a combination of many of the risk factors identified above. The original source of CWD is unknown. First identified in captive research mule deer in Colorado and Wyoming, CWD subsequently was found in wild deer and elk in northeastern Colorado and adjacent southeastern Wyoming. Later, CWD was detected in captive commercial cervid herds in eight states and two provinces, as well as in free-ranging deer in one province and six states outside Colorado and Wyoming (Goeldner 2004). Precisely when and how CWD was introduced into wild and captive cervids remains unknown, despite abundant speculation.

Translocation of privately owned elk has been confirmed as the source of infection for 12 captive elk herds (7 linked to 1 facility and 5 linked to another facility) in the United States (L. Creekmore, personal communication 2003), and, in Saskatchewan, 38 elk herds became infected with CWD through primary or secondary links to a single source herd (Luterbach 2002). Factors involved in the extensive spread of CWD between captive cervid herds included lack of recognition that the disease was present in privately owned elk until 1996 and lack of a live animal test for CWD. In Saskatchewan and Alberta, 41 captive elk herds were destroyed at a cost of more than $15 million, and a national CWD surveillance and control program was implemented for captive cervids.

In 2001, it became apparent that one infected facility in Colorado had shipped numerous exposed captive elk to at least 18 states, as well as to more than 40 other facilities within Colorado. Infected elk subsequently were found in one Kansas herd and two other herds in Colorado (United States Animal Health Association 2001). As of October 2004, CWD had been confirmed in a total of 29 captive elk herds and 5 captive white-tailed deer herds in the United States. Three infected elk herds remained in Colorado, and two deer herds remained in Wisconsin. All other herds had been depopulated with indemnification made available to nearly all owners by the U.S. Department of Agriculture and state agencies (Goeldner 2004). A national program to eliminate CWD from captive deer and elk in the United States has been under development since 1998.

Experiments have not been conducted to directly evaluate the role of supplemental feeding and baiting of wild cervids in CWD epidemiology. However, these practices increase animal-to-animal contact and exposure to contaminated environments. And, they can be reliably considered to increase opportunities for CWD transmission. Although precise transmission modes are unknown, horizontal spread is suspected, and environmental contamination has been documented experimentally to result in CWD transmission (Miller et al. 2004). Bans on baiting and feeding have been initiated in areas where CWD has been found in wild deer in order to reduce opportunities for disease transmission.

Propagation of captive cervids requires appropriate fencing, and some facilities are used as high fence shooting enclosures. In addition to spread of CWD via translocation of animals between facilities for breeding, shooting or other purposes, potential exists for the spread of CWD to free-ranging wildlife in the area. Although it has not been proven, CWD is suspected to have spread between captive and wild animals, in both directions, and poor fence integrity could be expected to increase opportunities for this to occur. A 2003 audit of farmed white-tailed deer operations in Wisconsin found 639 licensed facilities and 24 unlicensed farms. Most facilities were in full compliance, but 77 had fence violations. Although the majority of farms reported no problems, 186 reported escapes or intentional releases of deer with at least 436 escaped deer not recovered (Wisconsin Department of Natural Resources 2003). To illustrate the point that true risks exist, CWD was confirmed in October 2002 in a white-tailed deer six months after it had escaped from a Wisconsin deer farm with infected deer (Wisconsin Department of Natural Resources 2002).

Concerns have been raised regarding transport and disposal of carcasses of wild animals killed by hunters in areas with CWD. Although carcass movement never has been documented as a source of CWD infection in new areas, several states have used a regulatory or public education approach to reduce such risks by promoting proper disposal and by discouraging or prohibiting the movement of certain higher risk tissues, particularly from the lymphoid and central nervous systems, out of affected areas or into areas in which CWD has not been recognized (Michigan Department of Natural Resources 2004).

The potential role of biological products in CWD epidemiology is unknown. A variety of products, including meat, hides, antlers, antler velvet, semen and urine may be obtained from captive cervids, and many of these may be sold and shipped within and between states, as well as to other countries. Incomplete knowledge regarding the precise modes of CWD transmission has raised concerns that the disease could be spread via some of these products. For example, questions frequently arise about semen, because it may be shipped when movement of live animals is prohibited. And, urine-based attractant products are of concern because they may contain other excreta, are sold nationwide, and are distributed in the environment by deer hunters. The CWD risks that these products represent are unknown, and, although the transmissibility of the CWD agent via excreta or secretions has not been demonstrated to date, further studies are warranted to evaluate potential risks.

In 2002, a multiagency team drafted the *Plan for Assisting States, Federal Agencies and Tribes Managing Chronic Wasting Disease in Captive and Free-ranging Deer and Elk.* Although incompletely funded, the program made significant progress in the last two-plus years. The plan was designed to reduce the risks of CWD spreading to currently unaffected areas, to contain of CWD within areas recognized to be affected, and to eradicate or to reduce of CWD prevalence in these areas. Significant components of the plan include research, surveillance, disease management, diagnostics, technical data management and communication/public outreach.

Reducing Disease Risks through Policy, Regulation and Public Education

The highly artificial activities associated with disease problems described above represent risks that can be managed. In fact, some of the disease problems cited above precipitated changes, such as bans on importation, transport and the release of animals in response to the monkeypox outbreak. They also caused the implementation of federal programs in the United States and Canada to eliminate bovine tuberculosis from captive cervids. And, a national plan was developed to manage CWD in captive and free-ranging cervids in the United States. As effective as any of these changes may prove to be, they all represent reaction to problems only after they have been recognized.

Managing disease in free-ranging wildlife is much more problematic than disease control in captive wildlife, domestic livestock and poultry. Disease may develop, spread among free-ranging animals, and increase in geographic scope before it is detected. Even when a wildlife health problem is identified, few proven techniques are available to control or eliminate it. Disease management efforts in wildlife should be expected to be difficult, expensive and time consuming, and they may provoke significant public opposition, particularly when depopulation or dramatic reduction of wild animal numbers is involved. And, there is no guarantee of success. Consequently, prevention must be regarded as the most efficient and reliable approach to disease problems in wildlife, and a proactive strategy should be followed.

Many of the activities identified above as altering epidemiological risk factors are still practiced, and some have increased in recent years. If the trend of increasing artificial activities directed at wildlife species continues, additional disease problems can be anticipated. In view of their authority and responsibility for conserving wildlife resources, state wildlife management agencies should assume a primary role in developing policies and regulations to reduce wildlife disease risks. Because many of the diseases involving wildlife also affect domestic animals and humans, federal or state agriculture and public health agencies may have an interest in or authority to address the problem. In some cases, authority over specific activities, such as supplemental feeding of wildlife, may be in question or it may appear that no agency has authority. In these instances, it may be necessary to obtain authority to regulate the activity and to reduce risks. Wildlife management agencies should engage and should work with the animal and public health agencies to promulgate and justify science-based policies. Inaction by state wildlife resource agencies could result in loss of some of their traditional authority for managing wildlife resources or the continuation and potential worsening of wildlife health problems.

The potential results of policy changes must be thoroughly assessed in order to ensure that desired outcomes are attained and that new or additional wildlife, domestic animal or human health problems are not created. In most cases, prohibition or stringent regulation of risk-altering activities would not have any unintended health consequences. However, in some instances where a complex health problem already exists or is imminent, careful consideration of policy changes and the potential outcomes is especially important. A specific example of the latter would be the brucellosis situation in U.S. elk and bison and the need for a comprehensive assessment and strategy development by the Greater Yellowstone Interagency Brucellosis Council. Outcome assessments, like policies and regulations to reduce disease risks, should be strongly grounded in science.

Promulgation of policies and enforcement of regulations will not be enough to significantly reduce the disease risks associated with the above activities. Support of the stakeholders and the general public is necessary for any reasonable chance of success, particularly when long-practiced and popular activities are stringently regulated and when some people are financially impacted. The significance of public support for policies and regulations cannot be overemphasized, and it can be attained only through long-term public education and outreach programs. State wildlife management agencies recognize the importance of effective public outreach programs and should utilize them to provide a consistent message that scientifically justifies the need for policies and regulations that reduce the risk of disease problems in wildlife.

Summary

We have reviewed examples of several significant wildlife health problems that originated or were exacerbated by artificial activities that altered epidemiological risk factors for the introduction, establishment and dissemination of disease agents in free-ranging wildlife. The examples cited here are only a portion of the wildlife health issues resulting from such activities, and there are many others, including some that involve fish, amphibians or reptiles. Some of these highly artificial practices have been banned or have been stringently regulated because of the recognized risks; however, many continue both legally and illegally. Although the risks associated with these activities have been recognized and a variety of regulations have been implemented to reduce these risks, in nearly every case they have been viewed as single-issue problems (e.g., translocation of raccoons or release of pen-raised turkeys or feeding of Michigan deer). We assert that a more holistic view is needed to achieve progress in protecting wildlife health and preventing future problems because all of these practices alter epidemiological risk factors. Effective public education regarding the relationship of these practices to disease risks will be necessary to garner support for policies and regulations designed to protect wildlife health.

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Finding the Cure: The U.S. Department of the Interior's Role in Managing Zoonoses and Other Infectious Diseases of Wildlife

Susan D. Haseltine
U.S. Geological Survey
Reston, Virginia

Leslie A. Dierauf
U.S. Geological Survey
Madison, Wisconsin

Richard F. Kearney
U.S. Geological Survey Wildlife, Terrestrial and Endangered Resources Program
Reston, Virginia

Bryan J. Richards
U.S. Geological Survey, National Wildlife Health Center
Madison, Wisconsin

Introduction

Over the past 5 years, concerns regarding wildlife and human health have risen in national prominence and have attracted much attention from Congress, the news media and the U.S. public. The continued expansion of urban and suburban developments into formerly agricultural areas has brought a growing number of people into contact with wildlife. Increased levels of international travel and trade have resulted in new combinations of disease organisms, potential hosts and environmental conditions. Outbreaks of zoonotic diseases, such as West Nile fever and avian influenza, even in distant parts of the world, are reported widely and create anxiety among those unfamiliar with wildlife and disease ecology. The public's demand for swift action to reduce or eliminate the effects of these diseases can easily result in management responses that are both ill-conceived and wasteful, if not harmful in the long term.

The appropriate response to an outbreak of a zoonotic or other infectious wildlife disease should be one based on an understanding of domestic animal, wildlife and human populations, the disease organism or agent, and the biological, chemical and physical characteristics of the environment in which they interact. Rarely is the response to an outbreak based on such an understanding of the particular disease however. Our knowledge in the fields of public health and domestic animal health, while far from complete, is rather advanced when compared to our knowledge in wildlife health. In what is arguably the most complex of all three fields of study, relatively little is understood about interactions that take place among free-ranging wildlife, pathogenic organisms and the ecosystems in which they live. The science of wildlife health and the practice of wildlife disease management both are still in their infancy. It is time to move beyond this situation.

U.S. Department of the Interior Authorities

In the United States, the responsibility for managing free-ranging wildlife resources is shared by the federal government and the states. The U.S. Department of the Interior (DOI), as the steward for over 507 million acres (205 million ha) of surface land (an area equal to one-fifth of the nation's land mass), is committed to managing the wildlife resources on these lands in a sound and sustainable manner. In addition to its stewardship role, DOI has responsibilities for wildlife research and management assigned by federal laws, such as the Endangered Species Act, the Fish and Wildlife Coordination Act, the Marine Mammal Protection Act, and the Wild Horses and Burros Act. DOI also supports our nation in meeting our obligations under international treaties and conventions, such as the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere, the Convention on International Trade in Endangered Species, and migratory bird treaties with Canada, Mexico, Japan and countries formerly of the Soviet Union.

At times, DOI engages in wildlife health matters at the specific direction of Congress. Public interest in disease issues, such as the management of West Nile fever, chronic wasting disease (CWD) and sylvatic plague, has led to congressional mandates expressed in appropriation acts over the past decade. Thus DOI, like the U.S. Department of Agriculture, the U.S. Department of Health and Human Services, state agencies and other organizations, plays an important part in the research and management of zoonotic and other infectious diseases of wildlife.

Unlike the other federal agencies, however, DOI's primary focus is on conserving wildlife in its natural environment. This focus compels DOI to develop a more comprehensive understanding of wildlife disease ecology, of how the disease agents function in unmanaged ecological settings, of how they spread through free-ranging wildlife, of what effects the diseases create in wildlife populations and of what subsequent effects any change in wildlife populations may have upon the larger ecosystem. This focus on the ecological consequences of wildlife disease makes DOI unique among the federal agencies involved in disease research and management.

U.S. Department of the Interior's Role in Wildlife Disease Research

The primary role for DOI in wildlife disease research is to develop the scientific foundation for management of wildlife resources on DOI-managed lands. Within DOI, scientific research on wildlife disease is performed by the U.S. Geological Survey (USGS). This facilitates an integrated approach, allowing researchers to call upon the USGS's full range of biologic, hydrologic, geologic, geographic and informatics capabilities in examining the ecological components of wildlife disease.

Research on wildlife disease ecology takes place at USGS science centers and cooperative research units across the country. Most disease research activity, however, takes place at the USGS National Wildlife Health Center (NWHC), located in Madison, Wisconsin. Established in 1975, the NWHC was the first federal program devoted to investigations of wildlife health and disease on a national scale. Emergency preparedness, responding to wildlife disease outbreaks, preventing and controlling wildlife diseases, and conducting both field and laboratory research on wildlife disease have been critical missions of the NWHC since its inception.

USGS support to the field of wildlife health has not been limited to conducting its own research. For more than 25 years, the USGS has supported work by the Southeastern Cooperative Wildlife Disease Study (SCWDS), a cooperative program involving 15 states and territories, the Wildlife Management Institute, the University of Georgia, USGS and the U.S. Fish and Wildlife Service. SCWDS works for the benefit of wildlife resources and animal health, and it provides benefits to each cooperator far beyond what could be purchased with any member's individual contribution.

Avian Cholera—The Start of Wildlife Disease Research

In 1944, avian cholera, a highly infectious disease affecting North American waterfowl was first reported among wild birds in Texas and California. This disease is caused by the bacterium *Pasteurella multocida* and spreads from bird to bird through either inhalation or ingestion of the microorganism. Avian cholera can spread rapidly when wild birds congregate in high numbers in a wetland area (U.S. Geological Survey, National Wildlife Health Center 2003a).

When wildlife scientists first started investigating avian cholera, they knew very little. As research into its causes progressed, they discovered that the bacterium could persist for months in the environment and that waterfowl, such as snow geese (*Chen caerulescens*), could be asymptomatic carriers of the bacterium, transporting it into wetland environments they used during migration (Samuel et al. 2004). Increases in snow goose populations, combined with decreases in available wetland habitat, contributed to the catastrophic waterfowl losses due to avian cholera.

Over the past 20 years, scientists at the NWHC have collected *P. multocida* isolates and now have an extensive collection to which molecular fingerprinting methods are now being applied (Samuel et al. 2003b). Researchers are correlating these fingerprint patterns with other information associated with each sample, such as date of isolation, bird species infected, location of disease occurrence and severity of disease outbreak. This information will be used to establish criteria for predicting the potential impacts of *P. multocida* on wild bird populations under a range of environmental conditions. Natural resource managers require such information to conduct risk analyses, to plan disease prevention strategies and to weigh the advantages of alternative responses to avian cholera outbreaks when they occur.

U.S. Department of the Interior's Role in Wildlife Disease Surveillance

Besides conducting disease surveillance on the lands it manages, DOI supports other efforts to monitor the geographic extent and rate of spread of wildlife diseases. The NWHC has been at the center of numerous surveillance efforts, providing urgently needed diagnostic and analytical support to federal and state departments of health, to wildlife agencies and to others. As a result of its ability to synthesize the results of research in a broad range of scientific disciplines and to make complex scientific data available in a coherent and useful fashion, DOI is prepared to support any increase in wildlife disease surveillance activities conducted under Homeland Security Presidential Directive #9 (HSPD-9).

A Case Study in Disease Surveillance: West Nile Virus

Many wildlife species can serve as sentinels, warning us of emerging or resurging diseases. One of these species is the greater sage-grouse (*Centrocercus urophasianus*). In the 2004 field season, dead sage-grouse collected by USGS partners in California tested positive for West Nile virus (WNV). A mosquito-borne virus from Africa, WNV emerged for the first time in North America in 1999 with the discovery of a dead crow (*Corvus brachyrhynchos*) outside the gates of the Bronx Zoo in New York City (Rappole et al. 2000). In a span of just 5 years, WNV has since spread in epidemic proportions to every state except Alaska and Hawaii.

The NWHC Honolulu Field Station, working with the Hawaii Department of Public Health, is conducting WNV surveillance on birds and mosquitoes at Hawaiian ports and airports. The disease has not reached Hawaii yet, and surveillance will give an early warning should the disease move across the Pacific Ocean from the North American mainland. An additional WNV study relating to Hawaiian ecosystems is being conducted jointly by the NWHC and the USGS Pacific Islands Ecosystem Research Center. In this study, researchers are testing the susceptibility of the amakihi, a common Hawaiian honey creeper, to WNV as well as assessing its potential to carry the virus (as a reservoir) and to increase the numbers of the virus (as an amplifier).

WNV has the potential to create landscape-level losses among many other bird species dependent on healthy habitat in which to live. As of November 2004, USGS scientists, working in collaboration with the Centers for Disease Control and others, have learned that 288 species of birds, 23 species of mammals and 1 reptile species have been affected by this epizootic in North America (Centers for Disease Control and Prevention 2005b, U.S. Geological Survey National Wildlife Health Center 2005).

Characterizing and Managing Risk

Risk assessment is not easy. One can begin by looking at risk factors, such as with CWD. CWD poses significant challenges for resource managers, due to our incomplete understanding of the disease's etiology (cause) and epidemiology (how the disease moves across the landscape and from animal to animal). In May 2004, the USGS sponsored an interdisciplinary workshop in Fort Collins, Colorado, on the design of risk analysis tools, risk modeling direction and information collection needs (U.S. Department of the Interior et al. 2004). Participants discussed management priorities in assessing and preventing CWD, in particular how to create awareness, how to enlist buy-in from other groups for CWD, how to conduct fact-finding to help informatics decision-makers decide where to focus surveillance efforts, and how to ensure that surveillance efforts are fair and include all stakeholders. From the workshop came a consensus product that rated potential risk for CWD entering a state that did not have CWD-positive animals. A total of 37 risk factors were identified and ranked as high, medium of low in their importance in making management decisions regarding the likelihood of CWD entering a state. The 2004 CWD surveillance workshop demonstrated that a great deal of research, analysis and information sharing remains to be accomplished.

A Case Study in Responding to Disease: Managing the Effects of Plague

The highly endangered black-footed ferret (*Mustela nigripes*) depends on five species of prairie dog (*Cynomys* sp.) for food (it feeds on prairie dogs, mice and other small mammals) and shelter (ferrets live in prairie dog towns). Prairie dogs occur in an 11-state region, from North Dakota south to Axizona, New Mexico and Texas. Recovery planning efforts by DOI land management bureaus (the U.S. Fish and Wildlife Service, the U.S. Bureau of Land Management and the U.S. National Park Service) call for the reintroduction of black-footed ferrets in a core area across this same expanse of the West.

Outbreaks of the plague can dramatically affect the populations of both species and can threaten DOI recovery efforts. Plague, caused by the bacterium *Yersinia pestis*, is transmitted by fleas that feed on both ferrets and prairie dogs (Koomhof et al. 1999). Mortality rates can be as high as 95 percent of the animals that become infected. Researchers are working on a palatable oral vaccine and delivery system for immunization that will protect the ferrets, prairie dogs and other species that inhabit prairie dog towns against infection with plague (Mencher et al. 2004). Such collaborative efforts are paving the way for plague management in areas where the disease threatens native wildlife and in areas where the risk of plague exposure to humans is also significant, such as national parks and areas where rural and urban lands interface.

U.S. Department of the Interior's Role in Being Prepared

Being prepared for potential outbreaks of zoonoses requires a significant investment of time, energy and resources. It requires an understanding of potential threats and the means to counter those threats. Lastly, it requires an organizational commitment to develop contingency plans, communication systems and response capabilities that may be called upon in time of crisis.

Under the U.S. Department of Homeland Security's national response plan, DOI has the mission to provide rapid diagnostic and assessment support in the event of disaster involving the rapid emergence of a zoonotic disease. DOI has developed and tested its capability to provide that support as recently as January 2005.

A Possible Pandemic Scenario—Avian Influenza

Between 1918 and 1919, a pandemic of influenza killed 20 to 40 million people, more than those killed (and more quickly) than the first World War. To put this disease in perspective, influenza killed more people in a single year than did 4 years of the Black Death, or bubonic plague, in the mid-1300s. Medical historians have described this influenza pandemic as the worst pandemic in recorded history.

Avian influenza viruses circulate freely in populations of free-flying waterbirds throughout the world (Swayne et al. 2003). Different virus subtypes circulate independently of one another and move within and sometimes among migratory flyways. The number and characteristics of subtypes vary annually. Over time, the extent to which the virus causes disease can drift and shift, with high rates of virus replication occurring in high density populations of domestic poultry and with different species acting as mixing vessels for viral genes, increasing their virulence and infectivity. Domestic (and presumably feral) swine can also play a role in this gene mixing and may allow the influenza virus to become highly pathogenic and spread between mammals, including humans.

The avian influenza outbreak currently taking place in Thailand, Vietnam and other parts of Asia is caused by a highly pathogenic avian influenza virus known as H5N1. Within the last year, more than 40 people have died from the respiratory form of the virus, and at least 1 confirmed cluster of human-to-human transmission and resulting deaths occurred in March 2004 (Centers for Disease Control and Prevention 2005a). Confirmation of the disease being the result of an avian influenza virus was not made until more than seven months later.

Could such a series of events happen here in North America? Yes, most definitely. We must be prepared for such a disease emergency, and we must have a coordinated response to such an event, working collaboratively across federal, state, tribal, provincial, academic and local agencies, across international borders, and across agriculture, wildlife and public health jurisdictions, so we are able to respond rapidly and to effectively implement well planned strategies. That means coordination and communication now, prior to the actual emergency occurring. We must take advantage of interagency collaboration, so we will understand each other and each other's capabilities and capacities prior to any event occurring. We must ensure that we continue to conduct global monitoring of wildlife health, so the occurrence of any disease outbreak is recognized early and responded to rapidly by all of us in a coordinated fashion.

Getting to True Collaboration

It is clear that management and monitoring of wildlife disease must be a joint effort that crosses jurisdictions, public and domestic animal health fields, and international borders. Just like wildlife, disease recognizes no boundaries. Collaboration is the healthiest solution to preventing, controlling, identifying and treating emerging and resurging wildlife infectious diseases and zoonoses. Only by leveraging resources will we be able to muster the people and capabilities needed to be prepared for and to respond to disease outbreaks.

Collaborative efforts are not easy. They require effort on everyone's part and take time to nurture, grow and bloom. If everyone participates to their fullest, we can work collaboratively on at least a few big projects that cross inter- and transdisciplinary boundaries.

A Case Study in Collaboration: Chronic Wasting Disease

CWD is a fatal neurological disorder of deer and elk first identified over 40 years ago. CWD is contagious and can be transmitted from animal to animal through some as yet unknown form of contact. Additionally, the disease-causing agent, an abnormal protein or prion, can apparently be shed by a diseased animal, can persist in the environment, and can be taken up at a later time, causing disease in previously healthy animals (Williams and Miller 2002, Miller et al. 2004).

For over two decades, wildlife biologists thought that CWD only affected a small region of Colorado and Wyoming. Due to increased surveillance efforts over the past 5 years, however, CWD has been detected among free-ranging deer and elk in a much wider geographic area within Colorado and Wyoming. It has also been observed in six additional states—Nebraska, Utah, New Mexico, South Dakota, Wisconsin and Illinois (U.S. Geological Survey National Wildlife Health Center 2003b).

A cooperative effort involving DOI (USGS, U.S. Fish and Wildlife Service and U.S. National Park Service), the U.S. Department of Agriculture, and Colorado, Wyoming, Nebraska and Wisconsin, resulted in the preparation of guidelines that many states and provinces now use to guide their CWD surveillance activities (Samuel et al. 2003a).

Compared to other diseases affecting wildlife, what we do not know about CWD is still vast. We do not know the exact route of transmission and are not yet able to detect the disease in live, free-ranging deer and elk. We do not yet know the impacts CWD is having on deer and elk populations and what other species might become infected. Research is ongoing and collaborative efforts among federal agencies, states, provinces and academic institutions are taking place across North America.

To understand this disease, scientists require much more data. A tool showing great promise for facilitating the exchange of data between wildlife researchers and managers is the CWD Data Clearinghouse being developed by the National Biological Informatics Infrastructure's Wildlife Disease Information Node. Better tracking, examination and analysis of CWD data and faster results from CWD research are possible with collaborative information sharing among those involved with this disease.

Summary

Effective science-based planning and policy come from an understanding of wildlife disease ecology and knowledge about how people, animals and other elements of the environment interact. Interdisciplinary research bridges the historic gaps between traditional scientific disciplines and newer areas of expertise. Once scientists, managers and policy leaders are able to recognize, understand and explain such interactions, they can apply these concepts to the management of our lands and waters, as well as communicate valuable information to the public.

During the last century, wildlife disease was considered more of a nuisance than a matter of substance. Over time however, the need for proactive surveillance and prevention has grown. The public demands rapid response when outbreaks occur; citizens worry about how such diseases can affect their own health. A combination of field and laboratory research is leading the way toward greater understanding of wildlife infectious diseases and zoonoses, utilizing novel technological advances and taking advantage of the opportunities available for collaborative efforts. Of course, outbreaks of both new and old diseases will continue to occur across the continent and the world. If we are vigilant, if we are prepared, we will be able to respond.

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The Role of U. S. Department of Agriculture-Animal and Plant Health Inspection Services in Wildlife Disease Management

Thomas J. DeLiberto
U. S. Department of Agriculture—Animal and Plant Health Inspection Services, Wildlife Services
Fort Collins, Colorado

Bobby R. Acord
U. S. Department of Agriculture—Animal and Plant Health Inspection Services
Washington, DC

Elisabeth A. Markese
U. S. Department of Agriculture—Animal and Plant Health Inspection Services, Veterinary Services
Riverdale, Maryland

Introduction

Wildlife is a publicly owned resource in the United States, and, as such, various segments of our society view wildlife with different ecological, aesthetic, economic and cultural value. This has inevitably led to a great diversity of opinions on the management of our wildlife resource. For example, producers and conservationists often view livestock and wildlife in direct competition for resources, leading to differences in opinion over issues, such as habitat and population management.

Disease prevention and management in livestock and wildlife also have been generating controversy over management strategies affecting the health of both animal resources. As the United States approaches eradication of diseases, such as bovine brucellosis and tuberculosis (TB), reservoirs of these diseases in wildlife are increasingly viewed by producers and by state and federal animal health authorities as potential sources for reintroduction of disease into livestock. Alternatively, conservationists view livestock as a source of diseases (e.g., chronic wasting disease [CWD] in farmed cervids) that could be transmitted to wildlife. Additionally, the potential for bioterrorism has heightened awareness by conservationists, agriculturalists and public health officials of the potential effects of zoonotic diseases intentionally introduced into livestock and wildlife populations.

The bidirectional transmission of infectious diseases among domestic animals and wildlife, the zoonotic implications of some diseases, as well as the effect of diseases in wildlife on the international standards used for trade in domestic animals and animal products, pose a major and continuing challenge for wildlife and agricultural professionals. Consequently, The World Organization for Animal Health (OIE) encourages all countries to develop and maintain wildlife disease surveillance systems. It is now widely recognized that countries that conduct such surveillance programs are more likely to understand the epidemiology of specific infectious diseases and zoonotic infections. In turn, these countries are better prepared to exclude exotic diseases and, through surveillance and response efforts, protect wildlife, domestic animals and humans.

Part of a national strategy for monitoring animal diseases and for quickly responding to disease introductions must include a national monitoring and surveillance system for wildlife diseases. Similar to disease surveillance programs in place for U.S. livestock, this system for wildlife health should have the capability to investigate events of mass morbidity and mortality and new disease syndromes, to identify and to categorize new pathogens, and to monitor the status of known diseases within wildlife populations. However, disease surveillance and management in free-ranging populations is technically difficult and expensive, and it requires the involvement of numerous cooperators and stakeholders, including government agencies and universities. Management of wildlife in the United States is primarily under the jurisdiction of agencies within the U.S. Department of Interior, states and tribes that regulate migratory, threatened and endangered species. Additionally, health departments have authority to regulate zoonotic diseases, such as rabies, plague and influenza. Therefore, the development and implementation of an effective and efficient wildlife disease surveillance system in the United States requires cooperation, coordination and communication between all of these agencies and stakeholders.

A number of surveillance programs for diseases in wildlife have already been established by state departments of natural resources, the National Wildlife Health Center (NWHC), universities (e.g., the Southeastern Cooperative Wildlife Disease Study [SCWDS], University of California Davis Wildlife Health

Center) and the U.S. Department of Agriculture (USDA). While these programs are an excellent start and are providing valuable information to state and federal officials, a nationally coordinated wildlife disease surveillance system would further support ongoing efforts with the collection of samples, would facilitate information exchange among cooperators, would ensure adequate sampling for diseases of national biosecurity concern (e.g., plague, tularemia, classical swine fever [CSF]) and would provide additional laboratory infrastructure in the event of a disease outbreak.

The following is an overview of the various efforts underway by USDA's Animal and Plant Health Inspection Service (APHIS) to refine its domestic animal disease surveillance programs and to incorporate wildlife disease surveillance into these efforts. APHIS recognizes the solid foundation for wildlife disease surveillance already established in the United States. Working through a variety of program initiatives, including livestock health, wildlife damage management, and homeland security, APHIS can supplement these efforts to develop effective surveillance systems for wildlife health in the United States.

The Animal and Plant Health Inspection Service's Role

Within USDA, APHIS is charged with safeguarding U.S. agriculture and natural resources from exotic pests and diseases and with facilitating agricultural trade. In recent years, APHIS' protective role has also grown to include wildlife damage management, the welfare of animals, human health and safety, and addressing invasive species in the United States.

In collaboration with its cooperators, APHIS conducts extensive domestic surveillance programs to detect serious agricultural pests and diseases before incursions become large-scale and unmanageable. APHIS also has emergency response plans and personnel in place to quickly detect pest or disease incursions, to control the outbreaks and to work toward eradication. In addition, APHIS also monitors pest and disease threats abroad and, using this information, develops regulations that govern the safe movement of livestock, meat products, plants and plant products into the United States.

Because of this technical expertise and leadership in assessing and regulating the risks associated with agricultural imports, APHIS has also assumed a greater role in the global agricultural trade arena in recent years. Most notably, APHIS is at the forefront of discussions regarding the OIE standards related to bovine spongiform encephalopathy (BSE) and avian influenza (AI). In other important areas, the agency helps U.S. exporters meet other countries' animal and plant health import requirements, and APHIS officials negotiate science-based standards that ensure U.S. agricultural exports, worth over $50 billion annually, are protected from unjustified trade restrictions.

In order to accomplish these important goals, APHIS relies on disease surveillance data gathered through various disease control and wildlife programs. This information is provided to trading partners to assure officials that U.S. livestock and meat products are free of diseases of concern, such as CSF. Billions of dollars of trade rests on APHIS' ability to successfully monitor U.S. animal populations for disease and to share this critical information with the OIE and U.S. trading partners.

Veterinary Services' Role

APHIS relies on USDA's Veterinary Services (VS) to protect and improve the health and marketability of our nation's animals, animal products and veterinary biologics. VS achieves these missions by preventing, controlling and, when possible, eradicating animal diseases through preventive veterinary medicine and regulatory programs. In addition, VS monitors for emerging animal health issues on the domestic front and abroad. Again, this information is integral to APHIS' efforts to provide trading partners with data on the health of U.S. livestock, as well as the development of sound import requirements designed to safeguard animal health.

In regard to disease safeguarding and wildlife concerns, VS typically focuses on: (1) reducing the risks of disease transmission from free-ranging wildlife to animal agriculture and vice versa, (2) working collaboratively with APHIS' Wildlife Services (WS), other wildlife management and agricultural agencies, and individual states to reduce the risk of disease transmission and to contribute to overall wildlife and public health, (3) protecting the health of animal agriculture, including commercial alternative livestock species, such as farmed cervids, and (4) reducing, through import and post import regulations, the disease risks to animal agriculture by intended or unintended entry into the United States through trade.

Similar to its domestic animal policies, VS' wildlife policies are risk-based and disease-driven. When VS addresses disease concerns in free-ranging wildlife, local circumstances, such as land ownership issues, regulatory authorities and existing management strategies, are predominant factors in the decision making process. In recent years, VS has formed long-term relationships with state, federal and university wildlife disease organizations to assist in developing its disease management policies.

Wildlife Services' Role

Since its creation in the late 1800s, WS has developed to provide cost-sharing wildlife damage management services to cooperators. Through its state-based operational program and the National Wildlife Research Center (NWRC), WS has a history of cooperatively working with federal, state and local agencies, nongovernmental organizations, tribes, and the public to develop methods and to manage wildlife conflicts.

Within APHIS, WS has been charged with developing a national wildlife disease surveillance and emergency response system (SERS) for free-ranging animal populations that supports and complements existing programs undertaken by state departments of natural resources, universities, NWRC, and VS. The goal of WS' system is to provide an infrastructure capable of assisting state, federal and tribal agencies with their respective efforts to survey for and to address wildlife disease threats. As noted previously, augmenting existing state and federal surveillance programs with a nationally coordinated SERS will provide much-needed assistance in the areas of surveillance, laboratory capacity and information sharing among all of the involved agencies and stakeholders.

WS has forged partnerships with VS, APHIS' International Services, the U.S. Department of Homeland Security (DHS), and Canadian and Mexican agriculture, health and natural resources agencies to implement a cooperative, border, disease-surveillance program that targets both livestock and wildlife. Enhanced animal disease biosecurity along the Mexican border is helping to facilitate trade as called for by the North American Free Trade Agreement. The program is also proactively helping to deter any intentional introduction of animal diseases along the border.

WS is implementing SERS primarily through the work of a national wildlife disease coordinator and a cadre of wildlife disease biologists assigned to WS field offices. In addition to providing assistance to state, tribal and other federal agencies to accomplish their disease surveillance and control objectives, wildlife disease biologists serve as liaisons to WS, VS, state departments of health, agriculture and natural resources, and other state, tribal and federal agencies that are concerned with wildlife disease issues. The wildlife biologists also are available to rapidly mobilize and to assist with disease outbreaks and other emergencies requiring WS participation.

In the field of research, the NWRC focuses on the development of methods that reduce human-wildlife conflicts, such as diseases shared between livestock and wildlife, as well as zoonotic diseases. Current research being conducted at NWRC focuses on diseases, such as rabies, TB, CWD, pseudorabies (PRV) and AI. Additionally, laboratory facilities at NWRC are available to provide diagnostic support to other agencies in the event of a disease emergency, such as the introduction of a foreign animal disease (FAD).

Cooperative Disease Management

VS and WS have a long history of working with states to support surveillance and eradication activities for diseases, such as foot and mouth disease (FMD), PRV, CWD, TB, rabies and plague—diseases that have implications for domestic livestock and wildlife health, as well as human health. Some have expressed concern that APHIS' increased role in wildlife disease management could decrease states' authority. Historical collaborations and recent developments in various disease programs demonstrate APHIS' commitment to partnering with a diverse array of stakeholders to maximize the benefits and effectiveness of its safeguarding and emergency response programs. The extensive challenges presented by exotic animal diseases make eradication impossible except through cooperation and collaboration between APHIS and state agencies. For instance, without the outstanding cooperative effort to address the outbreak of exotic Newcastle disease in southern California, APHIS would not have been able to eradicate this dangerous and costly disease or to restore export markets for U.S. poultry producers.

The Animal Health Protection Act of 2002 (AHPA), APHIS' primary legal authority to address serious animal diseases in the United States, reflects the need for federal-state cooperation in dealing with disease outbreaks and related situations. Under the AHPA, the USDA Secretary, after consultation with state officials, can declare animal health emergencies and can provide states with financial resources that are not available under ordinary circumstances. In addition, large numbers of animal health professionals can be mobilized through

APHIS' emergency programs to assist states with various emergency response functions.

Foot and Mouth Disease

Beginning as early as 1924, the federal programs that evolved into modern-day VS and WS recognized the immense value of working with state and with other federal officials to combat animal diseases. The two organizations teamed up with the California Fish and Game Department, the California Department of Agriculture, the U.S. Forest Service, and the U.S. Park Service to successfully eradicate FMD from deer in the Stanislaus National Forest. That multiagency cooperative effort is still used as a template in today's disease management and eradication efforts for both domestic and wild animal populations.

Pseudorabies

VS is currently shifting the focus of its PRV program, which has successfully addressed the disease in U.S. commercial swine production. With PRV essentially eradicated in commercial production swine, VS has begun focusing on PRV surveillance and control in known and potential disease reservoirs, especially small herd transitional swine exposed to feral swine. In November 2003, revised pseudorabies eradication program standards were issued that established criteria for the control and management of PRV in these reservoirs. The standards require states at advanced stages of PRV eradication to develop feral and transitional swine management plans as part of annual disease reporting requirements. These plans must address existing feral swine populations, must market controls to prevent introduction of feral pigs or transitional swine into commercial production swine herds and must assure that separation is maintained to prevent the interface of feral swine and transitional production swine with commercial production swine. VS and WS have been working with state departments of agriculture and natural resources, county agriculture extension services, hunting clubs, environmental groups, SCWDS, and other pertinent groups to gather distribution and population demographic information on feral swine.

Additionally, WS and VS have begun coordinating with these groups in an effort to systematically sample feral swine populations for diseases, such as PRV. This effort will not only ensure diseases of concern in feral swine are monitored, but also will facilitate the exchange of data between state and federal agencies.

Pseudorabies research being conducted at NWRC, in collaboration with VS, Penn State University and Texas A&M at Kingsville, focuses on the development of fertility control strategies for feral swine and on documenting interactions of feral and transitional swine populations. These studies will assist in reducing the prevalence of PRV in feral swine and will lead to more efficient methods of reducing transmission between feral and transitional swine populations.

Chronic Wasting Disease

To eradicate CWD from farmed cervids, APHIS has been working to develop a national CWD herd certification program and interstate movement restrictions. In addition, APHIS worked with the U.S. Fish and Wildlife Service to lead an interagency task force that created the Plan for Assisting States, Federal Agencies, and Tribes in Managing Chronic Wasting Disease in Wild and Captive Cervids. Subsequently, APHIS worked with other federal agencies, states and tribes to produce a progress report for Congress, published in May 2004, identifying progress made on actions consistent with the national plan and highlighting areas for future efforts.

Financial support—$14.8 million in 2003, $18.5 million in 2004 and $18.7 million in 2005—from APHIS has been divided among farmed cervid programs, all 50 states and several tribes for a variety of surveillance and management programs in free-ranging wildlife. Through cooperative agreements, APHIS distributed $4 million in fiscal year (FY) 2003 and $5.4 million in FY 2004 to state wildlife agencies. And, it distributed $500,000 in FY 2003 and $750,000 in FY 2004 to Native American tribes to assist with CWD surveillance and management in wild cervids. States, federal agencies and tribes are all working together to implement the national plan within existing budgets.

Assistance to states and tribes with CWD surveillance is also provided through WS' SERS. In FY 2004 wildlife disease biologists assisted 17 states, 2 tribes and the District of Columbia in achieving their CWD surveillance objectives. This support varied from collecting samples from hunter-harvested deer at check stations to sharpshooting deer, depending on the needs of each state or tribe. Additionally, APHIS has been supporting research at the NWRC on:

- fence-line interactions of captive and wild cervids for evaluating potential for disease transmission
- determining the most appropriate fencing strategies to minimize ingress and egress of captive and wild cervids
- examining deer movements in relation to the spread of CWD
- evaluating alternative tissues for detection of CWD
- developing a CWD vaccine
- developing decontamination techniques for facilities and equipment.

Much of this research effort is being conducted in collaboration with other federal and state agencies.

Bovine Tuberculosis

To address bovine TB in Michigan wildlife, APHIS has teamed up with the Michigan Department of Natural Resources (MDNR), the Michigan Department of Agriculture (MDA), the Michigan Department of Community Health (MDCH) and Michigan State University (MSU) on a number of projects. Since 1995, APHIS has worked with MDNR and MSU in surveillance efforts to detect and monitor TB in white-tailed deer. During the hunting seasons, APHIS assists with necropsy and collections of diagnostic specimens from hunter-harvested white-tailed deer.

In an effort to reduce the risk of transmission of TB between deer and cattle, APHIS has been working with farmers to construct fences around stored cattle feed and to evaluate the effectiveness of those fences. Additionally, APHIS personnel assist landowners in removing deer through the use of MDNR-issued deer control permits.

Collaborative research efforts by NWRC with MDA, MDNR, MDCH and MSU have evaluated the use of guard dogs and frightening devices to reduce TB transmission between deer and cattle. Other research being conducted by NWRC includes evaluations of coyotes as a sentinel for TB and development of a model to evaluate TB in deer populations and to evaluate the risk of transmission among potential reservoirs and transient hosts.

In addition to surveillance efforts, APHIS also participates in monthly TB working group meetings. For many years, personnel from APHIS, MDNR, MSU and MDCH have met to discuss concerns and issues relevant to TB in wildlife as well as to plan intervention strategies.

Emergency Response and Cooperation with States

After the events of September 11, 2001, there has been a greater recognition of the need for higher levels of emergency response preparedness in the United States. On February 28, 2003, President George W. Bush issued Homeland Security Presidential Directive 5 (HSPD-5), Management of Domestic Incidents, charging the DHS with the responsibility of unifying the nation's efforts to deal with, "domestic prevention, preparedness, response, and recovery plans into one all-discipline, all-hazards plan" (4)—the National Response Plan (NRP). Under the NRP, USDA is the designated lead agency for agricultural emergencies.

The President also directed the Secretary of DHS to develop and administer the National Incident Management System (NIMS). This system provides a consistent nationwide approach with which federal, state, local and tribal governments can work effectively and efficiently, together, in order to prepare, prevent, respond and recover from domestic incidents, regardless of cause, size or complexity. The NIMS enhances management of domestic incidents by establishing a single, comprehensive system for incident management and helps achieve greater cooperation among departments and agencies at all levels of government. Under NIMS, USDA has the responsibility to support first response partners across the country.

To increase the level of preparedness available in the field, area emergency coordination positions have been created to support planning and preparedness activities in animal health emergency management and in coordination with other agencies at the state level through the VS area offices. People in these positions work with the states to build a rapid and consistent FAD detection and response capability in each state while sharing best practices regionally and nationally. The local coordination and coalition building provided by these officers allows APHIS to more rapidly mobilize personnel and equipment during a disease outbreak.

VS' emergency management (EM) staff is coordinating the creation of six national incident management teams to assist APHIS and states in responding to animal health emergency events in the United States. These teams are designed to supplement state animal emergency response organizations with additional resources and technical expertise. These teams will operate under the principles and guidelines of NIMS.

As part of WS' SERS, wildlife disease biologist positions have been created to serve as APHIS first responders in outbreaks of disease or other emergencies involving wildlife. These biologists provide states with additional assistance in emergency response and serve as points of contact for state wildlife liaison officers (SWLOs) and for area emergency coordinators on wildlife issues. During FY 2004, wildlife disease biologists assisted state and VS officials with emergency response programs for BSE, AI and rabies.

Collaborations among APHIS and state natural resources agencies are also fostered through SCWDS. Training for these SWLOs and APHIS personnel on wildlife health and emergency response is provided by SCWDS through cooperative agreements with APHIS.

Bioterrorism

Recognition of exotic animal diseases as a potential tool of terrorist organizations to inflict economic harm has made animal disease a homeland security issue, adding new responsibility to APHIS' role in disease management. The capacity of the United States to respond to the intentional introduction of a disease or other animal health event is only as good as the preparedness of the local and state first responders.

The President has issued a number of directives that further define federal agency roles and responsibilities for protecting against bioterrorism. For example, Homeland Security Presidential Directive 9 (HSPD-9) assigns federal agencies, especially DHS, USDA and the U.S. Department of Health and Human Services (HHS) the responsibility to, "defend the agriculture and food system against terrorist attacks, major disasters, and other emergencies" (1). USDA and HHS are assigned lead roles under this directive because these agencies have oversight of the agriculture and food sectors. Specific tasks for USDA and HHS are to develop safe, secure and state-of-the-art agriculture laboratories that research and develop diagnostic capabilities for foreign animal and zoonotic diseases. Also under HSPD-9, USDA and HHS are the lead agencies responsible for improving existing recovery systems that will stabilize agriculture production and will rapidly remove and dispose of contaminated animals, plants and food products following an agroterrorism attack.

The importance of developing comprehensive and fully coordinated surveillance and monitoring systems for wildlife diseases is also recognized in HSPD-9. Incorporation of wildlife in HSPD-9 encourages federal agencies to collaborate with state agencies to protect wildlife from FAD introductions. Developing monitoring systems, such as WS' SERS that is based on interagency partnerships, protects U.S. agriculture and human health and safety, as well as native ecosystems.

In response to HSPD-9, APHIS and the American Association of Veterinary Laboratory Diagnosticians signed a memorandum of understanding to establish the National Animal Health Laboratory Network (NAHLN). This network of geographically dispersed, APHIS-approved state and federal laboratories provides "surge capacity" for agencies in the event of a major FAD outbreak in the United States. Laboratories that are part of the NAHLN will support response efforts by screening diagnostic samples submitted as part of surveillance and control efforts. As part of NAHLN, USDA's National Veterinary Services Laboratories (NVSL) serves as the national reference laboratory and subject matter experts for state and university veterinary diagnostic laboratories. The NVSL also provides FAD training to state and university personnel.

Summary

In today's global environment, it is becoming increasingly difficult to prevent the introduction of FADs into the United States to conduct surveillance of diseases in livestock and wildlife populations, and, when necessary, to conduct effective eradication campaigns. Each of these tasks is too large, expensive and important for any single agency to tackle alone. Consequently, APHIS has partnered with states, industry groups, universities and others to develop and carry out effective animal health safeguarding programs. APHIS' resources in many key areas—budgetary, personnel, equipment, laboratory and data infrastructure—are essential complements to state efforts in managing animal diseases and in responding to emergency situations. Through SERS, regulatory programs, and emergency planning and coordination, APHIS can respond quickly to the needs of state agencies in addressing existing and emerging animal disease concerns. This close federal and state coordination is critical to ensure the protection of wildlife resources, as well as U.S. agriculture.

In addition, APHIS knows that federal, state and tribal animal health and wildlife agencies will continue to face new challenges in their missions to manage diseases that affect both livestock and wildlife species. Open communication, respect for differing areas of expertise and priorities, and cooperation across political, industrial, and cultural lines are critical issues that will ultimately determine the success and effectiveness of our efforts to protect animal health in the United States. As we prepare to meet these challenges together, APHIS looks forward to continuing collaborations and to building new partnerships with all stakeholders in the health of U.S. animal resources.

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State Wildlife Management Agency Responsibility for Managing Diseases in Free-ranging Wildlife

E. Tom Thorne
Wyoming Game and Fish Department
Laramie

Rebecca A. Humphries
Michigan Department of Natural Resources
Lansing

Daniel J. O'Brien
Michigan Department of Natural Resources, Wildlife Disease Laboratory
Lansing

Stephen M. Schmitt
Michigan Department of Natural Resources, Wildlife Disease Laboratory
Lansing

Introduction

State wildlife management agencies have primary management responsibility for most free-ranging wildlife in the United States. Given their local nature, their knowledge of resident wildlife, personnel and equipment resources, and their public support, they remain the appropriate agencies exercising primary responsibility for management and research of diseases in free-ranging wildlife. However, in order to fully meet these responsibilities, states need cooperation, communication, collaboration and funding assistance from appropriate federal agencies; whereas, challenges to the traditional authority of state agencies are unnecessary and invariably detrimental. Recent history provides examples of federal-state interactions that have proven counterproductive and examples of highly successful support and cooperation.

Good frameworks for state-federal cooperation for more effective management and research of diseases in free-ranging wildlife exist, and existing state and regional wildlife disease programs provide excellent models. Unfortunately, the full potential of these state and regional programs to effectively and efficiently manage wildlife diseases is not currently being met. Federal funding to states for wildlife disease work should not be politically driven. It should be based on need, on a fundamental recognition of the independent value of healthy, free-ranging wildlife populations, and on willingness to maintain strong state and regional wildlife disease programs over the long term. States should be encouraged to develop their own local programs, but recognition of the value of coordinated federal guidance and oversight, along with timely state reporting, are appropriate.

Primacy of State Fish and Wildlife Agencies

In the United States, free-ranging wildlife is a public resource, and state wildlife management agencies have broad constitutional and statutory trustee authority for the conservation of the fish and wildlife within their borders. Conservation of wildlife resources implicitly recognizes their fundamental and independent value, and it includes primary responsibility for preserving their health and well-being for future generations. Thus, it is entirely appropriate that state wildlife management agencies remain the lead agencies in dealing with diseases, just as they are in other aspects of wildlife conservation.

State fish and wildlife agencies are the principal front-line managers of fish and wildlife for the benefit, use and enjoyment of the state's citizens and, collectively, the nation. They are responsible for managing diseases in free-ranging wildlife and have in place the local knowledge, personnel, equipment and local public support to address wildlife disease issues, including emergencies. Many state fish and wildlife agencies have disease experts, such as wildlife veterinarians, on staff. Most states now routinely conduct surveillance to detect diseases, to respond to outbreaks and to implement management programs to minimize disease impacts on wildlife and domestic animal populations. In addition, state wildlife agencies commonly maintain management programs to respond to wildlife-human conflicts and to mitigate damage of agricultural commodities.

State fish and wildlife agency authority extends to federal lands (excepting national parks) as well, with states managing the fish and wildlife and federal agencies, as landowners, the habitat. This has been affirmed by Congress through enabling legislation for several federal agencies. Only for marine mammals has Congress given exclusive jurisdiction to federal agencies. Although Congress has given federal agencies, such as the U. S. Fish and Wildlife Service

(USFWS) and the National Oceanic and Atmospheric Administration (NOAA)-Fisheries, certain statutory responsibility for selected conservation programs (e.g., threatened and endangered species, migratory birds, and anadromous fish), states retain concurrent jurisdiction for those species. Even in the case of an extraordinary disease emergency, in which the Secretary of the U.S. Department of Agriculture (USDA), under the federal Animal Health Act of 2002, has broad authority to seize and dispose of any animal, including wildlife, Congress has affirmed and directed that, "If fish or wildlife is affected by control or eradication measures proposed by the Secretary. . .the Secretary will consult with officials of the State agency having authority for protection and management of such wildlife." Congress has further constrained the Secretary's authority, stating unequivocally that, "nothing in this section or in this title should be construed as impliedly vesting in the Secretary authority to manage fish and wildlife populations."

Managing Wildlife Disease Issues: What Has Not Worked

While acknowledging the primacy of the state fish and wildlife agencies, the sheer scope of such diseases as brucellosis, bovine tuberculosis and chronic wasting disease points out the opportunity for, and the necessity of, cooperative, multiagency wildlife disease control efforts. A cooperative approach is far preferable to any single agency attempting to assume sole legal authority over, or unwittingly assuming it has the resources to manage, significant wildlife disease problems (Thorne et al. 2000). Moreover, conflicts of legal authority over wildlife diseases effectively mean that no single agency alone can control them. The protracted and still unresolved case study of brucellosis in the Greater Yellowstone Area provides ample evidence of this (Keiter and Froelicher 1993; Thorne et al. 1997). Attempts by agencies to seize sole control will inevitably cause unanticipated and counterproductive outcomes, such as erosion of crucial public support, unwanted intervention by legislatures and years of draining litigation. Institutional memories of such attempts may persist for decades, further hampering the interagency cooperation necessary to resolve wildlife disease problems. Meanwhile, the spread and virulence of these diseases seems unlikely to pause to accommodate interagency bickering.

Interagency relations concerning the federal Animal Health Act of 2002 provide another relevant example. The sweeping authority granted under this act to seize and dispose of wildlife has already been noted, as have the checks on that authority that have been afforded to the states, constraints of which federal administrators are well aware. However, these administrators and field staff often operate in very different spheres. And, in the field, it has not been unusual to find both federal and state agriculture agency staff who have interpreted the act as conferring autonomy upon USDA in matters of wildlife disease control. In not so subtle fashion, this subjective interpretation has sometimes been presented to state fish and wildlife agencies as fact, arguably in order to coerce policy decisions favored at the federal level but unpopular, and sometimes untenable, at the state level. "Showing the horse the whip," has created confusion, concern and resentment among state fish and wildlife management agencies. Whether real or imagined, these specters of usurping state authority are enormously counterproductive and can exacerbate any existing mistrust. Given a background where USDA's wildlife disease related activities are already viewed by some as an inherent conflict of interest, considering the agency's primary mission of promoting the agriculture industry, it is understandable how misconceptions take root and grow. An unequivocal acknowledgment on the part of USDA of the fundamental and comparable values of free-ranging wildlife and livestock might help to allay such misconceptions.

Yet another example of what has not worked in managing wildlife disease issues is attributable to the states themselves. The high profile of such diseases as chronic wasting disease and bovine tuberculosis has led a number of states to initiate wildlife disease surveillance programs of varying scope. Not uncommonly, a single person, often a veterinarian, is hired to oversee the program but instead ends up being the entire program. With little management or administrative support, an uncertain budget, and no commitment on the part of state government for its sustained support, such programs frequently have not survived. Although strength and persistence are usually improved by involving other states cooperatively as regional partners, even this does not assure success in the absence of committed and sustained support. For example, the Northeastern Research Center for Wildlife Diseases, in Storrs, Connecticut, was established as a cooperative venture with funding from several state fish and wildlife agencies in the region. However, the lack of full participation by some nearby states, coupled with a lack of federal agency cooperators (Nettles and Davidson 1996), as well as other factors, eventually led to the group's dissolution.

A final example can be drawn from the realm of wildlife disease research. In response to some of the more conspicuous wildlife disease outbreaks, such as bovine tuberculosis and chronic wasting disease, federal agencies have approached state fish and wildlife agencies with funds available for collaborative research. In some cases, however, collaboration has fallen short of its promise with the states providing ideas and data and with the federal agencies consuming those, and all ostensibly available research funding, internally. This can still be productive if the federal agency pursues projects that the states have identified as being of high priority. When this does not happen, scarce research funds may be spent on studies that were unlikely from the outset to produce meaningful results, essentially reproducing outcomes already known with confidence, or studies which, due to design problems, produce no meaningful or useful outcomes. As fuel for driving practical, applied research, there is no substitute for an intimate, local understanding of what is, and what is not, an important question to answer. Far more often than not, such an understanding is likely to originate in the network of field personnel comprising the heart of state fish and wildlife management agencies, a network no federal agency has equaled.

Managing Wildlife Disease Issues: What Has Worked

Though challenges remain, there are also many examples of state-federal agency interactions that have worked quite well, to the benefit of all. The first and most prominent example is the provision of significant and sustained federal funding for wildlife disease surveillance and management programs administered and carried out by state fish and wildlife agencies. A pair of success stories come to mind. First, since the passage of the Federal Aid in Wildlife Restoration (Pittman-Robertson) Act of 1937, proceeds from an 11 percent excise tax on sporting firearms, ammunition and archery equipment have been collected by the federal government and have been distributed to state fish and wildlife agencies as grants to fund wildlife conservation programs. As noted, management and research of wildlife disease issues fit well within the framework of conservation. To that end, Pittman-Robertson monies have been put to good use in many states to supplement state funds or to leverage state funds and to allow their application to other needs.

Second, USDA's Animal and Plant Health Inspection Service-Veterinary Services (APHIS-VS) branch made more than $5.4 million available to state wildlife agencies in fiscal year 2004 for chronic wasting disease testing of free-ranging cervid populations (Goeldner 2004). This was the second year these funds were available, and all 50 states received funding based on risk. Over 2 years in Michigan, for example, $161,000 in APHIS-VS funds were used to support testing of over 1,400 wild cervids, comprising nearly 12 percent of all free-ranging Michigan cervids tested for chronic wasting disease over the period. By showing admirable flexibility in the development of cooperative agreements with individual states, APHIS-VS funding helped both state and federal agencies better characterize the geographic distribution and intensity of chronic wasting disease and of the attendant risk. In return, it is the responsibility of the states to provide accurate and timely reporting to USDA on the use of these funds.

Another example of fruitful state-federal cooperation has been the provision of federal personnel to assist state fish and wildlife management staff in times of peak need. USDA's Animal and Plant Health Inspection Service-Wildlife Services (APHIS-WS) recently hired 23 wildlife disease biologists to assist the states with disease surveillance, particularly for chronic wasting disease. The Michigan Department of Natural Resources Wildlife Disease Laboratory (MDNR-WDL) incorporated 15 of these biologists into their bovine tuberculosis and chronic wasting disease testing programs in November 2004. Their help was in addition to services provided by four APHIS-VS veterinarians and technicians as part of a cooperative program in place now for nearly a decade. The capable assistance of these federal personnel saved MDNR-WDL an estimated $120,000 in labor costs.

Other success stories can be found in the area of research. When communication between state and federal agencies has been unhindered, abundant problem-oriented, practical research has been generated by federal agencies to address questions generated by state wildlife agency disease control personnel. Bovine tuberculosis in Michigan serves as a perfect case in point. Since soon after the discovery of endemic bovine tuberculosis in the state's white-tailed deer (*Odocoileus virginianus*), a highly productive cooperative relationship has existed between the MDNR-WDL and researchers at the USDA Agricultural Research Service's National Animal Disease Center (ARS-NADC), in Ames, Iowa. By taking the time to ask MDNR-WDL personnel what research questions were relevant for bovine tuberculosis management in wildlife, in a span of only a few years, ARS-NADC scientists experimentally documented both direct (Palmer et al. 2001a) and indirect (Palmer et al. 2004b) deer-to-deer transmission of bovine tuberculosis, characterized its pathogenesis (Palmer et al. 2002a,d), described aerosol (Palmer et al. 2003) and milk-borne (Palmer et al. 2002b) transmission, set the stage for premortem tuberculosis testing and vaccination of white-tailed deer (Palmer et al. 2001b; Palmer et al. 2004a) and helped clarify the role of raccoons (*Procyon lotor*) in bovine tuberculosis ecology (Palmer et al. 2002c). Every one of these studies produced valuable information that found immediate application in management, policy and public education related to tuberculosis in Michigan. No other group of researchers—state, federal or academic—has come close to producing the advances in our understanding of bovine tuberculosis in U.S. wildlife that have resulted from this highly successful state-federal collaboration.

A cornerstone of the research and management of wildlife diseases is strong state programs under the authority of state wildlife management agencies. Such programs have been established and have been maintained in a number of states, including Alaska, California, Colorado, Michigan, New York, Wisconsin and Wyoming. In 1927, the groundwork was laid for the pioneering U.S. program: "As the value of our wild life resources increases, and as the deliberate management of those resources is intensified, we shall no doubt parallel the previous experience with domestic birds and mammals, and shall have to contend with an unending series of diseases and parasites. . . . Under these circumstances it is highly desirable that Michigan should develop at home, first class facilities for research in connection with the pests, parasites and diseases of . . . wild life forms. It should not be necessary for us to depend upon Washington, or upon laboratories in other states, for the service of this sort" (Michigan Department of Conservation 1928:265–7). With that independent vision, the Michigan Department of Conservation's Wildlife Disease Laboratory was established in 1933, the first of its kind. Although its initial role was to study starvation, nutrition and diseases of Michigan wildlife, within two decades, the laboratory's activities were breaking new ground on regional and national issues. In 1937, the laboratory established a course on wildlife diseases to train veterinary and game biology students at Michigan Agricultural College. In the early 1950s, Michigan became only the second state to experience an outbreak of epizootic hemorrhagic disease in white-tailed deer, and the laboratory was involved in its research and diagnosis (Fay et al. 1956). In 1961, the first large-scale, nationwide testing of wildlife for a USDA program disease was carried out by the laboratory, a survey for brucellosis in mule deer (*O. hemionus*) and white-tailed deer (Fay 1961). Over

16,000 blood samples were processed. The laboratory was also the first wildlife disease program to identify type E botulism in piscivorous wild birds (Fay 1966), the first to publish the use of carfentanil and naltrexone as immobilizing-reversal agents for moose (Seal et al. 1985; Schmitt and Dalton 1987), and the first to describe the spillover and subsequent self-sustaining maintenance of bovine tuberculosis from cattle to white-tailed deer (Schmitt et al. 1997). Since that last discovery in 1995, the laboratory's surveillance program for tuberculosis has, with the help of its state, federal and university partners, tested more than 141,000 free-ranging Michigan deer, elk (*Cervus elaphus*) and noncervids, the largest surveillance effort for a single wildlife disease in North American history. The laboratory has also become a leader in the field research and management of bovine tuberculosis in North American wildlife (Bruning-Fann et al. 2001; O'Brien et al. 2001, 2002, 2004a, 2004b; de Lisle et al. 2002). Less known, but equally important, is the laboratory's original mission to monitor causes of death and illness for the multitude of game and nongame Michigan wildlife species, carried out on an ongoing basis for over 7 decades. This success story was possible in large measure because of substantial and sustained funding for the laboratory from both state (hunting and fishing license fees and general fund monies) and federal (Pittman-Robertson grants) sources. The MDNR-WDL is a perfect example of how state-federal funding partnerships can synergize to the benefit of both and, indirectly, to the benefit of the agricultural community.

A final example of what has worked well in the realm of cooperative wildlife disease programs is the regional cooperative, as exemplified by the Southeastern Cooperative Wildlife Disease Study (SCWDS). Established in 1957 by the Southeastern Association of Game and Fish Commissioners in response to several dramatic mortality events in white-tailed deer, SCWDS quickly became a partnership involving the University of Georgia's College of Veterinary Medicine and 11 southeastern state fish and wildlife management agencies. SCWDS membership now includes 16 state natural resources agencies and the Puerto Rico Department of Natural Resources. Federal support for SCWDS began in 1963 with annual appropriations through the U.S. Department of the Interior and, in 1979, through annual cooperative agreements with APHIS-VS (Nettles and Davidson 1996). Recently, annual cooperative agreements were initiated with APHIS-WS. Currently, a variety of other sources, of both governmental and nongovernmental granting organizations, also provide some funding support.

Primary functions at SCWDS have remained the same for several decades: determining the cause of morbidity and mortality in free-ranging wildlife, defining impacts of disease and parasites on wildlife populations, delineating disease interrelationships among wildlife and domestic animals, and determining the role of wildlife in the epidemiology of human diseases. These functions are pursued within a broader context of working for the benefit of wildlife resources, animal health and public health. The accomplishments of SCWDS in diagnostic, research and instructional activities are far too numerous to adequately treat here. For our purposes, it suffices to say that SCWDS serves as a prominent example of how the philosophy of state-federal cooperation has provided synergistic benefits far beyond what could have been accomplished by an individual entity.

Summary

Good frameworks exist for state-federal cooperation for more effective management and research of diseases in free-ranging wildlife. Existing state and regional wildlife disease programs provide excellent models. Unfortunately, the full potential of these state and regional programs to effectively and efficiently manage wildlife diseases currently is not being met. Federal funding to states for wildlife disease should not be politically driven but should be based on need, on a fundamental recognition of the independent value of healthy, free-ranging wildlife populations, and on willingness to maintain strong state and regional wildlife disease programs that are sustainable over the long term. States should be encouraged to develop their own local programs where funding is adequate, but recognition of the value of coordinated federal guidance and oversight, along with timely state reporting, are appropriate.

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Programs for Monitoring and Managing Diseases in Free-ranging Wildlife in the 21st Century

John Baughman
International Association of Fish and Wildlife Agencies
Washington, DC

John R. Fischer
The University of Georgia, College of Veterinary Medicine,
Southeastern Cooperative Wildlife Disease Study
Athens, Georgia

Introduction

With a few notable exceptions, diseases historically have not been regarded as a significant factor in wildlife management. However, wildlife managers have increasingly recognized the importance of diseases in wild animals as a consequence of the recent emergence of several high profile diseases. Growing recognition that wild animals are important components of health problems, ranging from chronic wasting disease (CWD) of deer and elk to West Nile virus (WNV), virtually guarantees that more attention and resources will be directed toward disease issues in the future. Diseases will demand attention because of their significance to the health of wildlife populations, domestic animals on human beings.

Although attention to wildlife health issues has increased dramatically and many programs have been implemented or strengthened in recent years, the capability of state fish and wildlife management agencies to deliver wildlife health-related services is not uniform and, in many states, is rudimentary. Improvement in three general areas would enhance the ability of state wildlife management agencies to prevent, detect, monitor and respond to major wildlife disease issues.

1. Adequate and sustained funding to support wildlife disease research, monitoring and management is essential to enhance existing programs and to implement new programs in underserved areas.
2. Cooperation and communication between agencies and interest groups are necessary to efficiently recognize problems and to take measures to

prevent or to reduce their impact on wildlife, humans and domestic animals.

3. Better outreach, via timely dissemination of objective information, is required to gain the acceptance and assistance of stakeholders and the general public for programs to prevent, to reduce or to eliminate disease problems involving wild animals.

Successful wildlife health programs must be centered in the state wildlife management agencies where the responsibility and authority rest for conserving wildlife resources. Due to overarching issues, shared authority and limited resources, cooperation with local, state and federal public health, animal health and natural resources agencies will be essential; however, there is no one-size-fits-all approach to wildlife health programs. Several states, including Alaska, California, Colorado, Michigan, New York, Wisconsin and Wyoming, have had strong programs with full-time wildlife health professionals for decades. Other states have pooled resources to form regional wildlife health cooperatives, such as the Southeastern Cooperative Wildlife Disease Study (SCWDS).

Regardless of the structure of a state's wildlife health program, the greatest opportunities for addressing significant local wildlife health issues will be found in programs in which the state wildlife management agency prioritizes the issues and collaborates with other state and federal agencies to address them. Through this approach, state wildlife management agencies can develop information to enhance their understanding and management of diseases in wildlife while also contributing data useful to other agencies and maximizing limited financial, technological and human resources.

Growing Importance of Disease Issues in Wildlife Management

Historically, disease problems in wild animals have not been considered a significant factor in wildlife management. However, a few notable exceptions have been recognized, and some have resulted in management changes ranging from new regulations to alterations of hunting seasons. For example, the recognition of the effect of lead shot ingestion on waterfowl and on the raptors and scavengers that consume them resulted in bans on the use of lead shot in waterfowl hunting areas. In another situation, hunters were refunded the price of their hunting licenses when the heavy impact of a hemorrhagic disease outbreak on the local white-tailed deer population was identified in a portion of South Dakota. But, these examples pale in comparison to more recent disease issues that have occurred or have only threatened to occur.

In 1999, WNV was found in North America for the first time (Lanciotti et al. 1999). This virus is maintained in nature by a cycle involving wild birds and mosquitoes. Unlike many of the other arboviruses endemic in North America's wild birds, WNV often kills many of the birds that it infects. Additionally, mosquito bite transmission of WNV to aberrant hosts, such as horses and human beings, may result in debilitating illness and death. Although the population impacts of WNV-related mortality on wild birds remain largely unknown, the virus may threaten certain highly susceptible species, such as sage grouse, that already are under heavy pressure due to other factors, including habitat loss in portions of the western United States. However, the primary consideration regarding WNV and wild birds generally is associated with their utility in WNV surveillance programs. Throughout the United States and Canada, wild birds have been recognized as important early indicators of WNV activity in an area, and surveillance for WNV-related wild bird mortality is used as a tool by public health and animal health agencies to recognize localities where humans, horses and other species may be at risk. Consequently, wildlife management agencies have become involved in WNV surveillance programs in some areas (Eidson et al. 2001).

In 2001, a severe outbreak of foot and mouth disease (FMD) originated in one small area in the United Kingdom and subsequently spread throughout the United Kingdom and to other European countries via the movement of infected domestic animals (Davies 2002). In the United States, concerns increased dramatically regarding potential introduction of the FMD virus. Throughout the country, federal and state animal health agencies prepared contingency plans for an incursion of FMD. Because all cloven-hoofed animals are susceptible to the FMD virus, wild and feral species, including deer, elk and feral swine, were considered to be potential victims, as well as possible reservoirs or disseminators of the virus if it were introduced. Consequently, state wildlife management agencies directed considerable attention and time to this issue and assisted state animal health agencies in the development of contingency plans, test exercises and other preparedness activities. Federal animal health and natural resources agencies also planned for potential FMD introduction into wild animals. An extraordinary amount of attention, particularly at the level of the state natural resources agencies' wildlife division administrators, was directed toward FMD preparedness, and it was at this point that many managers realized that health issues certainly had become a significant component of wildlife management.

The human and financial resources committed by wildlife management agencies to FMD preparedness turned out to be minor, however, when compared to those expended since the emergence of CWD as a national wildlife health problem in 2002. CWD of deer and elk was first recognized as a syndrome in captive research deer in the 1960s in Colorado. First thought to be a nutritional malady, CWD subsequently was identified as a member of the family of transmissible spongiform encephalopathies (TSE) (Williams and Young 1980) that also includes scrapie of sheep and goats, Creutzfeldt-Jakob disease (CJD) of humans and bovine spongiform encephalopathy (BSE), also known as mad cow disease. CWD was found in free-ranging mule deer and elk in a portion of northeastern Colorado and adjacent southeastern Wyoming during the 1980s, and it was found in captive, commercial elk or deer herds in Saskatchewan, Alberta, and in eight states in the West and Midwest beginning in 1996 (Goeldner 2004). When CWD surveillance in free-ranging deer and elk intensified in 2000, it was recognized that the endemic area was larger than originally believed, extending outward in the original two states and eastward into the southern Nebraska panhandle. Chronic wasting disease subsequently was found in wild deer at western locations remote from the endemic area; however, it was the discovery of CWD in wild white-tailed deer in 2002 in southwestern Wisconsin that indicated to states across the country that CWD was no longer just a western problem. Since then, unprecedented amounts of wildlife management and animal health agency resources have been committed to CWD surveillance, management and contingency plans. With events such as this, disease issues could no longer be considered an insignificant component of wildlife management.

Wildlife Health Capabilities of State Wildlife Management Agencies

The ability of individual state wildlife management agencies to prevent, detect, monitor and manage disease problems involving wild animals is highly variable. In response to the WNV, FMD and CWD situations described above, several states have increased their capabilities through the expansion of existing programs or through the creation of new staff positions, often filled by veterinarians, that are devoted primarily or exclusively to wildlife health issues.

However, wildlife health-related services in some states remain quite basic. Improvement in three general but fundamental areas would enhance the capabilities of state wildlife management agencies to address wildlife health programs.

First and foremost, adequate and sustained funding for the research, surveillance and management of disease issues involving wildlife is critical to enhance existing capabilities and to initiate new programs in underserved states. Increased amounts of federal financial support to states for wildlife health issues recently have become more available, but often they are limited to a single disease issue and rarely, if ever, do they cover all of the expenditures of the state wildlife management agencies engaged in disease management efforts. Additionally, although the disease problems may occur primarily or exclusively in species under the authority of the state wildlife management agency, federal funds may not always find their way to the responsible agency, because appropriations may be captured by federal agencies administering the funds or directed to agricultural, animal health or public health agencies.

An excellent example of federal financial support for state wildlife management agencies to conduct disease surveillance and management has come through the U.S. Department of Agriculture-Animal and Plant Health Inspection Services (APHIS)-Veterinary Services. Beginning in federal fiscal year 2003, APHIS-Veterinary Services has administered from \$4 million to \$5 million each year in direct support of state wildlife management agency activities related to CWD (Goeldner 2004). Additionally, APHIS-Veterinary Services dramatically increased the capacity of approved laboratories for TSE testing in 2002 by providing equipment, reagents, training, consultation, and quality control and assurance to a total of 26 facilities. One of the TSE testing laboratories in the expanded network is SCWDS, where samples only from free-ranging deer and elk submitted by state wildlife management agencies are handled. The provision of federal funds through APHIS-Veterinary Services for CWD surveillance and management activities directed and conducted by state wildlife management agencies should serve as a model for federal support of state wildlife health programs.

However, state funds also must be committed to their respective wildlife health programs because federal funding often is transient or limited to individual diseases or programs and because federal funding alone will not be enough to support a state wildlife health program that can address a variety of issues on a year-round basis. Consequently, federal support should be regarded as supplemental in nature and not as a substitute for sustained state funding dedicated to wildlife disease issues. States without adequate financial resources to support a wildlife health program will not be in a good position to efficiently utilize federal funds that may become available because adequate infrastructure, including personnel trained in wildlife health, laboratories, equipment, supplies and other items, must be in place. Furthermore, the recent spread of WNV across the country, the recognition of CWD in wild white-tailed deer in Wisconsin and Illinois, and the surprising occurrence of other diseases that don't belong here, such as monkeypox (Centers for Disease Control and Prevention 2003), are strong indicators that we should expect the unexpected and should be in position to recognize and respond to new problems. This will never be possible if wildlife health issues are handled on a reactive, rather than a proactive basis.

Second, better cooperation and communication are needed between state and federal agencies and interest groups to more efficiently recognize disease issues and to limit their impacts on wildlife, domestic animals and humans. None of the disease examples cited above affects only wildlife; all of them span a spectrum of species or extend beyond free-ranging and captive wildlife to the arenas of livestock, poultry and human health. In fact, most are viewed mainly as human or domestic animal health issues. On one hand, when more than one agency or constituency is engaged, they offer additional challenges, such as competition for limited financial resources and other potential conflicts. On the other hand, effective cooperation and communication among multiple agencies provide opportunities for individual constituencies to avail themselves to the expertise and resources of other agencies and professions when facing a multifaceted problem. Experiences with a number of disease issues indicate that single agencies are highly unlikely to be successful when addressing such problems alone.

Surveillance for WNV is one of the better examples of multiple agencies with differing expertise, responsibility and authority coming together to address a single disease. Federal funding and strategy recommendations for WNV surveillance by states have been available through the U.S. Department of Health and Human Services for several years. Individual states are provided with federal funds to support surveillance systems of their own choosing. Some states use the funds for WNV surveillance in humans, horses, wild birds, sentinel chickens or mosquitoes, but many states employ a combination involving the animal health agency, public health agency and wildlife management agency (Eidson et al. 2001). Nationwide data, including case numbers and maps, obtained through this system are made available in approximate real time; therefore, local information acquired through detection of WNV in dead wild birds frequently offers public health and animal health agencies an opportunity to warn that human exposure to mosquitoes should be minimized and that horse owners should consider vaccinating their animals before the first human or equine infection is recognized. An additional benefit of increased wild bird surveillance for WNV has been the identification of other wild bird disease problems, including toxicoses and infections with other arboviruses.

However, there are some potentially difficult issues regarding wildlife and wildlife management agencies when it comes to situations like that of WNV. The overriding concerns for WNV are for public health, with secondary concerns regarding domestic animal species, such as horses. Concerns for wildlife resources may arise only in unique situations, such as described above for sage grouse. Consequently, the great majority of funding may be devoted to public and domestic animal health. And, when wildlife is considered, it may only be in the context of a sentinel for potential human or domestic animal infection. Despite the deaths of tens of thousands of wild birds infected with WNV in recent years, wildlife agencies may not be engaged in WNV-related activities, and, if they are, adequate financial support may not be provided to the agencies to cover their involvement.

Another wildlife resources issue regarding WNV is not unique to this disease but is inherent in dealing with most disease problems in wildlife. In contrast to human and domestic animal infections, little can be done to prevent or reduce WNV infection of free-ranging wildlife species. In the absence of the ability to effectively manage the disease in wildlife, better understanding of WNV epidemiology in these species may allow wildlife managers to more accurately predict the population impacts on certain species or on families of birds, rather than recognizing and reacting to them only after the fact. This understanding can only be acquired through well-funded wildlife disease surveillance and research that is directed and conducted by, or with extensive input from, state wildlife management agencies.

Public outreach is the third general area in which improvement will enhance the ability of state wildlife management agencies to address disease issues. Accurate and objective information must be disseminated in a timely fashion in order to gain shareholder acceptance and assistance as well as general public support for programs to prevent, reduce or eliminate diseases involving wildlife. Just as multiagency cooperation and communication are necessary to address complicated disease problems, little chance for success should be expected for programs without adequate, and hopefully overwhelming, public support.

Management of wildlife resources as a public trust should be based on sound scientific principles. However, implementation of regulations or policies designed to reduce wildlife disease risks often requires strong public support, which generally can be acquired only through long-term outreach programs. Typically, trained agency personnel support science-based recommendations from wildlife health professionals; however, the support of policy makers, such as commissioners, boards and legislators, may be jeopardized by political rather than scientific considerations. It is at this level that difficulties often arise and approval of important wildlife health-related policies may be impeded. A concerted, unified and long-term public outreach program on such issues likely is the only approach that will secure the support necessary at all levels.

Chronic wasting disease offers examples of how well public outreach can work, and it shows how difficult it can be for wildlife management, public health and other agencies to regain the high ground when the flow of information to the public has been taken over by sensationalistic media. Unfortunately, much concern about CWD has been fueled by the association of BSE with the development of new variant CJD in humans in the United Kingdom and other countries. Fortunately, natural susceptibility to CWD has been recognized only in mule deer, white-tailed deer, Rocky Mountain elk, and moose. However, this has not stopped some media from intense and often sensational reporting of fatal neurological disease in humans who hunted or consumed wild deer, elk and other game. In the majority of such human cases reported by the media, in-depth investigations by public health authorities revealed that the actual disease present was not a transmissible spongiform encephalopathy. However, the alarming media coverage was particularly intense in Wisconsin and, in 2002, the state reportedly experienced approximately a 10 percent decrease in annual sales of licenses to hunt deer.

The CWD situation in Colorado was unlike that in Wisconsin. Chronic wasting disease had been recognized in wild deer and elk in Colorado for approximately two decades prior to 2002 when it was first found in Wisconsin and, significantly, the Wisconsin situation occurred after the human health problems associated with BSE arose in the United Kingdom. Colorado and Wyoming had produced written information and videotapes describing the current understanding of CWD epidemiology, including the lack of evidence that the disease is transmissible to humans. In contrast to the drop in license sales seen in Wisconsin, Colorado reportedly experienced an increase in sales of licenses to hunt deer and elk in the state in 2002. This difference likely can be attributed at least in part to the public receiving a consistent message through wildlife management, animal health and public health agencies in Colorado for a number of years; whereas, the Wisconsin public had been exposed to the issue for only a matter of months and had been bombarded with media coverage of unsubstantiated reports of CWD transmission to humans.

The need for nationwide public access to accurate and timely CWD information was recognized shortly after the discovery of the disease in Wisconsin, and the CWD Alliance was formed to provide this service. Information about CWD also can be found at the Websites of many state and federal natural resources and animal health agencies, and all of these Websites can be accessed through the CWD Alliance. The alliance is supported primarily by nongovernmental organizations (NGOs) of sportsmen and women, as well as the outdoor recreational industry. Its Website (http://www.cwd-info.org) is regarded as an excellent source of a variety of information, ranging from results of scientific studies to individual state regulations and legislation. When the *Plan for Assisting States, Federal Agencies, and Tribes Managing Chronic Wasting Disease in Free-ranging and Captive Cervids* (National CWD Management Plan) was drafted by a multiagency team in 2002, public outreach was identified as a critical component. Funds obtained by state wildlife management agencies from APHIS-Veterinary Services for CWD work can be used for public outreach activities, as well as for other CWD-related activities identified in the National CWD Management Plan. In Wisconsin, the support of the public, particularly landowners in areas affected by CWD, is regarded as essential for the success of Wisconsin's aggressive CWD management program and considerable public outreach activities, including door to door visits by Wisconsin Department of Natural Resources personnel, have been undertaken or expanded to educate the public and to encourage its support.

Successful Wildlife Health Programs

The authority and responsibility for conserving wildlife reside largely in the state wildlife management agencies, and wildlife health programs must be centered here in order to be effective. Certainly, there are situations, such as in national parks or with endangered or migratory species, in which federal agencies have sole or shared authority. Limited financial, technological and human resources for many aspects of wildlife management, including addressing health issues and the multifaceted aspects of most wildlife disease issues, warrant cooperation between multiple state and federal agencies, NGOs and other interest groups. Individual agencies cannot be expected to be successful when approaching difficult multiresource disease problems alone and without adequate public support. Although these generalizations hold true across the country, continued variation in the wildlife health programs of individual states should be expected.

State wildlife management agencies with historically strong wildlife health programs have long recognized the value of investing in these programs; they undoubtedly will maintain and likely will expand them. This already has occurred in some states where additional staff positions have been created and budgets for health programs have increased. Additionally, new wildlife health programs have been created in some states that previously did not have staff or other resources dedicated to disease issues. Positions for wildlife veterinarians have been added in at least six states, largely in response to the emergence of CWD as a national wildlife disease issue.

In addition to independent wildlife health programs, several states and provinces have pooled their resources to form cooperatives. Wildlife management agencies in the midwestern, southeastern and western associations of fish and wildlife agencies have formed regional wildlife health cooperatives. The midwestern and western wildlife health cooperatives are consortia of individual state wildlife health programs, several of which have long invested in staff positions and other infrastructure dedicated to disease issues. In a similar fashion, the veterinary colleges and several governmental organizations and NGOs in Canada have formed and support the Canadian Cooperative Wildlife Health Center.

The oldest of the cooperative programs is SCWDS. The SCWDS program began in 1957 in response to severe white-tailed deer mortality events that caused great concern among state wildlife management agencies that had made substantial investments in deer restoration programs. The SCWDS program was founded at the University of Georgia, College of Veterinary Medicine by the Southeastern Association of Fish and Wildlife Agencies in 1957, with 11 original state members. Currently SCWDS has annual cooperative agreements to provide wildlife health services to the fish and wildlife management agencies of 16 states and Puerto Rico. However, unlike the midwestern, western and Canadian cooperative wildlife health programs, SCWDS is under one roof.

In addition to serving the member state wildlife management agencies, SCWDS provides wildlife health services to the U.S. Department of the Interior (DOI) through an annual appropriation that began in 1963 and is administered by the National Wildlife Health Center of the U.S. Geological Survey's Biological Resources Division. SCWDS also has provided wildlife health services to APHIS through consecutive annual cooperative agreements since 1979. Through this cooperative approach, the funds of individual SCWDS member states are leveraged with dollars from each other, as well as from DOI, APHIS and grants obtained by SCWDS faculty, to develop and disseminate wildlife health information of use to all supporters. This approach allows the individual agencies supporting SCWDS to obtain much more for their investments than they would if working independently (Nettles et al. 1996). All of the above cooperatives, whatever their structure, allow for better information sharing and, in many cases, have promoted a more uniform approach to common disease problems affecting a number of different states or provinces.

Summary

The emergence of wildlife health issues as a significant component of wildlife management ensures that more human and financial resources will be directed toward future disease issues. Responsibility and authority issues—as well as growing recognition that disease agents in wild animals have implications for wildlife populations, livestock, poultry and humans—demand that state wildlife management agencies confront these issues. In addition to traditional wildlife health issues, state wildlife management agencies must be engaged in emerging issues, including the threats of bioterrorism and agroterrorism, as well as unintentional introduction of disease agents, such as the highly pathogenic avian influenza virus circulating in Southeast Asia. If they do not become engaged, they risk the possibility of other state or federal agencies stepping in to do so. Or worse yet, the issues involving wildlife will not be addressed.

Improvements in funding, cooperation, communication and public outreach will enhance the capabilities of state wildlife management agencies to address current wildlife health issues, as well as those that arise in the future. The examples described above confirm that investments in these areas are worthwhile. Despite common problems and goals, there undoubtedly will continue to be substantial variation in the approach taken by individual states. However, the most efficient and effective wildlife health programs will be those in which state wildlife management agencies prioritize the issues, direct the activities and collaborate with other state and federal agencies, including those with authority for human and domestic animal health, to address disease problems. Through this approach, state wildlife management agencies will enhance their understanding and management of diseases in wildlife, while also contributing data useful to other agencies and maximizing the financial, technological and human resources that inevitably will be limited.

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Session Five.
Advancing the Cause of Integrated Bird Conservation

Chair
David Pashley
American Bird Conservancy
The Plains, Virginia

Cochair
Ashlie Houston
Ducks Unlimited, Inc.
Washington, DC

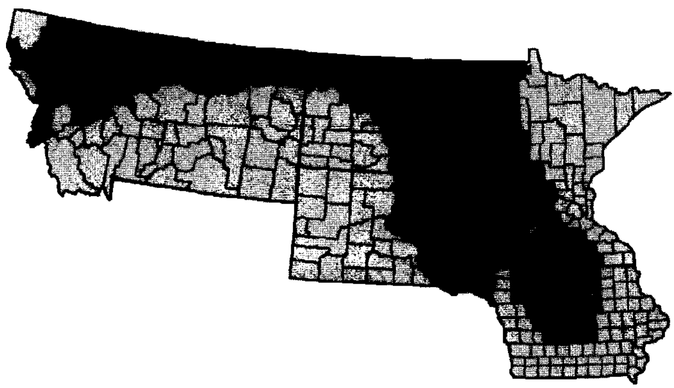
Integrated Bird Conservation: The Prairie Pothole Joint Venture Model

Jeffrey W. Nelson
Ducks Unlimited, Inc.
Bismarck, North Dakota

James K. Ringelman
Ducks Unlimited, Inc.
Bismarck, North Dakota

The Prairie Pothole Joint Venture (PPJV) includes one-third (100,000 square miles [259,000 km^2]) of North America's Prairie Pothole Region (PPR, Figure 1). Its uniqueness lies in the millions of depressional ponds that constitute one of the richest wetland systems in the world. These "prairie potholes" and their surrounding grasslands are highly productive and support an incredible diversity of bird life. The PPR is breeding habitat for myriad wetland and grassland birds, and it also provides essential habitat for millions of migrating birds during spring and fall.

Figure 1. The geographic boundaries of the Prairie Pothole Joint Venture.



Once a vast grassland, the PPR is now an agrarian system dominated by cropland. Changes in land use have, for the most part, been detrimental to the migratory birds that use the PPJV. Many wetlands have been drained or degraded, and the loss of native prairie—particularly in the eastern portion of the PPJV—has been extensive. Despite these losses, millions of wetlands and large tracts of native prairie still remain. The PPR is one of the most altered—still one of the most important—migratory bird habitats in the Western Hemisphere. It is the backbone of North America's "duck factory" and is critical habitat for many wetland- and grassland-dependent migratory birds.

The mission of the PPJV is to implement science-based conservation programs that sustain populations of waterfowl, shorebirds, other waterbirds and prairie landbirds at objective levels through targeted wetland and grassland protection, restoration and enhancement programs. The PPJV operates through partnerships that implement conservation using a mix of habitat protection, restoration and enhancement programs.

Waterfowl and the History of Prairie Pothole Joint Venture Science and Conservation

Much of our scientific understanding of prairie pothole wetlands and grasslands, and most of the conservation work accomplished to date in the PPJV, is due to a focus on waterfowl (Anatidae). Nearly 100 years ago, waterfowl conservationists demanded an end to market hunting and embraced the management of these migratory birds by international treaty. They raised funds for waterfowl conservation by requiring the purchase of federal and state ducks stamps and creating nonprofit organizations dedicated to habitat conservation and management. With the resulting funds, national wildlife refuges (NWRs) and waterfowl production areas (WPAs) were purchased and focused mostly on the securement of waterfowl habitat (Leopold et al. 1968). Later, perpetual wetland and grassland easements were acquired. In 1986, when the future of waterfowl looked particularly bleak, the North American Waterfowl Management Plan (NAWMP) was created. A new model for conservation—the joint venture model—was devised to implement the NAWMP. The North American Wetlands Conservation Act (NAWCA) was enacted as a means to fund the NAWMP and as a catalyst to stimulate partnerships and leverage resources under the joint venture model.

Today, just within the PPJV, the U.S. Fish and Wildlife Service owns or manages 42 NWRs, nearly 3,000 WPAs, 24,000 wetland easements and 2,000 grassland easements, mostly on native prairie (R. Reynolds, personal communication 2004). In addition, there are hundreds of wildlife areas owned and operated by state agencies and nonprofit conservation organizations. During 1987 to 2002, the PPJV restored 358,763 acres (145,248 ha), enhanced 2,019,143 acres (817,467 ha), and protected (through fee title acquisitions or easements) 2,542,423 acres (1,029,321 ha) of wetlands and uplands (Prairie Pothole Joint Venture 2004). Most of these accomplishments were intended to sustain or to improve duck recruitment and were funded both directly and indirectly via fees and taxes on hunting. In the process, this habitat continues to provide many benefits to other grassland- and wetland-dependent birds (Duebbert 1981, Renken and Dinsmore 1987, Hartley 1994).

Science has also benefitted from hunter interests. The desire to monitor and maintain "huntable" duck populations resulted in extensive surveys of breeding waterfowl populations that began in the 1940s (Crissey 1984) and became operational in 1955 (Smith 1995). A banding program that helped define migratory pathways also aided in distinguishing populations of waterfowl and provided a means to estimate annual harvest and survival rates. Consequently, there exists a longstanding index to the size of the continental breeding duck population, as well as the wetlands on which they depend.

Beginning in the 1970s, ducks were instrumented with very high frequency (VHF) radio transmitters to follow movements in attempts to better understand their habitat requirements and species preferences. New techniques were devised to estimate individual vital rates, such as nesting success, hen mortality and brood survival using radio-marked birds. This led to demographic models that revealed the relative importance of different vital rates to population dynamics, thereby highlighting the most important phases of the life cycle that had important implications for habitat conservation and management. In this century, new technology allows us to track the movements of waterfowl throughout the Western Hemisphere using satellite radio transmitters, thereby extending our knowledge of long-distance movements and the interdependence of habitats along the migratory pathway.

Shorebirds, waterbirds and landbirds are (with the exception of a few species) not hunted. Therefore, population monitoring has been much less intensive, and our knowledge of population status and trends is poor. Banding programs, while significant, lack the advantage of recovering large samples via hunter returns. With few recoveries, our knowledge of migratory movements and survival rates is imprecise. Little is known about demographic vital rates because many species are secretive, sensitive and difficult to capture, and most species' body sizes are too small to tolerate radio transmitters. Consequently, little is known about factors that limit populations or about how to address limitations through management. Most importantly, without an organized fraternity of supporters, there has been little funding available specifically for the conservation of shorebirds, waterbirds and landbirds. Fortunately, with the passage of the Neotropical Migratory Bird Act and the implementation of the State Wildlife Grants Program, dedicated funds are becoming available.

The Concept of Integrated Bird Conservation

Despite the disparity between the science foundation and funding support for waterfowl versus other avian taxa, there is keen interest in integrated bird conservation. Despite our best efforts, habitat continues to be lost faster than it can be protected or restored, and the costs continue to escalate. From a pragmatic perspective, the joint venture model has shown the power of partnerships to leverage resources and to accomplish real conservation on the ground. It is a particularly attractive model for agencies with broadening mandates to address the needs of all wildlife but are confronted with the reality of stagnant or declining financial and human resources. The potential of leveraging resources to do more for all birds is a strong driving force for partnerships aiming to implement integrated bird conservation.

Since its inception, the PPJV has focused its objectives on waterfowl. In 1995, the PPJV Steering Committee approved a second objective of stabilizing or increasing populations of declining wetland/grassland-associated, nonwaterfowl migratory birds. Because of the lack of basic information, no habitat or population objectives were set. In 2005, the PPJV will complete a new implementation plan that provides a comprehensive framework for integrated bird conservation. The main body of this implementation plan is complemented by four appendices, each of which addresses conservation planning for four species groups. For waterfowl, planning relies on the North American Waterfowl Management Plan and its planning specific to the PPR. Shorebird conservation plans are derived from the U.S. Shorebird Conservation Plan. Waterbirds are addressed as a component of the NAWMP, and the associated step-down plan for the PPR, the Northern Prairie and Parkland Waterbird Conservation Plan. Lastly, the North American Landbird Conservation Plan was the foundation for conservation planning for this diverse group of species. The four species group appendices will be updated as often as necessary to reflect revisions to national plans, to new knowledge of population status and trends, and to new scientific findings that bear on conservation delivery. Although the main body of the implementation plan will be less dynamic than the appendices, it too will be updated as often as necessary to keep pace with new challenges, important scientific discoveries and fresh opportunities.

Plan Content and Flow

To the extent possible, each species group plan addresses the following topics. A "Background and Context" section describes the importance of the PPJV to each bird group. It clarifies the importance of the PPJV relative to other habitats used by a species group, and it sets the stage for understanding the challenges ahead. "Population and Habitat Trends" reviews our knowledge of the population dynamics for important species. A "Biological Foundation" section presents the basic ecological relationships and associated conservation challenges that form the underpinnings for the goals, objectives and strategies of each plan. Because of our incomplete knowledge of natural systems and of the avian species that use them, "Biological Foundation" rests on a set of assumptions, which are explicitly stated. Some assumptions, which we phrase "Key Uncertainties," are fundamental to our conservation planning. These we address in "Research" to assure ourselves that our assumptions are correct and to continue building the base of knowledge needed to refine program delivery.

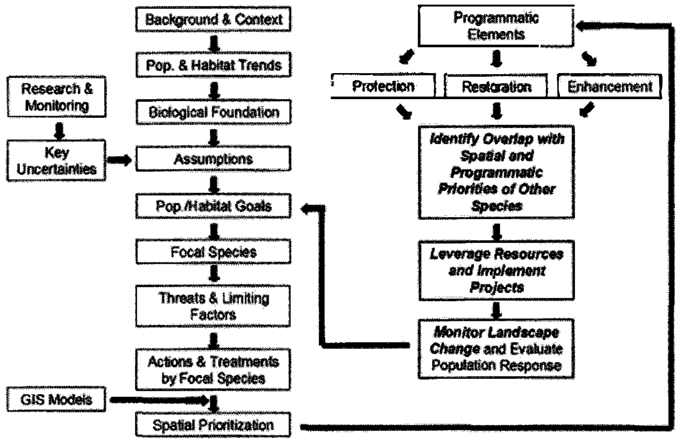
After this background material, each species group plan presents "Population and Habitat Goals" and may also include a discussion called "Focal Species." Focal species are those species that have: (1) a high level of conservation priority because of declining status in the PPR or (2) a high rate of occurrence in the PPR, constituting the core of the species breeding range and (3) a habitat utilized by several other species of interest. The use of focal species helps make the scope and scale of all-bird conservation tractable by allowing one to concentrate programs, monitoring efforts and research on a subset of birds that are both representative and most important to the PPJV. "Threats and Limiting Factors" identifies and associates with focal species. Often, threats relate more to the need to retain existing, critical habitats; whereas, limiting factors constrain population growth rates by impacting one or more vital rates. The threats and limiting factors are then addressed in "Actions or Treatments," often specific to focal species. Lastly, conservation programs are targeted to specific locations within the PPJV, which is discussed in "GIS Models" and in "Spatial Prioritization." When urgency, opportunity and resource limitations are important considerations, some species group plans also set programmatic and temporal priorities, in addition to spatial priorities.

This sequence of planning, from "Background and Context" through the identification of protection, restoration or enhancement objectives for target landscapes, is accomplished for each species group independently. Opportunities for integrated conservation actions are sought by partners when the priority needs and actions identified for multiple species groups overlap. Partners then convene to develop NAWCA and other grant proposals, which identify specific projects and financial contributions from those participating. When funding is secured, many PPJV partners activate to become delivery agents for protection, restoration and enhancement projects. Annually, or at multiple-year intervals, the population status of focal species is monitored, directed studies are performed to address key uncertainties and habitat features are monitored to assess the net change in critical resources. This cycle informs future goals and management actions consistent with an adaptive management feedback loop (Figure 2).

Spatial Models

It is a daunting task to target conservation programs in a landscape as large as the PPJV. Moreover, despite its outward appearance, the prairie is

Figure 2. The strategic planning process used to implement integrated bird conservation in the Prairie Pothole Joint Venture. Multi-species integration occurs at the steps identified by bold, italic typeface.



remarkably diverse. This diversity causes some areas to be more attractive—and important—to certain species. Locations with unusually rich wetland communities or large expanses of native grasslands are two important examples. However, it may also be critical to pinpoint rare habitats used by a species whose population is declining. The PPJV has a history of using spatially explicit geographic information systems (GIS) models to successfully target waterfowl conservation programs. They continue to be at the very foundation of our planning for integrated bird conservation as models for other birds are refined and developed.

For all of their merit, GIS spatial models do have some shortcomings, which we acknowledge here. Chief among them is that their map-like appearance lends the impression that the information used to develop the image is science-based and well founded. However, unless the end-user makes an effort to understand the underlying models and assumptions, they can be misled. One cannot visually distinguish a GIS-generated map derived from an "expert" opinion from one developed using rigorous empirical models. Moreover, even GIS maps derived from empirical models or remote sensing data all have associated errors and variance terms. This variance is usually not quantified or depicted on GIS maps. The problem becomes more acute when multiple GIS layers are "stacked" one upon another, producing a single, new GIS product that has "accumulated" variance terms from each layer.

GIS maps also tend to average out the considerable temporal variation associated with prairie ecosystems. For example, a location depicted as important for a particular species may have the resources needed by this species only every few years, due to natural environmental variation. Lastly, GIS maps often display bird density metrics (number of individuals per unit area, for example) and infer from that the relative quality of the habitat. However, ecologists have recognized that density can be a misleading indicator of habitat quality (Van Horn 1983), so users should be cautious in making this interpretation.

We highlight these issues not to dissuade the use of GIS models but rather as a cautionary note. Spatial models are a remarkable tool for understanding and monitoring habitat features at a landscape scale and displaying population and demographic information for avian populations. Consumers of GIS information must understand the underlying assumptions and strength of the data used to construct the models and to avoid thinking of GIS products as colorful maps that depict the truth. Rather, they are valuable, visual planning tools that approximate reality. Whenever possible, PPJV spatial models attempt to quantify (or at least acknowledge) error terms, variance and temporal variation, while conveying the proper interpretation of density metrics. Moreover, validation of spatial models has been, and will continue to be, an important facet of the PPJV's science foundation. Ultimately, spatial models offer our best hope of prioritizing and implementing bird conservation in a 100,000 square miles (259,000 km^2) landscape.

Operating Principles for Integrated Bird Management

There are two fundamental principles underlying the PPJV's approach to integrated bird conservation. The first principle is that conservation actions will be developed using the best available science. For planning purposes, this means explicit objectives, identified of important uncertainties and key assumptions, a logical process for deciding on the most appropriate management actions, and a system to monitor responses to management and to continually improve management performance. This science foundation does not mean that partners turn a blind eye to the social and political landscape and the associated realities of delivering conservation. It does, however, place a premium on science-based management and discourages planning or management actions based simply on opinion, experience or nonbiological considerations.

The second fundamental operating principle is that no partner should be obligated to compromise their priorities in the name of integrated bird conservation. This is best accomplished, using the philosophy of "separate planning—integrated action." Separate planning enables partners from different bird groups to maximize the use of available information, to reduce it and to interpret results consistent with their own needs, and to set spatial priorities and programmatic actions they deem to be most important. "Integrated Action" is then considered and encouraged as plans are implemented. This approach maintains maximum flexibility and allows partners to adapt to unexpected opportunities, such as new funding sources. It accommodates new information and urgencies. It also avoids a dangerous pitfall inherent in using spatial models—the attempt to prioritize integrated bird conservation projects as part of planning in a Joint Venture context.

Implementing projects in areas of multispecies spatial overlap (locations on a map of potential importance to several species) does not necessarily equate to greater conservation benefits. This might occur for two reasons. First, some rare and declining species are in that situation because they use rare habitats, including some that are not used by many other species. The piping plover's preference for alkaline mudflats and barren sandbars is one such example. Thus, it could be argued that the most important conservation be targeted to areas critical to only one species, rather than a large suite of beneficiaries. A second reason relates to the gradients of habitat quality that can be identified for most species. Delivering conservation projects in an area of overlap that is simply okay for several different species may result in fewer net conservation benefits than if separate projects were delivered in exceptional areas for each species, none of which were overlapping. This problem is avoided when plans are developed independently, each of which identifies highest priority areas before opportunities are sought for integrated implementation.

Looking Back to the Future

With a track record of accomplishments approaching 6 million acres (2.43 m), the PPJV has accomplished much in implementing the NAWMP. Because ducks are waterbirds, actions to protect, restore and manage wetlands on their behalf have benefited shorebirds, wading birds and other wetland-dependent species. Ducks are also grassland birds, dependent on upland habitats for secure nesting sites. Consequently, in just the Dakotas portion of the PPJV, the U.S. Fish and Wildlife Service has protected, through acquisition or easement, 1.5 million acres (607,300 ha) of wetlands and 1.2 million acres (485,800 ha) of grasslands. These investments have been funded almost entirely by the Migratory Bird Conservation Fund (federal Duck Stamp sales) or by NAWCA and its attendant nonfederal matching funds, provided mostly by Ducks Unlimited, Inc. Although these are important contributions towards all-bird conservation, they are insufficient to meet the demands of prairie bird conservation. Compared to other species groups, puddle ducks are relatively uniform in their preferences for wetlands and upland-nesting cover. In contrast, various grassland bird species require a diversity of vegetative structure and composition, and some are area-sensitive with respect to their breeding habitat requirements. More needs to be done, and we believe that the PPJV model for integrated bird conservation sets the stage for action.

The PPJV, along with many other conservation efforts based on joint venture models, has by most measures been a rousing conservation success. If there is any failing, it is that, despite our best efforts, critical habitat elements continue to be lost, usually faster than they can be restored. The decades ahead promise to be even more challenging. As we move forward, integrated bird conservation should not be viewed as means to address more species using the same resources. Rather, the promise of integrated bird conservation is one of bringing new energy and new partners to the table, each with the ability and willingness to offer incremental resources to a symbiotic partnership.

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Integrated Bird Conservation at the State Level

Marty McHugh
New Jersey Division of Fish, Game and Wildlife
Trenton

Where conservation dollars are going to go is going to be based on statewide comprehensive strategies. So, they're the first out of the gate. I assume that others will be following.

When the strategies are finally in, it will be feasible, for the first time, to develop a national program, an integrative program, for bird conservation, with a monitoring system that can be stepped down on a regional basis.

The International Association of Fish and Wildlife Agencies (International) is going to play a major role in looking at all these strategies, trying to tease out all the national issues that pop up, and then letting organizations, governmental entities, even private entities like corporations know what are the issues that can be furthered that have been set forth in these comprehensive strategies.

At the same time, at the state level, it will be possible for public groups or agencies to know where each state wildlife agency will be devoting its time and effort, so they can provide input that can be integrated into the U.S. Fish and Wildlife Service's decisions along the way. There will exist in each state a new mechanism for the integration of the management of all birds after we get these strategies in.

Through the creation of the state strategies, state agencies will have a handle on the impact of their actions on all species, including birds, comprehensively. That's why they're called state comprehensive wildlife conservation strategies. Through the process of putting out these strategies, the agencies' emphasis and the resources that they devote to each of the species of concern will be vetted with all of the interest groups, including the bird groups through the process. That has to be very exciting for all of the interested bird groups that I know are represented here today.

That's got to be very exciting for promoting integrated bird management with respect to these comprehensive strategies. But, that's not the only thing that's happening. Once those strategies are in, it's going to be a very exciting time.

By the way (I'll give a plug here as well), at the next International meeting—I think it's in September—the theme of the meeting—thanks to Jerry Myers and John Bachman—is probably going to revolve around the Teaming with Wildlife efforts and around these comprehensive strategies. So, make sure you get to that meeting if you can.

Another opportunity, besides using comprehensive strategies to move all bird-integrated conservation, is one that I have only recently become aware of and one that I'm sure has been discussed at this meeting this week. Apparently, a group of biologists from the full spectrum of bird interests, including game, nongame, state agencies and federal agencies, have been working to propose and to create a process for a system of all-bird conservation on a flyway basis. They are proposing to use the waterfowl council system as a basis. As you all know, there is a basic need for state nongame biologists to have a system, to join together to consider the needs of migratory birds along the entire length of the flyway. Some of what Jeff was talking about before highlights that need.

We also would like to see a system to recommend actions to be considered by state and federal agencies, to create a system for the regulation of these species. Now, I know that group of biologists that has come together has offered several alternatives, some of which have been or will be discussed this week. Whatever pops out, it's clear that this is a tremendous opportunity to advance the conservation of nongame birds on an integrated basis. However it looks, state game and nongame biologists will have an opportunity to finally integrate more regularly and more effectively, and nongame birds will have a better foundation for protection in states and in the federal regulatory system. We're looking forward to seeing the discussion on that be furthered. I know I, as a state director, am looking forward to that because we're wrestling with bird issues on a regional basis and on an international basis, the latest being the red knock for me. But, I know that there are other state directors wrestling with these issues on that kind of a basis. To have that kind of a system feed into a flyway-type organization or process would be very helpful for everyone, and I'm sure that it excites everybody that's here today.

I will be available for questions on that. I only know a little of the detail on that, so I may not be able to answer all those questions. But, I look forward to seeing how that evolves and to being a part of that process.
So, thank you for your attention

Congressional Perspective on Integrated Bird Conservation

Loretta Beaumont
U.S. House of Representatives, Interior Appropriations Subcommittee
Washington, DC

I'm here to talk about the outlook for bird funding in the U.S. Department of the Interior (Interior) appropriations bill. As Ashley mentioned, the bill has been a little bit reconstituted this year with the changes in jurisdiction in the house. It's actually gotten quite a bit bigger with the addition of the Environmental Protection Agency, which has been a struggle for us in a bill of our size.

I do think that there's a lot of good news with respect to bird conservation on a federal funding level. In this year's budget, and I'm sure that Mike will expand further on this, all of the bird programs (with the exception of one small one) fared very well. In a very constrained budget climate, there were increases recommended for most bird programs. I'd like to just run through and to address each of them individually that are in the Interior bill for those of you who may not be familiar with all of them.

First is the Migratory Bird Program, run by the U.S. Fish and Wildlife Service, that many of you may know because they do the bird surveys and are so critical to the hunting seasons and other efforts that the federal government has responsibility for. Last year, we began to increase that budget just a little bit. It had been pretty much flatlined for a great number of years, and we were at a situation where we were in danger of shutting down some of the surveys. The fallout that would have come from it started to freak out some people, including members of Congress. It took getting to the verge of a catastrophe to do something.

But, money was added. This year, the budget continues that approach and adds even more money to keep the migratory bird programs of the U.S. Fish and Wildlife Service going.

For the Joint Ventures Program, the House of Representatives several years ago championed the joint venture programs and said that it's time to start thinking about doing more of these types of programs. They leverage money, in some cases seven to one. They have a lot of involvement from local communities and from outside groups. It's time we did something to bring them up to a more healthy level of funding. At the time, the funding was about $4 million, and we set a goal—I think this was 2001—of raising the programs over 3 years from $4 million to $10 million. That goal was accomplished. It's a miracle that everyone played along: the U.S. Fish and Wildlife Service and (eventually) the Administration. The program is quite healthy now and, as a matter of fact, has proposals in this year's budget to expand to several new joint ventures and to expand some of the existing ones—quite a sizeable proposal. Unfortunately for all of these increases, I can't tell you that it's going to happen. It's just nice to see that they've been recognized.

The one disappointment in the program was the international program, which does an awful lot of cross-jurisdictional programs dealing with birds and other species. Unfortunately, the Wildlife Without Borders program was targeted for a reduction in this year's budget. I'm hopeful Congress will not accept that proposal.

The neotropical migratory bird program is only a few years old, and it has been a rousing success so far. When we started, we didn't expect it to have the type of interest that has come in. It has a very high bar set with respect to cost sharing. Some have objected to that. Nonetheless, we've gotten amazingly good responses to the solicitations. The program, after starting at about the $2 million level, is up to the $4 million level, and the request proposes continuing it at that $4 million level. For the very first time, the Administration has asked for more money for that program. I think that's great.

The North American Wetlands Conservation Act (NACA) program is. . .what can I say? It's been around for a while now, and it's just been a phenomenal success. I don't think anyone who's familiar with the program would argue that it delivers an awful lot of valuable resource conservation, and it's expanded phenomenally over time in funding levels. That has not been true the last couple of years, nonetheless, over the past 5 years at least, it has gone from a $15-million program to a close to $40-million program. That's just amazing. The budget request this year has a very sizeable increase in for NACA. Again, I'm not sure whether we'll be able to live up to that expectation, but it's certainly not a reflection on the program.

Finally, there is the newest in our group of programs, the State and Tribal Wildlife Grants Program, which the speakers alluded to. I think that everyone is excited about the state wildlife grants, and the plans that they are currently working on are due to be released next October. There was a little bit of apprehension I think. We have invested a lot of money in the program over the last 5 years. There are a lot of expectations, and I think a lot of nervousness regarding whether we are going to get what everybody's hoping for or if we're going to get out of this project. But, everyone who has reviewed the project, including the appropriation committee's investigative staff comes away infected with the same enthusiasm that all the states have for the program. I think that's a really good sign.

We are hopeful that, 5 years from now, it will be held up as a real flagship program that people look to as a great way to further conservation efforts. By then we'll have some real results. The plans will be done. We'll have on-the-ground projects to show what the whole program was set up for, i.e., addressing species of greatest conservation need in every state. Also, we'll hopefully have some good data on where species were when we started and where they are now, which are sorely lacking in so many areas. We have it on ducks, as we heard before, but we really don't have it on a lot of other species. It's not just birds.

Basically, those are the six programs I wanted to mention. I want to talk a little bit now about what the outlook is for the appropriations process as a whole and about the Interior bill within that overall program.

The budget committee acted just this week on a budget resolution. That budget resolution cuts domestic discretionary spending as a whole by about one percent. Unfortunately, when you add inflation, that's more than a one percent cut. So, the amount of money that's available for domestic discretionary spending is less, not more than it was for fiscal year 2005.

Having said that, it does not mean that we're going to have a lot less money than we have in fiscal year 2005. It does mean that we're not going to have sizeable, if any, increase in the amount available in 2005.

As was alluded to earlier, the Interior appropriations bill now has the Environmental Protection Agency as one of its programs of jurisdiction. That program was handed to us with a $700 million shortfall in it, based on the amount of money that the administration requested for it versus the amount of money that it typically would need. So, it's a real challenge. We're certainly not going to find $700 million by routing money from underfunded bird programs or by trying to take money away from the U.S. National Parks Service. We're hopeful that our allocation from the full committee will recognize that shortfall, and will help us out so that we can keep intact these very real, very worthwhile programs that we have in the rest of the bill while at he same time do the right thing by the Environmental Protection Agency.

I want to say one thing to all of you here. I think it's amazing that you're all here and are still going on a Friday afternoon. I see many faces I recognize in the audience and many others that I don't. My door is always open up on Capitol Hill. I love all of the bird programs and all of the U.S. Fish and Wildlife Service programs. I think it's amazing to see how much it's done with such a relatively small amount of money. We deal with a lot of other programs in the bill. If all of them tried to emulate some of the successes and practices that we have in the bird programs and the U.S. Fish and Wildlife Service, they'd be a lot better off.

Thank you.

Executive Agency Perspective on Integrated Bird Conservation

Mike Hickey
Office of Management and Budget
Washington, DC

I would talk about Farm Bill programs, but I don't know much about them. I could give it a swing. I know there's WRP and CRP, and there are a couple of other acronyms out there.

Anyway, while I've got you laughing. . .when I give a presentation, I always go to my son, who's in fourth grade, and ask him do you have a joke that I can tell people because my time slot is usually like this: in the afternoon, people are dragging and, as my wife asks, "you're going to tell them what"? So, I asked him this time, and he failed me. My source of good jokes failed me. Fortunately, I have TWO kids, and my daughter, who's in first grade, came up with one. So, bear with me; she told it to me this morning. I said I need a bird joke. She said, "OK, here's one I know. A duck went in to buy Chapstick™." (Raise your hand if you've heard this.) Duck went in to get Chapstick™. The cashier said, "Do you want this on your credit card"? The duck said, "No, I want it on my bill." Hey, she's in first grade, what do you expect?

All right, here's something that I know a little bit about. At least, I put the presentation together. I am Mike Hickey, and I am the program examiner for the U.S. Fish and Wildlife Service within Office of Management and Budget (O and B). I'll get to that in just a second. I grabbed these pictures off the Internet, so if I forgot a plan, it's not because I think any less of you or anything.

Really quickly, I'm going to cover in these thirty-odd slides—and if some of you got the packages you know that it goes on *ad nauseum*—the role of O and B, I'm going to talk a little bit about the executive branch, focused on results. Finally try to wrap things up by talking about the relationship of all that to bird conservation.

I've noticed that people who are not in Washington, DC, usually don't know what O and B is, let alone what it stands for. People who ARE in Washington, DC, THINK they know what O and B is, and they certainly know what it stands for. But, they really don't know what we do.

O and B is the small agency under the executive office of the President that helps agencies. Some of the agency folks will go "right," but we help agencies to develop their budget proposals for the annual budget submission to Congress. We also are responsible for reviewing regulations that the agencies submit to the federal register, for reviewing testimony (like when they go up before the appropriations committee), for reviewing legislation proposals and for helping to put together and to implement presidential management initiatives.

The emphasis on results for this administration really began when President George W. Bush was on the campaign trail before his first term. This is a good quote that I like to put up for people to read, and I'll let you read it there. Basically it's saying that we're focusing on results, and, if a program can't achieve results, then it's time to rethink it and move on.

There are three guiding principles to the President's management agenda that came out in 2001. Those are guiding principles to help push the government to better results through citizen-centered, not bureaucracy-centered, activities, as well as through looking at market-based alternatives to ways of accomplishing their mission.

Quickly, the President's management agenda reflects his commitment to results. It identifies governmentwide initiatives, and it focuses on remedies to problems that we have all been aware of and have seen through the implementation of activities to resolve those. It builds on the Government Performance and Results Act.

When we first came out with this initiative, people were asking, "why this; why now"? We've been through this before. Some of the responses actually are common sense because we need to show that programs are running efficiently. There wasn't any real interest in incentives or rewards for people who were operating programs—not migratory bird programs, obviously, but other programs that weren't really showing results.

Once money had been allocated to federal programs, there wasn't a very good way of recognizing what had been accomplished. It would get put into the budget each year and would become a fixed cost. But, we would never know what really happened. Accountability is something that is really stressed, as is better results.

Here's a list of the governmentwide initiatives. There are five of them that were originally put into the President's management agenda. The last one on the screen is the new one, which is quite recent and which is the Federal Real Property Assessment Management Initiative. The results aspect of the President's management agenda comes into the Budget Performance Integration Initiative.

We measure each agency on a quarterly scorecard. Some of you may have seen this: red, yellow, green. It's pretty straightforward. There are criteria set up for how each agency is rated in terms of their status over the long term, as well as quarterly progress. Quarterly progress is evaluated on specific activities that the agency is supposed to accomplish within that fiscal quarter. There's what the most recent scorecard looks like, and, if I could, I would have compared it against the first one, which had reds and yellows. You can see now that there are quite a few greens that are showing up.

These are the criteria for measuring the Budget Performance Integration Initiative. A key there is strategic plans with performance goals that are outcome driven. Those of you that have been involved in integrative bird management with the different plans know what I'm talking about when I'm talking about strategic plans, and how hard it is to come up with real outcome-based goals.

There's also performance-based budgeting, which is a key factor in fiscal times like we are in now. You've got to be able to show that you have performance goals and that you're actually budgeting the whole cost of those performance goals. Absent that, and against a results-based Administration that's trying to cut the deficit in 5 years, your program doesn't really do very well.

Then, the Program Assessment Rating Tool (PART), which I'll get into in just a little bit, looks at helping to improve programs, at helping to support management actions, at justifying plebian requests and at developing any legislative proposals.

The PART is a series of 25 questions that we ask agencies or programs to answer to help us to evaluate and to assess how well they're doing as a program. We talk about program design and purpose. We talk about strategic planning management results and accountability. The one thing that people need to know is that this tool is helping us to provide a consistent approach to evaluating programs. There's more information for those of you who did get the packages on the Websites.

The history of the PART is that it started in 2003 without any real set procedure. In 2004, we developed this questionnaire. In 2005 and 2006, we refined it. There's just a little rundown of what the PART is really looking at. It asks do you have long-term and short-term goals? Do you have results? It also demonstrates that it supports the Government Performance and Results Act at a programmatic level.

Each program will get a rating. This is key; if you fell asleep, wake up for just a second. The ratings may not seem to mean much, but, when you go through the questionnaire, they get scores. Because we know that we're not that precise scientifically, we have bands, four bands, that illustrate these ratings.

At the bottom, you'll see the results not demonstrated. People may ask: "What in the world is that about"? Give them an ineffective if they don't show results. Well, sometimes programs are just crafting new goals where they don't have data and baselines yet. So, we need to be able to provide that as a way out of getting a not-so-glamorous score.

Here are the different sections of the questions. The first section talks about whether the purpose and design of the program are clear. There are some sample questions. Keep in mind, when I'm meeting with agency folks with the U.S. Fish and Wildlife Service folks, we go through all these questions. Because this is an evidence-based process, it's almost like discovery. The assumption is that the answer to the questions is "no" unless there's enough evidence to convince us all that the answer should be "yes."

The second section is strategic planning. As you all know, the U.S. Fish and Wildlife Service migratory bird program put out their strategic plan last year. That was one of the things that they brought to the table in terms of their evidence, as well as a number of the continental and regional bird plans.

The third section is program management. People ask: "If we're talking about results, why are we talking about management"? Well, if your program isn't managed well, you're not going to be able to achieve your results. We get into everything—talk about financial management, accountability. We get down into it.

Then, of course, the final section is the heart of the PART. We get to the results. This is where most of the performance data is reflected. We look at the goals that the programs have established and see whether they've actually achieved what they said they were going to achieve.

I want to talk about performance goals really quickly because, when I look through the bird plans, I see a mixture of goals. Program goals, I think we all can agree, are supposed to embody the mission and vision of the program. There are a couple of key things that we look at: performance measures, the targets and the time frame, outputs versus outcomes, and making sure that it's actually something that can be measured.

Then there are these issues of outcomes and outputs. Outputs are really what people are doing. Imagine acres of hardwood wetlands that are restored. Say a program is restoring wetlands. They'll report annually how many acres they have restored or protected or whatever it may be. An outcome is really what they're trying to accomplish in the end there. Are you really trying to accomplish healthy sustainable bird populations, for example? With the part, we're pushing agencies to go for the outcomes because those are what really make the difference.

Strategic goals are the types of goals I find in many of the documents I look at, particularly with the U.S. Fish and Wildlife Service. I put one up there from waterbird conservation plan. These are kind of broad statements. They're good, and this is what we're kind of looking for in terms of the long range.

But for performance goals, I've pulled something from the North American plan, the original one. That's something that I can deal with because that, to me, is tangible. It's something I can measure, and it's got a time frame on it. Someone else can tell me whether or not that goal was accomplished.

Down at the bottom, there's a little formula that tells people how I come up with a performance goal. A performance measure is a statement that says number of acres restored, or that indicates a number of black ducks, at a wintering population index of X in Atlantic and Mississippi flyways. The target is the 385,000. The time frame, in this case, is the year 2000.

These are some guidelines that I go over with the U.S. Fish and Wildlife Service folks when I'm working with them on goal setting. In regards to the integrated bird conservation plans and the way that you're developing your plans (especially with the state wildlife grant plans), I'd encourage the states to adopt this type of view to develop their goals. Make sure that it's something you can measure, and that you know your time frame. Otherwise, you have an open-ended goal that's going to lead you nowhere. You'll always be trying to attain something. You need to set something up that's going to be actually, you can measure whether or not you're accomplishing it because that helps you to refine your program if you need to.

I put the reality check back in here because, when you're setting goals, everything that can come up does come up. I like this quote from Einstein: "Everything that can be counted, does not necessarily count. Everything that counts cannot necessarily be counted." You can think about that for a little bit.

The other thing is that natural disasters do occur, and, when we set goals, we understand that, particularly when we're talking about outcome goals. If there's a drought that just completely devastates a prairie pothole region, then there's no way you're going to reach some of your goals. That's fine. It's not fine for the birds, but it's fine when you report on your goal and say, "we didn't accomplish this goal because 10 out of the 10 years that we had this goal set for, there was a drought."

The other thing is that achieving outcome goals requires more than just the federal government. Everybody in the room here knows that. After 3 years of doing the PART, the federal government has assessed over 600 programs, roughly 60 percent of the federal budget. There are 127 programs that have actually gone through the PART twice. We've reassessed them. You can see the numbers there.

Since this is an evaluation that requires a lot of evidence and since it's a very high bar to get a good score, you don't see a lot of effectives. We're not inflating this. Only 15 percent of all those programs got an effective rating. What's good here, although you can't really tell by this slide, is that 29 percent of results not demonstrated when we first started was 50 percent. That means, as we're going through the programs, more programs have better goals which will be able to demonstrate better results.

After we do the PART assessments, the idea is that you use them to develop your budget justifications to O and B as well as to Capitol Hill, and that you propose different suggestions and can improve your program managerialwise and legislatively.

What does this all have to do with migratory bird conservation or bird conservation? Loretta's already gone through the different U.S. Fish and Wildlife Service programs. I won't break it up much more. This is just a breakdown of the migratory bird program within the U.S. Fish and Wildlife Service: duck stamp permits, conservation monitoring.

There are other programs, which we've talked about today. State wildlife grants, which can be big in terms of bird conservation, except for the Farm Bill program. That's even bigger. But, I'm not talking about that.

This past year, we went and did the PART on the U.S. Fish and Wildlife Service Migratory Bird Program. We included in it not just migratory bird management, but the North American as well as the neotropical migratory bird conservation program. They provided a lot of information and a lot of evidence to help us go through these 26 questions.

If you look through the budget—I know you all have it next to your bed cause it's good reading—there's a summary of that program assessment rating tool that we used on the migratory bird program. In all seriousness, you might want to look at that. In the next slide, you can see that the program got a "results not demonstrated." The results bar, which is a separate bar on the left, is quite low. That is the real reason that it got a results not demonstrated. We crafted some new performance measures and goals, which are in the boxes on the left.

Results are weak because of outcome-based performance goals were needed. In the PART process, we worked very closely with migratory bird folks at the U.S. Fish and Wildlife Service. We had 8-hour meetings talking about the same stuff.

We crafted some new outcome measures. If you look at these, you can see the percent of all migratory bird species that are at healthy and sustainable levels. We came up with that because that was what the program thought was one of its long-term goals. When we looked at all the plans, either the continental plans or the regional plans, this was embodied within either the vision or the goals that were set out in all those plans. So, this is something that we felt everyone could unite around.

Now, if you look at the baseline in the target, there's not much change there. That shouldn't surprise anybody in this room because we know change isn't going to happen overnight. It's a slow process, but at least they've got a time-based target and a goal that they can work towards.

The second one is a recreation goal, which I was kind of curious about. When we brought all the regional chiefs for the U.S. Fish and Wildlife Service or for bird programs together to talk about these goals, it became apparent that the reason that we have many of these bird programs in the first place is because of the recreational roots of migratory birds and other birds. We felt that this was a very necessary goal to have in there. So, we have the recreation goal as well as the conservation goal, which we feel are complimentary.

This is an output measure. As I told you earlier, outputs are what they really are doing. This one is achieving what the management needs. It's not as specific as I would like, but we're kind of in the process of refining it. As you can see, the baseline and targets are under development. So, there's more to come here.

There were some recommendations that came out of the PART. They included adopting these goals and recognizing that there's going to be a lot of work with a lot of the folks in this room and elsewhere because they certainly can't be accomplished without such cooperation.

Request funding in the '06 budget, which you heard Loretta mention. There is a request for funding in the budget for bird programs, particularly to help achieve that long-term goal. Develop these baselines and targets.

Independent evaluation is one thing I didn't talk about earlier, but that's a key part of a double-check on whether or not the program is succeeding. Then, linking performance plans to performance goals is the accountability. If you have goals out there, but, if no one is going to be held accountable for them, then they're worthless. This helps bring it home. Make sure somebody's doing the work. Somebody's got to be held accountable if the goals aren't achieved.

Since I'm from the Office of Management AND Budget, I thought I'd put some budget numbers in the end here. This kind of gets into how integrated bird management really plays a part in, as Loretta said, the U.S. Fish and Wildlife Service Migratory Bird Program and the other bird programs, which have done quite well in terms of funding, particularly since 2001. They've done exceptionally well when you consider how tight the fiscal situation's been.

I can't guarantee what 2006 will bring. The people on Capitol Hill are just as tight as everyone else in terms of making their allocations. This is the result of setting some priorities and of acknowledging that there are programs that are working. As a result of the PART demonstrating that it helps you work toward achieving goals, you have partners like yourselves that help on Capitol Hill and elsewhere.

As I mentioned earlier, one of the big challenges is the goals that the U.S. Fish and Wildlife Service has set for itself can't be achieved by itself. That's where this whole all-bird concept comes into play.

The joint venture funding has increased, and that somewhat reflects the fact that it's shifted from just waterfowl to all birds.

The migratory bird program, and the other bird programs have this wonderful opportunity to achieve this goal. But, it's only by working through the North American plan, the shorebird plan, the water plan and other plans that they can show that they're all complimentary and are working towards the same goals.

We've already talked about funding. There's not much of it out there. Funding is a priority because it's not been held at the 4-percent increase that all the other programs have been held at in the federal government.

We still have a lot to do in terms of measuring results. We talked a little bit about the outputs. Right here is just an example. When we're measuring outputs and measuring outcomes, we can't just look at population trends. We've got to look at other things as well.

I appreciate your attention. Thank you.

Opportunities for Bird Conservation through Agricultural Conservation Programs

Randall L. Gray
U.S. Department of Agriculture,
Natural Resources Conservation Service
Washington, DC

Private lands are important to the conservation of birds because the lands comprise more than 70 percent of the land ownership in the lower 48 states. In addition, approximately 50 percent of the 900 million acres (360 million ha) of land in the United States is managed as cropland, pastureland and rangeland. This combination of factors highlights the importance of farm policy for the conservation of birds. The 1985 Food Security Act (Public Law 99-198), amended in 1990, 1996 and 2002, has provided an increasing amount of programs and funds for conservation on private lands. This succession of public laws, referred to as the Farm Bill, has created an array of programs affecting bird conservation, such as wetland restoration, upland habitat restoration, forest management and several easement programs to maintain existing and restored habitats (Heard et al 2001). In addition, many nonwildlife conservation practices associated with the Farm Bill can and do benefit fish and wildlife if properly planned. The 2002 Farm Bill authorized $17 billion towards private lands conservation over at least a 5-year period, indicating the growing significance of Farm Bill programs on conservation and on wildlife in particular. The next Farm Bill is beginning to take shape and will become an important focus of the conservation community over the next 2 years since the future of wildlife is inseparably tied to activities occurring on private lands.

Overview of Farm Bill Conservation Program Impacts on Bird Conservation

The 1985 Farm Bill heralded a new era in the role of farm policy. The statute established provisions to decrease the conversion of wetlands, the breaking out of land that was highly erodible and the reestablishment of highly erodible croplands back into permanent cover. Specifically, these provisions would have major effects on the conservation of soil and water as well as on fish and wildlife habitat. The vehicle for accomplishing this goal was the Conservation Reserve Program (CRP), which took highly erodible croplands out of production and put them into permanent cover. There was also wetland protection, referred to as Swampbuster and Sodbuster, which addressed erosion potential when breaking out new lands.

During the following decades, additional programs were added to the Farm Bill to address wetland restoration, grassland protection and restoration, and wildlife and fisheries habitat conservation and enhancement. These programs have contributed to habitat conservation and restoration projects that are benefitting birds throughout the United States.

Conservation Reserve Program

CRP is administered by the U.S. Farm Service Agency (FSA) with technical assistance provided by the Natural Resources Conservation Service (NRCS). It originally targeted highly erodible croplands set aside in permanent vegetation by offering 10- to 15-year contracts with landowners, operators and tenants. Participants receive cost share and technical assistance to convert their land to permanent vegetation, and then the receive an annual rental rate for the life of the contract.

Although the original focus of conservation plans developed for the contract was holding soil in place, the vegetation planted to accomplish this objective also provided habitat for wildlife, in particular benefitting grassland nesting birds, such as waterfowl and song birds. In 1994, the U.S. Department of Agriculture (USDA) announced a new emphasis on environmental improvement of lands enrolled in CRP, and FSA established more rigorous standards for soil erosion control, water quality protection, tree planting and wildlife habitat benefit enhancements. CRP has continued to expand to include wetland restoration, riparian buffers and, most recently, an upland field border practice for early successional dependent species, such as the bobwhite quail (*Colinus virginianus*).

Research continues to document the benefits of CRP on wildlife. A review of the literature on the effects of CRP on bird populations in midwestern states found overwhelming evidence (Ryan 2000) that CRP plantings were used by a variety of birds, including many species of conservation concern, such as dickcissel (*Spiza americana*), grasshopper sparrow (*Ammodramus* *savannarum*), bobolink (*Dolichonyx oryzivorus*), henslow sparrow (*Ammodramus bairdii*) and sedge wren (*Cistothorus platensis*). Another study found that between 1992 and 1997, CRP in the Prairie Pothole Region contributed to a 30-percent improvement in duck production, or 10.5 million additional ducks (Reynolds 2000).

As of 2004, there were approximately 34,700,000 acres (13,880,000 ha) of land under CRP contract providing varying levels of habitat for bird species. In 2004, the program established a new practice of field buffers for upland birds that has allocated 250,000 acres (100,000 ha) in 35 states for establishing upland bird habitat. While this practice will mainly benefit bobwhite quail, it will also enhance habitat for other early successional species that have declined with changing land uses.

Swampbuster

The wetland provisions of the 1985 Farm Bill, known as Swampbuster, were designed to address the loss of wetlands on agricultural lands by providing disincentives to conversion to cropland. Specifically, if a wetland is converted, the producer looses USDA subsidies, such as price supports, farm storage facility loans, disaster payments, crop insurance and farm and home administration loans.

Dahl et al (1991) estimated that wetlands within the lower 48 states had declined by 53 percent to an estimated 104 million acres (42,074,479 ha). This habitat loss affected fish and wildlife populations. Agriculture was indicated as being responsible for 87 percent of the loss between 1954 and 1974 (Frayer et al.1983). From the mid-1970s to the mid-1980s, the role of agriculture development in wetland conversions declined to 54 percent (Dahl and Johnson 1991). During 1980s the concern over the loss of wetlands was continuing to grow, and legislative solutions were being sought which led to the wetland provision of the 1985 Farm Bill.

Recent studies indicate that the annual rate of wetland loss due to agricultural conversions declined to 26 percent between 1992 and 1997 (U.S. Department of Agriculture, Natural Resources Conservation Service 2000) and then to 18 percent between 1997 and 2002 (U.S. Department of Agriculture, Natural Resources Conservation Service 2004). Though it is difficult to quantify the contribution of Swampbuster to this decrease of wetland loss, it is assumed to have played a dominant role and, coupled with the Wetlands Reserve Program

(WRP) described next, is a major factor in the reported wetland net gain on agricultural lands from 1997 to 2002 (U.S. Department of Agriculture, Natural Resources Conservation Service 2004).

Wetlands Reserve Program

The 1990 Farm Bill (also known as the Food, Agriculture, Conservation and Trade Act of 1990) created another important provision to address the loss of wetlands and associated migratory bird habitat by establishing the WRP to restore wetland habitat. WRP was piloted in 9 states in 1992, was expanded to 20 states in 1994 and was made available to all states by 1995. The program was quickly accepted by landowners, and there are now restoration projects in 49 states and Puerto Rico that encompass over 1.8 million acres (720,000 ha) with additional lands being added each year.

WRP is administered by the NRCS and is delivered in cooperation with many partners from the private and government sector. The program targets converted or degraded wetlands with a high probability of successful restoration. It authorizes permanent and 30-year easements as well as 10-year agreements. Restoration cost share assistance from 75 to 100 percent is provided, depending on the length of the easement. Most of the acreage is enrolled with permanent easements, and the remaining acres are enrolled with 30-year easements or 10 year contracts. The primary emphasis of the program is conservation of migratory birds, threatened and endangered species, and wetland-dependent wildlife. This is a wetlands program and is perceived to benefit primarily waterfowl, shorebirds and wading birds. However, a significant amount of acreage is in existing or restored forest and grassland that provides habitat for a variety of nonwetland species of birds.

In selecting projects, priority is given to expanding the effective size of existing habitats, such as private, state or federal wildlife areas, to decrease fragmentation as well as to aid threatened and endangered species. In addition, sites that are potential habitat for threatened and endangered species or that are within bird conservation areas receive higher priority. Existing easements range from 2 acres (0.8 ha) to over 16,000 acres (6,400 ha), and many are contiguous to other easements or protected areas (e.g. state or federal wildlife areas), which form even larger blocks of habitat. Although it is intuitive that converting cropland to wetlands, forest and grasslands is good for birds and other wildlife, there are few quantitative studies documenting wildlife response to WRP restoration. However, qualitative observations throughout the United States indicate the program is having major impacts upon birds (Gray, in press). For example, in southeastern Oklahoma, unusual or first-time observations and nesting records for wood storks (*Mycteria americana)*, white ibis (*Eudocimus albus*), willow flycatchers (*Empidonax traillii*), roseate spoonbills (*Ajaia ajaja*) and black-necked stilts (*Himantopus mexicanus*) were made on the 7,500-acre (3000-ha) Red Slough project. In Arkansas, over a half million waterfowl and 20,000 shorebirds were counted on the 7,000-acre (2,800-ha) Raft Creek Bottoms project following restoration. In the lower Mississippi Valley, the program is restoring over 500,000 acres (200,000 ha) of bottomland hardwood forests and wetlands that are providing habitat for an array of songbirds, waterfowl and wading birds. In Hawaii, the endangered nene goose (*Anser sandvicensis*) and koloa duck (*Anas wyvilliana*) are using land on WRP restoration projects.

Conservationists concerned with migratory bird habitat play a significant role in establishing priority areas where the program will have the greatest impact and will meet habitat restoration goals. The program allows landowners to conduct compatible uses, such as haying, grazing and timber harvesting, when such activities further the long-term protection and enhancement of the wetland.

Wildlife Habitat Incentive Program

The 1996 Federal Agriculture Improvement and Reform Act (Public Law 104-127) authorized the Wildlife Habitat Incentive Program (WHIP) which is administered by NRCS. WHIP provides cost share funding for up to 75 percent of the cost of installing wildlife habitat practices under agreements that last from 5 to 15 years. WHIP also allows a new type of landowner to participate. Whereas CRP and WRP are restricted to agricultural lands, WHIP participants do not have to be farmers or ranchers, nor do they need to own land with a history of agricultural production. In fact, many of the participants are new landowners who have purchased land for its wildlife or recreational opportunities.

WHIP funds are distributed based on state wildlife habitat plans that may include priority wildlife habitat areas or targeted species and their habitats. The national emphasis is on wildlife and fisheries habitats of national and state significance on habitats for fish and wildlife experiencing declining or significantly reduced populations, and on practices beneficial to fish and wildlife that might not otherwise be funded. Between 1996 and 2004, WHIP projects have benefitted wildlife habitat on approximately 3 million acres (1.2 million ha). This program positively impacts many bird species both directly and indirectly. In 2005, a national priority was established for conservation, restoration and enhancement of sage-grouse habitat.

Environmental Quality Incentive Program

In 1996, the Farm Bill established the Environmental Quality Incentive Program, which is also administered by NRCS. Though this program focuses on water quality issues, it does include provisions to address cost share practices for wildlife, particularly species at risk. In 2005, funds are being specifically targeted for sagebrush habitat that will benefit the sage-grouse as well as other sage-associated species.

State Technical Committees

The 1996 Farm Bill also established a procedural component for program implementation that was new. Congress established state technical committees to advise the NRCS State Conservationist and the FSA State Director on program implementation. This brought an array of groups to the table to discuss conservation priorities and thus advise state-level USDA leadership. State technical committees are comprised of members of commodity groups, wildlife groups and other state and federal agencies. The committee is an important conduit for information from the bird conservation community to inform policy decisions that will have significant effects on bird conservation.

Grassland Reserve Program

The 2002 Farm Security and Rural Investment Act (PL 107-171), the most recent addition to the Farm Bill, added another program that will significantly affect grassland birds. The Grassland Reserve Program's goal is to protect grasslands under long-term contracts or easements. The primary program emphasis is maintaining working cattle operations and conserving biological diversity. In 2004, $2 million was targeted for the protection of lands that benefit the sage-grouse, and additional acreage is being targeted for sage-grouse habitat in 2005. The program is new, and the impacts on wildlife have yet to be realized.

Conservation Security Program

The 2002 Farm Bill also added the Conservation Security Program (CSP) to the array of tools for providing conservation on private lands. This program is different from its predecessors since it focuses on rewarding landowners who are good stewards. CSP is a voluntary program that supports ongoing stewardship. Landowners and producers are financially rewarded at differing tiers that are determined by the amount of property addressed and the number of conservation practices implemented. Enhancement payments are also made to land users willing to address additional conservation issues, such as species of conservation concern. For example, if the eastern meadowlark is of concern in the area, payments can be made for setting aside blocks of grassland that provide suitable habitat.

The program was piloted in 2004, and several species of birds were targeted by the program. As CSP expands across the United States, opportunities to provide habitat for birds and other wildlife will increase.

Conservation Effects Assessment Project

The Conservation Effects Assessment Project (CEAP) is an effort to document the environmental benefits of Farm Bill conservation program practices (Mausbach and Dedrick 2004). A wildlife component of CEAP will broadly assess and measure fish and wildlife benefits of USDA conservation programs and practices. There have been numerous studies to document the effects of Farm Bill programs on fish and wildlife; although, the majority focused on CRP (Heard et al 2000, Allen 2004).

A wildlife task force is in the process of developing a detailed work plan to accomplish this goal. When implemented, elements of the work plan will generate outcomes that are intended to enable stakeholders to gain an appreciation of fish and wildlife benefits achieved. The results of this effort will increase program and conservation practice effectiveness in addressing fish and wildlife conservation needs on agricultural landscapes.

Furthering Bird Conservation with the Farm Bill

Farm Bill direction is decided at both the national and state level. Specifically, Congress determines the programs to be funded, and then the state agencies develop the specific rules that refine program goals and objectives. State level USDA leadership, in consultation with state technical committees, further defines program focus by setting local priorities.

Good science and conservation priorities are necessary during the legislative process, rule making, funding allocations, and state priority setting to ensure that programs are effective tools to address conservation needs. The bird conservation community's role should be to provide conservation science leadership to inform during the decision making process. They must speak with a coordinated voice as to which bird species and habitats are of highest conservation concern and what conservation practices are necessary. Recent efforts of the North American Bird Conservation Initiative and other efforts to ensure a science-based, unified voice are critical to furthering the most effective bird conservation on private lands.

NRCS has contracted several projects to specifically look at how many conservation practices can be better planned to enhance habitat for birds. Specifically, over $1.5 million is being used to evaluate conservation practices' effects on bobwhite quail and other upland birds. Similar studies are being conducted to look at program effects on grassland nesting birds. An addition, efforts will be launched this year to evaluate the effectiveness on conservation practices on sage-grouse and other sage habitat species.

NRCS is leading an effort, in conjunction with the bird conservation community, to establish bird habitat management guidelines for specific habitats by geographical region. This effort compliments the targeting of bird conservation priorities at the national and state scale, and it provides local conservation planners and landowners with information specific to the lands they work on. Hence decisions can be made with knowledge as to what is most beneficial to the birds of conservation priority that would occur within that landscape. This information will be useful in planning and implementing Farm Bill program practices as well as in providing knowledge for conservation and restoration decisions independent of federal programs.

There are challenges and opportunities facing the bird conservation community to ensure that the objectives of the programs are sustained and maximized over the long run. For example, management, or lack thereof, will determine the quality of habitat and the species of birds affected on CRP contracts or WRP easements. Programs, such as CRP and WRP, are a significant, contributing factor to migratory species, such as waterfowl and shorebirds, which often have differing habitat requirements throughout the year. Opportunities for coordinated management of WRP easements, in conjunction with federal and state refuges, can provide landscape level benefits for migratory species.

As natural areas become increasingly fragmented, it is important to manage areas in different ways to address differing species needs (Askins 2000). This further emphasizes the need for the bird conservation community to look beyond restoration and protection to a landscape perspective when prescribing management.

Farm Bill programs are voluntary programs that are designed to work with a landowner's objectives as a major consideration. Working with and educating landowners about bird habitat needs is a critical part of efforts to ensure the long-term conservation of birds. Many groups of landowners have come together to work cooperatively to address landscape level resource conservation needs. These initiatives should be encouraged and acknowledged to ensure that they maximize their effectiveness in addressing bird conservation needs.

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An International Perspective: A Western Hemisphere Initiative for Migratory Species

Herb Raffaele
U.S. Fish and Wildlife Service
Arlington, Virginia

Thank all of you for hanging in there. I'm sure it's been a long day and a long week. I appreciate having the opportunity to speak last.

I have some bad news for you. That is, first of all, I don't have a kid in elementary school, so I don't have any good joke to start with.

I've been traveling too much to put together a Microsoft PowerPoint presentation, but I do have something to say from my travels that might interest you. As David said, I think this is an important theme. So, for those of you who do sort of doze off during it, you'll at least have some food for thought on your long trips home.

I want to start by talking a little bit about why something new. You've heard a lot about some of the models that have been developed domestically. So, why should we be thinking about other new ideas with regard to bird conservation? The reason is because there are some unmet challenges. I want to discuss a few of them.

As Mike Hickey showed you at the beginning of his talk, there was a whole alphabet soup of different acronyms for different conservation initiatives that we have both here in the United States and for different types of species. In fact, I have another acronym, but I'm certainly not going to talk about it for a few minutes because, first, I want to talk about why we should need another acronym?

Let's start with some of the unmet challenges. One of the things that has been talked about quite a bit has to do with the advances in integrated bird conservation or in conservation of all birds. There is no question whatsoever that the advances in the last 10 years here domestically probably have been beyond anyone's expectations, as Loretta suggested in her response to a question along those lines.

At the same time, interestingly enough our concept here in the United States about integrated bird conservation is that we really are talking about taxa. We're talking about groups of birds. We're saying that there are game birds and there are nongame birds. There are upland birds, and there are water birds. We divide our birds into many, many different groups. Well it just so happens that we're one of the only countries in the hemisphere that really does that in a serious way. Nonetheless, that's the way we look at taxa.

But if, in fact, we talk about integrated bird conservation in other perspectives, and that would of course include where these birds range, we're not integrated at all. We're still thinking extremely domestically about all birds.

Now we can look a little bit at our history as a country. As was suggested before with regard to game birds, there was a tendency to look at flyways and to look at game birds throughout North America because most of the game birds didn't span beyond the Rio Grande. And, those that did certainly didn't expand beyond Mexico, except perhaps blue winged teal.

When we start looking at all birds, the whole picture changes. If we're going to look at integrated bird conservation from a distributional perspective other than the taxonomic perspective, we end up having to look far beyond our borders, far beyond North America and well into South America. In fact, we have to look to the southern tip of South America and all through the Caribbean. So, integrated bird conservation, geographically, becomes something much bigger than anything we've really looked at in the past.

Related to that is the fact that we, as institutions and organizations responsible for bird conservation, basically are domestic agencies. I work for the U.S. Fish and Wildlife Service. We're within the U.S. Department of the Interior. We're basically a domestic agency, even though we hold the responsibility for trust species that expand beyond the western hemisphere.

Many of you are from state agencies or from local conservation groups. Most of us professionally or nonprofessionally still are involved in domestic approaches to bird conservation. That makes it that much more difficult to deal with some of these challenges that have to go beyond U.S. borders.

Obviously, beyond the issue of us being domestic, there's also the reality of Latin America being very different than the United States in the way that it deals with issues. There was a question raised a few minutes ago by Dave Tralger about China's purchase of crops and its impact on the United States. Well, very likely there will be a ripple in the United States with regard to the impact of China and all the money that they're investing in resources. But, what is that impact beyond our borders?

I don't know how many of you know what's going on in Mexico right now. Very quickly, Mexico, in the past 6 to 10 years, has implemented its best protected area program that it has ever had. It's got millions of dollars more than it has ever had for the management of protected areas in its history. It has the best professionals for the management of protected areas and wildlife that it has ever had in its history.

Despite all these changes in Mexico, the amount of deforestation in Mexico has increased dramatically in the last few years, a lot of it in its protected areas. Why is that? It's primarily due to the tremendous increase in the value of timber. Wood now is worth three to five times more than it was 3 or 4 years ago. So, illegal harvesting has gone up dramatically, and the Mexican government has no adequate capacity to cope with it.

I was in Argentina last week. You remember those cattle that Argentina's famous for? Those cattle aren't there any more. Those cattle have been replaced by the growing of soy. That growing of soy is primarily exported to where? China. In fact, Argentina has just developed new technologies to expand its soy production, so it can go into all types of dry, arid habitat that was never used.

So, why does that relate? What does that have to do with our bird conservation issues? Well, some of you may recall less than 10 years ago that the tremendous value for swings and sorts in Argentina, about a third of the western population from Canada apparently died off there. Those were birds that were living in agricultural fields in Argentina. Over 90 percent of our sweets and talks weep in Argentina.

Many of you know about the pig thistles in Venezuela. Virtually all of our pig thistles went there. They're being poisoned by the hundreds of thousands, if not the millions, because of being a pest to rice production. There are all these very important reasons why we're having some unmet challenges with regard to our bird conservation.

I also very quickly want to touch on the issue of sound science, which has come up in virtually every single bird initiative that we've talked about. Again, our sound science tends to be applied to species. We have to do our sound science on different taxonomic groups of birds so that we can categorize them in terms of which are most endangered and which are less endangered.

We have to think about the sound science of the geography of these birds. Where are they spending their life cycles, and what are we doing about conserving them during the times that they're not in the United States?

We also have to think about them in their social context. In the United States, we have a very different reality, in terms of what we might do to conserve birds, as compared to many other countries. We don't begin to know the many elements of folklore that negatively effect birds in many other countries. For example, in Haiti, a local conservationist and I were talking about putting together a little book and about including some of the folklore about birds so that people would learn more about how people perceive birds in Haiti. She said that there's a tremendous amount of folklore here about birds, but it's all negative. She asked why we would put that in a book.

When people have negative attitudes about birds, when they think things about birds, it's not just that we need science to change their attitudes. But, we need different types of social actions that are that much more necessary in other countries than additional science is.

I should also mention that it used to be very painful when we used to run a migratory bird workshop that involved a lot of Latin Americans. When people from Central America would come up and describe to me the curtains that people had, in their houses in different parts of Central America, they were basically made of bird bands.

So, those are some of the challenges that we have. A number of our bird initiatives have tried to address them. Yet, if you look at this alphabet soup of bird initiatives, more than 90 percent of them have been created here in the United States or jointly with Canada. With the perception that, over time, that they could be adapted to or could be made in such a way that other countries that share our birds would want to be a partner in them. Frankly, in this day and age, we need a different approach to involving other countries in collaboration on bird conservation. If you really want to have partnership, which we've talked about so much here, other institutions and other countries have to be partners from the beginning.

Where does that leave us with regard to the point that David raised about something new and exciting? It was felt that some new dialogue on the hemispheric level needed to take place. Less than a year and a half ago, a meeting was hosted by some of the agencies of the United States with some support from U.S. nongovernment organizations and participants in Chile. A year and a half ago, in October 2003, a meeting was held of the wildlife directors of the western hemisphere to get them together and to say how we might collaborate and cooperate on conservation.

And, the questions were: "Is it going to be migratory birds, is it going to be certain taxa of birds, is it going to be migratory species and is it going to be biodiversity?" The questions were left open; in fact, one of the most interesting parts of that discussion over the course of a week was exactly what would the wildlife directors of the hemisphere want to cooperate on. In the end, they decided to focus on all migratory species. That means birds, bats, marine mammals and potentially migratory invertebrates—interestingly enough with the intention to consider cooperating even more broadly. But, migratory birds were certainly the basis of this discussion.

There was an agreement to collaborate on migratory species. There was also a process by which 21 different important priorities were identified by this group. It included different categories—everything from law enforcement and laws that were needed to cooperate on monitoring and research and so on.

All the nongovernmental groups that were at the meeting were invited to suggest how they might help to deliver those 21 priorities for two important reasons. One reason was so that we could have a sense of who was doing what with regard to these 21 priorities. Secondly, we had to find out where the missing elements were. Are there certain things missing with regards to protected areas management? With regard to capacity building, or whatever? So, opportunity one was to see where you could tap into resources, the tools to address the needs that were identified. Opportunity two, if in fact tools were not available, enabled groups interested in this issue to go out and create some new tools.

A third outcome was to in fact create an interim steering committee. The purpose of that interim steering committee was to give long-term life to this new initiative. Here's a new acronym—WHIMSI, the Western Hemisphere Migratory Species Initiative. Whether it will stay that acronym remains to be seen, but that's what it is at the moment. The bottom line is this interim steering committee was charged with giving life to this initiative over time, basically to create a permanent forum or a long-term forum for cooperation, collaboration and partnership on migratory species conservation.

The composition of the interim steering committee is fascinating. There was a lot of intense discussion. In fact, a huge dead end during the course of the meeting was trying to figure out how to have fair representation on this committee. Ultimately, the committee has a very unusual and extremely unique construction. It includes five government representatives from different parts of the hemisphere, four nongovernmental representatives, representing different international organizations working in migratory species conservation, including a representative dealing with sea turtles.

It includes three international conventions. Normally, an initiative like this falls under one convention. A convention is the host or the sponsor of an international effort like this. This has been completely flipped so that the international conventions instead are a part of the delivery mechanism for how this initiative gets implemented. It is a very dramatic shift from how such efforts normally function.

The three conventions involved at the moment include the Bramsar convention, which is the convention on wetlands of international importance, the western hemisphere sea turtle convention and the migratory bird convention, or the BON convention.

That steering committee was charged with giving permanency to the initiative. This past August, the committee met and drafted a document that would outline the structure for such a committee. Its membership would include anyone and any group, any individual interested in migratory species conservation anywhere in the hemisphere.

To date, a letter has been sent out from the steering committee and from the minister of the environment of Costa Rica, who is extremely supportive of this effort, to all the environmental ministers of the western hemisphere. That letter was sent out in late 2004, giving them background similar to what I've described to you on this effort and requesting their response. Those responses are beginning to trickle in from the different countries of the hemisphere and, thus far, have been quite positive.

Without going into more length, I will also include that the follow up to Chile—Chile II—will more likely than not be in the beginning of 2006. The first meeting was of wildlife directors. More likely than not the follow-up meeting, while it will still include wildlife directors, will almost certainly include all interested partners in the issue of conservation of migratory species in the hemisphere.

As a final point, that meeting, more likely than not, won't focus on a taxonomic perspective. Will all birds be included? Of course, all birds will be included. In fact, all migratory species likely will be included. The focus almost certainly will be drawn from those 21 priorities that were identified in the Chile meeting last year. One of the essential areas that has not received strong attention that's become clear is capacity building, which is one of the real serious problems in Latin America. As likely as not, that will be the central theme of basically Chile II, which we hope to have early in 2006.

I believe that covers the ground. Thank you very much.

Session Six.
Stemming the Tide of Nonnative Invasive Plants

Chair
Linda R. Drees
U.S. National Park Service

Cochair
Eric M. Lane
Colorado Department of Agriculture
Denver, Colorado

What Wildlife Agencies' Role in Invasive Species Management Is and Why It Matters

Steven A. Williams
U.S. Fish and Wildlife Service
Washington, DC

Good morning. I began to understand the extent of the challenges posed by invasive species only when I worked for Kansas. There, we were involved in controlling the *Sericea lespedeza*, or Chinese lespedeza, which is a perennial legume native to East Asia, which remains a major threat to the Flint Hills tallgrass prairie. In fact, *Sericea lespedeza* was the first federally listed forage crop to be declared a noxious weed. While in some places in the country the plant is used as forage, the Kansas cows aren't biting. This seemingly innocuous plant proved to be a land manager's nightmare, like so many other invasive species.

Our experience in Kansas—a state that is more than 90 percent privately owned—is just one example of the critical need for wildlife agencies to be involved in the fight against invasive species on both public and private lands. David Lodge, chair of the National Invasive Species Advisory Committee and an ecology and biology professor at University of Notre Dame, has called invasive species and their environmental damage, "the most irreversible form of pollution." Cornell University reported a few years back that exotic plants and animals on land and water cost the United States up to $138 billion annually, impacting human health, commercial activities, community infrastructures, natural resources and agriculture production. And, the Federal Interagency Committee for the Management of Noxious and Exotic Weeds has reported that between 200 and 250 invasive plant species are recognized as major problems in world agriculture. The displacement of native vegetation by invasive plants can have truly unfortunate consequences for animal communities. In fact, invasive species today are regarded as the second leading cause of species being listed as threatened or endangered.

Examples of devastation by invasive vegetation seem as boundless as their ability to spread. But, while their spread seems inevitable, federal agencies must continue supporting efforts to manage the problem and to deliver the resources and science necessary to stem the tide. There are two major organizations committed to this: the National Invasive Species Council and the Invasive Species Advisory Committee.

The Invasive Species Advisory Committee is composed of approximately thirty stakeholders from state organizations, industry, conservation groups, scientists, academia and other interests. It serves as advisor to The National Invasive Species Council, created in 1999, as an interdepartmental council that helps to coordinate and ensure complementary, cost-efficient and effective federal activities in regards to invasive species. Members include the secretaries of the U.S. departments of Agriculture, Commerce, Interior, State, Defense, Homeland Security, Treasury, Transportation and Health and Human Services, as well as the administrators of the U.S. Environmental Protection Agency, the U.S. agency for International Development, the U.S. Trade Representative and the National Aeronautics and Space Administration.

The council was directed to draft the National Invasive Species Management Plan, which called for an invasive species crosscut budget to be developed for fiscal year 2004. The Office of Management and Budget (OMB) encouraged the council to develop shared goal statements, strategies and common performance measures among agencies as part of the budget process. The result was a first-of-its-kind interagency performance budget that directed more efficient allocation of resources through improved interagency cooperation.

That served as a starting point for a much more comprehensive and cooperative effort than OMB encouraged.

Much of this money will fund continuing on-the-ground efforts that consist of a few strategies: surveillance, early detection and rapid response and long-term control measures.

Surveillance

In addition to addressing known infestations, we need to look beyond known weed infestations and to cooperatively keep a vigilant watch on all lands that are susceptible to weed invasion. How urgent is it to control weeds, especially small infestations? First, we need to remember that, unique among environmental degradation problems, weeds are self multiplying. They don't stop at some point like wildfire, nor do they deteriorate over time like chemicals. Second, severe and extensive weed infestations begin with just a few plants. Therefore, the thousands of small or new infestations currently growing out of control on relatively uninfested land truly constitute a state of biological emergency.

Early Detection and Rapid Response

Because invasive species are the number-one threat to habitat management on our national wildlife refuges, the National Wildlife Refuge System (Refuge System) is fighting back through a program based on integrated pest management. This involves prevention, early detection and rapid response by mechanical removal, and biological or chemical controls. The Refuge System's National Strategy for Management of Invasive Species illustrates how refuges that have used these tactics have experienced greater success in battling invasive species and in minimizing costs.

For example, Sevilleta National Wildlife Refuge in New Mexico has significantly reduced infestations of perennial pepperweed and of other invasive species through a cooperative mapping and control partnership with the Soil and Water Conservation District and others. Also, an early detection and response program established on Klamath Basin National Wildlife Refuge prevented the spread of yellow star thistle and spotted knapweed. Plus, establishment of the National Bison Range/Northwest Montana Wetland Management District Joint Control Program prevented the spread of purple loosestrife on the refuge.

The Refuge System is developing a nationwide system for early detection and rapid response based on a strong coalition of organized citizen volunteers and geographically based strike teams. Early detection in the invasive species program is critical and relies heavily on inventory and descriptions of the location, status and spread of invasive species infestations. With help from partners, the Refuge System has launched a pilot program on six refuges to use volunteers to map the occurrence of invasive species with geographic positioning system (GPS) units and pocket PCs.

Long-term Control Measures

Long-term control measures will remain a consistent part of the battle and will depend on the ecology of the infested areas. Some infestations can be treated with herbicides; others can be treated with prescribed burns or mechanical removal. No matter where the infestations are though, long-term control measures will be necessary in helping prevent the spread.

As federal agencies collaborate in resourceful cross-budgeting, I am reminded of the long-term control measures that perhaps hold the greatest promise, particularly for privately owned lands: cooperative programs that involve the people closest to the problem.

This hope is at the heart of many current federal programs that deliver resources to state agencies and private landowners, who in turn may become better equipped for the battle against invasive species. The U.S. Department of the Interior's (DOI's) Conservation Challenge Cost-share Program, for example, emphasizes local input and cooperative decision making to achieve land management and resource goals. For 2006, the budget proposes $44.8 million for these programs. These cost-share programs better enable agencies to work together and with adjacent communities, landowners and citizens to achieve common conservation goals.

A total of $21.5 million is proposed for resource restoration challenge cost-share projects to fund dynamic partnerships with individuals, tribes, state and local governments, nonprofit organizations, and others to carry out projects that restore damaged habitats and lands and that achieve the conservation goals of the land management agencies. Projects require a one-to-one match or better, thereby at least doubling the impact of federal dollars. The cost-share program, as with DOI's other cooperative conservation grants, is a linchpin of a new environmentalism of performance, partnerships, innovation and incentives.

In 2004, the Conservation Challenge Cost-share Program funded 633 projects with more than 1,913 partners in 44 states. Matching funds supported 60 percent of the cost of these projects. A total of $21.0 million in federal dollars were matched by $31.6 million in nonfederal dollars. The resource restoration challenge cost-share program is complemented by a $23.3-million request for the traditional challenge cost-share programs that focus on cultural, recreation and resource protection projects.

In central New Mexico, for example, riparian habitat dominated by native vegetation is being restored along the Rio Grande as a result of a large-scale cooperative project at the arid riparian and wetland land management and research demonstration area of Bosque del Apache National Wildlife Refuge (NWR). Project partners are the Range Improvement Task Force of New Mexico State University, Friends of the Bosque del Apache NWR, and the U.S. Fish and Wildlife Service (FWS). The project demonstrates innovative salt cedar control and riparian restoration techniques on 1,100 acres (445 ha) of the Bosque del Apache NWR. A strong educational component results in the sharing of knowledge on control and restoration methodology with other federal, state, local and nongovernmental land management entities, as well as private landowners in similar arid areas of the southwestern United States. Partners and volunteers aided in developing 300 acres (121 ha) as seasonal wetlands, in restoring 300 acres (121 ha) using controlled flooding for natural regeneration, and in replanting 500 acres with native plant communities. The federal investment of $300,000 was matched for a total of $600,000.

Like the Conservation Challenge Cost-share Program, FWS's Partners for Fish and Wildlife (Partners) gives landowners tools to manage private lands that benefit wildlife while maintaining productive activities. The program recognizes that, with over 60 percent of U.S. land in private ownership, the health of many populations depends on habitat found on private lands. State resource agencies work closely with FWS to establish priorities and to identify focus areas. Over the last 3 years, the program has undertaken thousands of restoration projects and has restored over 130 acres (52 ha) of wetlands and 605,000 acres (244,834 ha) of prairie, grasslands and uplands. The 2006 request is $52.2 million, an increase of $4.2 million or 9 percent over the 2005 level. These funds will allow

FWS to expand its established relationships with communities and with over 33,000 landowners, providing financial and technical assistance and restoration expertise to an additional 2,600 private landowners, tribes and other conservation programs.

Today, it gives me a great sense of satisfaction that, though our Partners program, FWS is working effectively with Kansas on the control of *Sericea lespedeza.* Through FWS's Partners for Fish and Wildlife program, the Tallgrass Legacy Alliance (Alliance) was created to conserve the tallgrass prairie ecosystem in Kansas. The Alliance works though local ranchers, the state, FWS, and a long list of other partners on various land issues, including the control of *Sericea lespedeza.* The Alliance shows the promise of success too, as it works with a philosophy that states: If we are to save the Kansas tallgrass prairie, the first step will be to keep the ranchers on the landscape; everything else becomes secondary.

This statement echoes the truest tenet in the battle against invasive species: people must be responsible for their land. It may sound unreasonable to control weeds in vast landscapes but consider this. In local watersheds, someone, be it landowner or civil servant, is responsible for every piece of land, and, in general, some employee or public land user looks at all lands at least once a year. Weed management can be a reasonable and successful endeavor, but comprehensive cooperation is the key.

A refuge manager once told me as he yanked a clump of musk thistle out of the ground: "all that's green is not good." We know it; our budgets, our resource-sharing efforts and our private landowner programs reflect it. And, the public must be engaged with us in it. We simply must continue to develop ways to work collaboratively and pull together to get to the root of the problem.

Thank you.

Programs to Assist States on Invasive Species

Hilda Diaz-Soltero
U.S. Department of Agriculture
Washington, DC

Introduction

Good morning. As former Secretary of Puerto Rico Department of Natural Resources, I am delighted to be with you here to discuss some of the U.S. Department of Agriculture (USDA) programs that may be available to assist you at the state and local levels to deal with invasive species issues.

USDA has compiled a document that presents the most complete list of grant opportunities for work on research on, technical assistance for or management of invasive species. The document has been published, and I brought 50 copies for you today. This grant-opportunities document is also made available through the Website http://www.invasivespecies.gov.

This workbook contains basic information on programs in USDA that could be used to fund invasive-species-related projects. This list should be a helpful place to start a search for resources for invasive species activities but by no means represents the complete universe of potential invasive species funding opportunities. USDA contacts listed below can assist you in determining which opportunities may fit best with your needs. Please, use this workbook to help in your important and vital work in safeguarding natural, recreational and agricultural resources.

U.S. Department of Agriculture Grant and Partnership Programs That Can Address Invasive Species Research, Technical Assistance, Prevention and Control

Program of Research on the Economics of Invasive Species Management
Agency. USDA, Economic Research Service (ERS)
Funding method. national competitive funding
Match. none
Authority. Omnibus Budget Appropriations Act, fiscal year 2004 (Puplic Law 108-7)

Eligible entities. any public or private research institution or organization, or individuals meeting peer-reviewed professional criteria, such as economic researchers

Taxa. the program is not taxa-specific nor geared toward particular taxa

Contact information. Craig Osteen, costeen@ers.usda.gov, and Donna Roberts, droberts@ers.usda.gov

Purpose. to provide analysis of economic issues related to managing invasive pests in increasingly global agricultural markets, in order to inform national decision-makers concerned with invasive species of agricultural significance, affecting or affected by USDA programs.

Cooperative Forest Health Management Program

Agency. USDA, Forest Service (FS)

Funding method. national competition

Match. 50 percent if less than 500 acres (202 ha); 33 percent if over 500 acres (202 ha); 25 percent if nonfederal public lands

Authority. Cooperative Forestry Assistance Act of 1978

Eligible entities. cooperative weed-management areas, states, nonprofit organizations

Taxa. invasive plants and weeds, plant pathogens and diseases, insects

Contact information. Rob Mangold, (703) 605-5340, rmangold@fs.fed.us

Purpose: to fund weed management activities on state and private forested lands

National Research Initiative (NRI)—Biology of Weedy and Invasive Plants

Agency. USDA Cooperative State Research, Education and Extension Service (CSREES)

Funding method. national competition

Match. cost sharing or matching is not required

Authority. Section 401 of the Agricultural Research, Extension and Education Reform Act of 1998 (AREERA) (7 U.S. Code 7621)

Eligible entities. state agricultural experiment stations, all colleges and universities, other research institutions and organizations, federal agencies, national laboratories, private organizations or corporations, individuals

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens, diseases, aquatic species

Contact information. Diana Jerkins, National Program Leader, (202) 401-6996, djerkins@csrees.usda.gov

Purpose. This program aims: (1) to support research on general processes and principles that contribute to plant competitiveness or invasiveness and (2) to support the development of novel methods to alter plant species competitiveness, invasiveness or abundance.

National Research Initiative—Integrative Biology of Arthropods and Nematodes

Agency. USDA, CSREES

Funding method. national competition

Match. cost sharing or matching is not required

Authority. Section 401 of AREERA (7 U.S. Code 7621)

Eligible entities. state agricultural experiment stations, all colleges and universities, research institutions and organizations, federal agencies, national laboratories, private organizations or corporations, individuals

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens, diseases, aquatic species

Contact information. Mary Purcell-Miramontes, National Program Leader, (202) 401-5168, mpurcell@csrees.usda.gov

Purpose. This program invites both fundamental and mission-linked proposals for innovative research in the following priority areas: (1) population biology, (2) biological control, (3) chemical ecology, (4) behavioral ecology and (5) fundamental resistance management studies (Proposals on this topic must show how results will be applied to development of resistance management programs.). Priority will be given to projects that demonstrate relevance to U.S. agriculture. Model organisms will be considered for support only if clear justification is given for how information gained will be applied to agriculturally relevant species. Proposed studies must include a justification for how anticipated results will be relevant to reduced stress on plants or livestock. Proposals that include a modeling component must give consideration to validation of the model.

Regional Integrated Pest Management Competitive Grant Program

Agency. USDA, CSREES

Funding method. regional competition

Match. No matching requirements

Authority. Authority for the funding of research projects is contained in Section 2 (c)(1)(B) of the Act of August 4, 1965, Public Law No. 890106, as amended (7 U.S. Code 450i (c)(1) (B)). Authority for the funding of extension projects is contained in Section 3(d) of the Smith-Lever Act of May 8, 1914. Chapter 79, 38 Stat. 372, 7 U.S. Code 341 et seq. For combined effort applications, separate awards will be executed for Public Law 89-106 and Smith-Lever funds.

Eligible entities. state agricultural experiment stations, land-grant colleges and universities, research foundations established by land-grant colleges and universities (Eligibility for extension projects is limited to land grant colleges and universities.), colleges and universities receiving funds under the Act of October 10, 1962 (16 U.S. Code 582a et seq.), and accredited schools or colleges of veterinary medicine.

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens, diseases, aquatic species

Contact information. Mike Fitzner, National Program Leader, (202) 401-4939, mfitzner@csrees.usda.gov

Purpose. The Regional Integrated Pest Management (IPM) Competitive Grants Program supports the continuum of research and extension efforts needed to increase the implementation of IPM methods, from the development of individual pest control tactics and the integration of tactics into an IPM system to extension, education and training. Four regions (northcentral, northeastern, southern, western) of the land-grant university system, in partnership with CSREES, administer the program. The goal of the Regional IPM Competitive Grants Program is to provide support for projects that develop and help users implement IPM systems that: (1) are profitable and environmentally sound over the long term, (2) reduce reliance on pesticides and (3) protect and conserve ecosystem quality and diversity. It is recognized that the specific needs of each region vary; thus, specific program priorities will vary among the regions.

Wetlands Reserve Program

Agency. USDA, Natural Resources Conservation Service (NRCS)

Funding method. within-state competition, based upon state-specific priorities whereby state conservationists, with input from state technical committees, develop ranking criteria based upon broad national guidelines for permanent-easement, 30-year easement and restoration cost-share agreements.

Match. USDA pays 75 percent of restoration costs; landowners pay 25 percent.

Authority. reauthorized in the Farm Security and Reinvestment Act of 2002

Eligible entities. landowners of nonfederal lands and tribes

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Leslie Deavers, (202) 720-1067, leslie.deavers@usda.gov

Purpose. offers landowners the voluntary opportunity to protect, to restore and to enhance wetlands on their property to achieve the greatest wetland functions and values, along with optimum wildlife habitat, on every acre enrolled in the program

Conservation Reserve Program

Agency. USDA, Farm Service Agency (FSA) administers Conservation Reserve Program (CRP), while technical support functions are provided by USDA, NRCS; USDA, CSREES, state forestry agencies; local soil and water conservation districts; and private sector providers of technical assistance.

Funding method. provides annual payments for retirement of environmentally sensitive croplands and cost share for establishing and maintaining cover, restores herbaceous vegetation for 10 years and restores forested vegetation for 15 years

Match. 50 percent of establishment costs plus annual payment, based on soil rental rate and limited to $50,000 per accepted application per fiscal year

Authority. Food Security Act of 1985, as amended, and regulations published in 7 Code of Federal Regulations, part 1410

Eligible entities. individuals and groups who have owned highly erodible or cropped wetlands for at least 1 year

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Robert Stephenson, Conservation and Environmental Programs Division, FSA, (202) 720-6221, robert.stephenson@usda.gov, and Malcolm Henning, National Program Manager, NRCS, (202) 720-1872, malcolm.henning@usda.gov

Purpose. CRP reduces soil erosion, protects the nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multiyear contract. Cost sharing is provided to establish the vegetative cover practices.

Wildlife Habitat Incentives Program

Agency. USDA, NRCS

Funding method. within-state competition, based upon state-specific priorities whereby state conservationists, with input from state technical committees, develop ranking criteria that is based upon broad national guidelines to create Wildlife Habitat Incentives Program (WHIP) agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed

Match. provides both technical assistance and up to 75 percent of the cost-share assistance to establish and to improve fish and wildlife habitat.

Authority. reauthorized by Farm Security and Rural Investment Act of 2002

Eligible entities. private landowners, owners of federal land when the primary benefit is on private or tribal lands, owners of state and local government land on a limited basis, owners of tribal land

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Martha Joseph, (202) 720-7157, martha.joseph@usda.gov

Purpose. a voluntary program for people who want to develop and to improve wildlife habitat primarily on private land

Environmental Quality Incentives Program

Agency. USDA, NRCS

Funding method. within-state competition, based upon state-specific priorities whereby state conservationists, with input from state technical committees, develop ranking criteria based upon broad national guidelines

Match. The Environmental Quality Incentives Program (EQIP) may cost-share up to 75 percent of the costs of certain conservation practices. Limited resource producers and beginning farmers and ranchers may be eligible for cost-share up to 90 percent.

Authority. reauthorized in the Farm Security and Rural Investment Act (Farm Bill) of 2002

Eligible entities. Persons who are engaged in livestock or agricultural production on eligible land

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Gary Kobylski, Acting National EQIP Manager, (202) 720-1840, gary.kobylski@usda.gov

Purpose. to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals and to offer financial and technical help to assist eligible participants in installing or implementing structural and management practices on eligible agricultural land

Conservation Reserve Enhancement Program

Agency. USDA, FSA, with technical support from NRCS

Funding method. A specific Conservation Reserve Enhancement Program (CREP) project begins when a state, tribe, local government or local nongovernmental entity identifies an agriculture-related environmental issue of state or national significance. These parties and FSA then develop a project proposal to address particular environmental issues and goals. Enrollment is limited to specific geographic areas and practices. CREP contracts require a 10- to 15-year commitment to keep lands out of agricultural production. CREP provides payments to participants who offer eligible land.

Match. A federal annual rental rate, including a maintenance incentive payment, determined by an FSA state committee, is offered, plus cost-share of up to 50 percent of the eligible costs to install the practice. Further, the program generally offers a sign-up incentive for participants to install specific practices.

Authority. U.S. Code Title 16, Chapter 58, Subchapter IV, Part I, Subpart b

Eligible entities. The program is a partnership among producers: tribal, state and federal governments, and private groups. CREP addresses high-priority conservation issues of both local and national significance, such as the loss of critical habitat for threatened and endangered wildlife species, the loss of soil through erosion, and the reduced habitat for fish populations, such as salmon. The land must have been owned or operated by the applicant for the previous year, must have been planted in crops for 2 of the last 5 years and must be physically and legally capable of being planted in a normal manner.

Taxa. invasive plants and weeds

Purpose. CREP is a voluntary land retirement program that helps agricultural producers protect environmentally sensitive land, decrease erosion, restore wildlife habitat and safeguard ground and surface water. Unique state and federal partnerships allow producers to receive incentive payments for installing specific conservation practices. Through CREP, farmers can receive annual rental payments and cost-share assistance to establish long-term, resource-conserving covers on eligible land.

Conservation Innovation Grants

Agency. USDA, NRCS

Funding method. EQIP funds are used to award competitive grants to nonfederal governmental or nongovernmental organizations, tribes or individuals. Conservation Innovation Grants (CIGs) enable NRCS to work with other public and private entities to accelerate technology transfer and adoption of promising technologies and approaches to address some of the United States' most pressing natural resource concerns.

Match. Selected applicants may receive grants up to 50 percent of the total project cost. Applicants must provide nonfederal matching funds for at least 50 percent of the project cost. An exception allows for beginning and limiting resource farmers and ranchers, tribes and community-based organizations that represent these groups to obtain a higher percentage of matching funds from in-kind contributions. The federal contribution may not exceed $1 million for a single project.

Authority. authorized as part of the EQIP with an unspecified annual funding level from fiscal year 2003 through fiscal year 2007

Eligible entities. EQIP funds are used to award competitive grants to nonfederal governmental or nongovernmental organizations, tribes or individuals.

The project must include participation of producers eligible under EQIP and may be watershed-based, regional, multistate or nationwide in scope.

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Kari Cohen, Natural Resources Specialist, (202) 720-2335, cig@usda.gov or kari.cohen@usda.gov

Purpose. CIG is a voluntary program intended to stimulate the development and adoption of innovative conservation approaches and technologies while leveraging federal investment in environmental enhancement and protection, in conjunction with agricultural production. CIG enables NRCS to work with other public and private entities to accelerate technology transfer and adoption of promising technologies and approaches to address some of the United States' most pressing natural resource concerns.

Grassland Reserve Program

Agency. USDA, NRCS; FSA and FS

Funding method. Applications will be rated, based on ranking and selection criteria developed in the states, following broad national guidelines. USDA proposes that land-eligibility criteria should focus on preserving the United States' most critical grassland resources, the native and natural grasslands, and the shrublands.

Match. Participants may choose a 10-, 15-, 20-, or 30-year contract, with USDA providing annual payments of not more than 75 percent of the grazing value of the land covered by the agreement for the length of the agreement.

Authority. authorized by Section 2401 of the Farm Security and Rural Investment Act of 2002 (Public Law 107-171), amending the Food Security Act of 1985

Eligible entities. Offers for enrollment must contain at least 40 contiguous acres (16 ha), unless special circumstances exist that allow accepting a smaller acreage, as determined by the NRCS state conservationist.

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Floyd Wood, NRCS, (202) 720-0242, floyd.wood@usda.gov, and Jim Williams, FSA, (202) 720-9562, jim.williams@wdc.usda.gov

Purpose. GRP helps landowners restore and protect grassland, rangeland, pastureland, shrubland and certain other lands, and it provides assistance for rehabilitating grasslands.

Conservation Technical Assistance

Agency. USDA, NRCS

Funding method. Assistance is provided to land users voluntarily applying conservation and to those who must comply with local or state laws and regulations.

Match. not applicable

Authority. NRCS and Conservation Technical Assistance (CTA) programs established by USDA Reorganization Act of 1994 (7 U.S. Code 6962), which combined the authorities of the former Soil Conservation Service (Soil Conservation Act of 1935) with seven cost-share programs for natural resource conservation.

Eligible entities. This program provides technical assistance to participants in USDA cost share and to conservation incentive programs. Assistance is funded on a reimbursable basis from the Commodity Credit Corporation. Private land users, communities, state and local governments, and other federal agencies are eligible recipients.

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Walley Turner, National Program Manager, (202) 720-1875, walley.turner@usda.gov, or local USDA, NRCS office

Purpose. The CTA program provides voluntary conservation technical assistance to land users, communities, state and local governments, and other federal agencies in planning and implementing conservation systems. This assistance is for planning and implementing conservation practices that address natural resource issues. It helps land users to voluntarily conserve, to improve and to sustain natural resources. Technical assistance is for planning and implementing natural resource solutions to reduce erosion, to improve soil health, to improve water quantity and quality, to improve and to conserve wetlands, to enhance fish and wildlife habitat, to improve air quality, to improve pasture and range health, to reduce upstream flooding, to improve woodlands, and to address other natural resource issues. The CTA program supports the National Resources Inventory (NRI). The NRI is a statistically based survey to assess conditions and trends of soil, water and related resources on nonfederal lands in the United States.

Plant Materials Program

Agency. USDA, NRCS

Funding method. NRCS field offices receive technical information and transfer it to end users, such as farmers and ranchers.

Match: not applicable

Authority. The program operates under the basic authority of Public Law 74-46, April 27, 1935, Chapter, 85, Section 1, 49 Stat. 163, 16 U.S. Code 590 [a-f]. Other authorities include: 7 Code of Federal Regulations, Part 613, Public Law 95-192, Public Law 74-210 (7 U.S. Code 1010-1011), and 7 U.S. Code 6962.

Eligible entities. It is limited to conservation cooperators' properties in conjunction with conservation districts, state agricultural experiment stations, state crop improvement associations and other federal and state agencies. Plants or seeds are not provided to the general public, and the public is not eligible to participate in the program.

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Robert Escheman, National Plant Materials Specialist, (609) 561-3223, extension 20, robert.escheman@usda.gov

Purpose. It provides technical assistance through plant science technology to NRCS field offices for transfer to end users, such as landowners and land managers. The program provides vegetative solutions for natural resource problems. It develops plant materials and information technology on how to establish and to manage plants. The program emphasizes field testing to determine a plant's value and restoration techniques.

Conservation on Private Lands Program

Agency. USDA, NRCS

Funding method. competitive grants administered by the National Fish and Wildlife Foundation

Match. at least 50 percent match required

Authority. Soil Conservation and Domestic Allotment Act, 16 U.S. Code 590a-590f; Agriculture, Rural Development, Food and Drug Administration, and Related Agencies Appropriations Act

Eligible entities. private landowners, primarily farmers and ranchers

Taxa. invasive plants and weeds, plant pathogens and diseases, insects, animals, animal pathogens and diseases, aquatic species

Contact information. Jody Olson, National Fish and Wildlife Foundation, (202) 857-0166, extension 555, Jody.Olson@nfwf.org

Purpose. Conservation and enhancement of wildlife and natural resources on private lands.

Cooperative Agricultural Pest Survey

Agency. USDA-Animal and Plant Health Inspection Service (APHIS)

Funding method. cooperative agreements

Match. No matching funds are necessary.

Authority. Plant Protection Act (7 U.S.C. 7701 et seq.)

Eligible entities. state departments of agriculture and their cooperating partners (occasionally universities)

Taxa. invasive plants and weeds, plant pathogens and diseases, insects

Contact information. Coanne O'Hern, (301) 734-4387

Purpose. The pest detection program works to ensure the early detection of harmful or economically significant plant pests and weeds through a nationally directed survey program through the Cooperative Agricultural Pest Survey network. The program works with state and university cooperators through national-, regional- and state-level committees to prioritize survey projects and to provide funds for state cooperators to conduct the agreed-upon surveys. The program also trains and equips state cooperators to conduct national surveys.

Various Plant Health Programs

Agency. USDA-APHIS

Funding method: cooperative agreements

Match. No matching funds are necessary in most cases.

Authority. Plant Protection Act (7 U.S. Code 7701 et seq.)
Eligible entities. state departments of agriculture
Taxa. invasive plants and weeds, plant pathogens and diseases, insects
Contact information. Assistant Deputy Administrator, Pest Detection and Management Programs, (301) 734-3769
Purpose. APHIS conducts a variety of survey, eradication, management and control programs for invasive plant pests, diseases and weeds. Depending on the program, state cooperators may conduct portions of the programs through cooperative agreements with APHIS. For example, APHIS provides funding for affected states to conduct eradication activities for Asian longhorned beetle, emerald ash borer and citrus canker.

Animal Health Monitoring and Surveillance
Agency. USDA-APHIS
Funding method. cooperative agreements
Match. No matching funds are required.
Authority. Animal Health Protection Act (7 U.S. Code 8301 et seq.)
Eligible entities. state departments of agriculture
Taxa. pests and diseases of livestock
Contact information. Debra Cox, (301) 734-8093, debra.cox@aphis.usda.gov
Purpose. The program conducts monitoring and surveillance activities for a variety of animal diseases, both invasive and domestic. While most of these activities are carried out by APHIS personnel, the program provides funding to state cooperators for specific initiatives, such as bovine spongiform encephalopathy testing and pilot projects for animal identification.

Emergency Management Systems
Agency. USDA-APHIS
Funding method. cooperative agreements
Match. no matching funds are required
Authority. Animal Health Protection Act (7 U.S. Code 8301 et seq.)
Eligible entities. state departments of agriculture and tribal nations
Taxa. pests and diseases of livestock
Contact information. Glen Garris, (301) 734-5875, glen.i.garris@aphis.usda.gov

Purpose. The program cooperates with state partners and tribal governments to implement and enhance emergency response capabilities for serious foreign animal disease outbreaks.

Various Animal Health Programs

Agency. USDA-APHIS

Funding method. cooperative agreements

Match. no matching funds are required.

Authority. Animal Health Protection Act (7 U.S. Code 8301 et seq.)

Eligible entities. state departments of agriculture and tribal nations

Taxa. pests and diseases of livestock

Contact information. Associate Deputy Administrator for National Animal Health Policy and Programs, (301) 734-8093

Purpose. APHIS conducts a variety of survey, eradication, management and control programs for invasive animal diseases. Depending on the program, State cooperators may conduct portions of the programs through cooperative agreements with APHIS. For example, APHIS provides funding for affected states and tribes to conduct surveillance for chronic wasting disease and for states to conduct surveillance for scrapie.

Wildlife Services Operations

Agency. USDA-APHIS

Funding method. cooperative agreements

Match. Cooperators provide matching funds, normally 50 percent of a project's cost.

Authority. Animal Damage Control (ADC) Act of March 2, 1931, (7 U.S. Code 426-426b, and 426c as amended)

Eligible entities. state and local agencies, businesses, private citizens

Taxa. invasive animals

Contact information. Bob Myers, (301) 734-7921, robert.p.myers@aphis.usda.gov

Purpose. Wildlife services operations program protects U.S. agriculture, natural resources, property, and human safety and health from wildlife damage and wildlife-borne diseases. The program works with affected states to manage certain invasive species, such as nutria in the Chesapeake Bay area and to prevent the brown tree snake from becoming established in Hawaii.

Other Grant Information

Below are some additional resources to identify invasive species resource opportunities. This list represents only a sample of what is out there. Please, contact local, state and federal agencies directly for additional possibilities. Several foundations and other nonprofit institutions may also have programs to assist you in funding your activities. The best place to look for federal grants is the new Federal Grants Portal, http://www.grants.gov.

- Federal Grants Portal: At this Website, http://www.grants.gov, there are 26 federal, grant-making agencies and over 900 individual grant programs that award over $350 billion in grants each year. The grant community, including state, local and tribal governments, academia and research institutions, and not-for-profits, need only visit this Website to access the annual grant funds available across the federal government.
- National Invasive Species Council: Its Website, http://www.invasivespecies.gov, has a list of grant opportunities for salt cedar (*Tamarix* sp.) control, management, research and education.
- Pioneer Grants Program: The Chesapeake Bay Trust awards competitive grants (approximately $100,000 in 2004). The purpose of this program is to fund projects leading to achievement of Chesapeake 2000 Agreement restoration and protection goals and to complete projects or to develop implementation strategies for projects resulting in measurable nonpoint source nutrient reductions. Contact them at 410-974-2941, or visit http://www.chesapeakebaytrust.org.
- Chesapeake Bay Small Watershed Grants Program: It is administered by the National Fish and Wildlife Foundation, and it provides grants to organizations working on a local level to protect and to improve watersheds in the Chesapeake Bay Basin, while building citizen-based stewardship. Visit its Website at http://www.nfwf.org/programs/grant_apply.htm.
- Delaware Estuary Grants Program: It is administered by the National Fish and Wildlife Foundation, and it provides grants to organizations working on a local level to protect and to improve watersheds in the

Delaware Estuary, while building citizen-based resource stewardship. Visit its Website at http://www.nfwf.org/programs/grant_apply.htm.

- The Native Plant Conservation Initiative: It is administered by the National Fish and Wildlife Foundation, and it supports on-the-ground conservation projects that protect, enhance and restore native plant communities on public and private lands. Projects typically fall into one of three categories and may contain elements of each: protection and restoration, information and education, and inventory and assessment. Visit its Website at http://www.nfwf.org/programs/grant_apply.htm.
- The Pulling Together Initiative: It is administered by the National Fish and Wildlife Foundation, and it provides a means for federal agencies to be full partners with state and local agencies, with private landowners, and with other interested parties in developing long-term, weed-management projects within the scope of an integrated pest management strategy. Visit its Website at http://www.nfwf.org/programs/grant_apply.htm.
- The Center for Invasive Plant Management (at Montana State University): It has a variety of grant programs listed—recently about 50 grants (some are limited to western United States)---at http://www.weedcenter.org/grants/overview.html.

To update you on the Noxious Weed Control and Eradication Act, a new invasive weeds program has been approved with Senate bill 144. The House of Representatives approved a similar bill in 2004. The most significant changes in the House of Representatives version were to designate USDA as the implementing department, rather than the U.S. Department of the Interior, and to prohibit the use of funds for invasive weeds projects in national parks and national wildlife refuges. The bills were signed into law, the Noxious Weed Control and Eradication Act, on October 10, 2004, by President George W. Bush. It creates a 5-year program in USDA.

Grants can be provided to weed management entities for the control or eradication of noxious weeds. Grants can receive up to 50 percent of federal funds and be matched by money or in-kind contributions. The authorization for appropriation is $7.5 million per year in grants for 5 years.

Agreements can be established with weed management entities to provide financial and technical assistance for the control or eradication of noxious weeds. Agreements can be up to 100 percent federally funded. The authorization for appropriation is $7.5 million per year in agreements for 5 years.

The phrase "noxious weed" is defined in this law as it is defined in the Plant Protection Act. It requires state, regional and local involvement. Some of the activities that can be funded are education, inventory and mapping, management, monitoring, methods development (research), and capacity building, including payment of personnel and equipment.

The legislation enacted provides only authorization for appropriation of funds. To date, there have been no funds appropriated for USDA to implement this legislation.

I hope this information is helpful for those working with invasive species. Partnerships and cost-sharing programs help all of us advance our goals of protecting our natural and agricultural resources, and of ensuring safe, healthy land and water for all of us to enjoy. Join with USDA in fighting invasive species: prepare, protect and prevent. Thank you for all your hard work and all your future work in this important area.

Invasive Species Management for State Wildlife Agencies: The Goals and Challenges to Implementation

Duane L. Shroufe
Arizona Game and Fish Department
Phoenix, Arizona

Lawrence M. Riley
Arizona Game and Fish Department
Phoenix, Arizona

Introduction

Invasive species can and do impinge both directly and indirectly on our wildlife resources. Some believe this to be principally an issue for the federal government to address and that it controls the relevant authorities. I believe that to be a shortsighted view and will advocate that we, as state wildlife leaders, have a significant authority and role to exercise. While our federal partners have a leadership role to play in what is shaping up to be the significant wildlife management challenge of this century, they cannot be the only leaders. If we can exercise our authorities together in a coordinated and complementary approach, we can meet our expectations of providing wildlife resources for both current and future generations in the United States. The question we as state wildlife leaders is not, "Why should we join the battle," it is "When shall we fully engage."

Why Wildlife Leaders Need to Be Concerned

The time for debate about whether invasive species pose a challenge to the quality and quantity of our wildlife resources is over. We may debate which species we should consider invasive, we may debate which battles are prudent and winnable, and we may even debate how we will finance doing battle. But, clearly there are battles we must enter. We need look no farther than issues like West Nile virus, whirling disease, Asian Carp or nutria to see the direct impact of unwanted invaders on resources for which we are responsible. And, our collective memory of the public controversy and concern that has emerged from each of those issues provides fair warning of the controversies that may yet emerge for us. What is sometimes more difficult to grapple with is the invader that competes with or reduces habitat capacity for wildlife resources. Often we view these issues as being beyond our grasp, yet each of us would readily admit that we are and must be advocates and champions for wildlife habitat. Invaders that indirectly affect wildlife resources should be of no less concern to us as wildlife leaders, but these issues will drive us to better utilize our leadership and coordination skills than perhaps we ever have.

State Wildlife Leaders Need to Take Up the Challenge

The invasive species issues that face us pose some new and unusual challenges. Because this issue can be very broad, we are challenged to know what to focus our attention on as wildlife leaders, whether to do battle on an invasive species front, and how to make our choices about which battles to wage.

Collectively, we recognize that not all introduced species are invasive, but putting our hands around the definition eludes us, as does "when and how" to do battle. If we, as wildlife leaders, are not influential in the decisions about which plants or animals to identify as unwanted invaders then others will make those decisions for us. Someone else will be framing the battle, and we may find ourselves as collateral casualties. Failure to lead in this component of wildlife management will leave the state wildlife authorities in a vulnerable position.

It is sometimes immediately clear to us, as wildlife mangers, when a new species emerges on the scene that it poses a threat to resources for which we are responsible. But, more often, it takes us a while to reach the conclusion that a new species is indeed a threat, and quite often we don't know at all what to make of the possibilities. We are ill prepared to make a decision about what to fight or when to fight.

There is a need to develop within our agencies and ourselves both the capacity and capability to mount a battle when that is what is called for. Likewise, there is need to develop within ourselves the ability to identify the enemy. Too often we are willing to hang at the extremes; either all nonnative species are the "enemy," or only the ones that have proven to be invasive, whose feasibility of eradication or control has slipped our grasp, are the enemy.

We Have the Tools

We, and our partners, have grown in recent years. We have developed our ability to use tools to help us make judgments about potential impacts of new species. Many of you have developed that front-line experience on the aquatic front, waging battles whose lines have become a bit more clearly drawn. Your involvement and the International Association of Fish and Wildlife Agencies' involvement with the Aquatic Nuisance Species Task Force over the last 15 years have certainly heightened the awareness of some of us. Electrical barriers, chemical treatments, biological control agents, and ballast water technologies were novel or unknown concepts when some of us began our tenure as wildlife leaders; now they've become stock and trade for some of us.

New tools continue to emerge, though they are not and may never be perfect, to help us screen species before they are imported to our country or to our state. And, new tools are emerging to help us identify pathways for unwanted hitchhikers before they slip unnoticed into our country or into our states—under the skirts of commerce, recreation or wildlife management. New tools are emerging to help inform us and the public we serve. We are beginning to learn how to use some of these tools to better inform our public; although, sometimes we dwell on alarming them.

New tools are emerging to help our staffs and our partners to detect new and unwanted visitors as early as possible and to monitor them effectively.

As Wildlife Leaders, We Have to Know When to Employ the Tools

The challenge to us as wildlife leaders is to know when to engage in battle and why we ought to. We, as wildlife leaders, need to know which fights to pick, which fights we can win and where to pick our battlegrounds.

Many of us have found ourselves engaged in battle with invaders like zebra mussels, Asian carp and species that we have some direct jurisdiction over. Or we've chosen to do battle on the aquatic front with species that have clear impact to habitat for the animals that we have direct responsibility for. The time has come for us to recognize that engagement in battle on the terrestrial front has been looming for some time.

We have to bring the right tools to bear as the battle develops, whether that battle is focused on a specific plant or animal or whether that battle is focused on the minds of the people we serve. Our best approach and least costly tool is information. Raising the awareness of the public and channeling their energies into constructive action may be the single most effective tool that we will find available to us. That same public will help us facilitate making right choices about potential new invaders, stop the movement of hitchhikers, and detect new invaders in our environment.

Now Is the Time to Engage

Why should we as wildlife leaders pick up this gauntlet now? We simply do not have the authority to take on this fight—or do we?

- We clearly have the responsibility to conserve, manage and restore our states' wildlife resources.
- Without hesitation, we would commit that, conserving wildlife means conserving, restoring and protecting the habitat that wildlife depends upon.
- Unwanted and unplanned for invaders, and that includes weeds, can and do threaten our wildlife resources.
- They constrain or diminish habitat and capacity of the land to support the resources we are charged to conserve and manage as a public trust.
- We have the responsibility and will bear the outcomes of taking no action. We have sufficient authority to enter the fight.
- We are acquiring the knowledge and the tools to fight the fight.
- We can perfect the partnerships and alliances necessary to fully engage when prudent.

As wildlife leaders in this country, we need to see this challenge clearly. It is not a new challenge, but it is one that is quickly emerging in the public's eye, in the eyes of our customers—the people that we serve.

As wildlife leaders, we need to define our roles for the future. To conserve and restore the quality of U.S. waters, we need to continue the battle on the aquatic front. We need to extend our capacities and tools to engage in battle on the terrestrial front, and we need to broaden our alliances to conserve wildlife resources.

I am confident that we will be able to refine the tools and train the staff necessary to detect and monitor invaders. I believe we must improve our capacity to fairly and fully weigh risks posed by new species and by existing imports while being decisive about the battles we choose. Once we choose our battles, then we need to be prepared to marshal our resources to engage, to eradicate, to limit or to manage truly unwanted invaders.

Invasive species management is not a new box of tools; it is a new dimension to the use of many tools we have long used—a new set of tactics. If we are to ensure the future of wildlife resources for the people of our states, we need to take up this new set of battle tactics. We'll need to seek out new sources to finance this work and to avoid draining already overburdened traditional sources of financing. We need to be prepared to exercise the authority we have rather than bemoan the authorities we think we lack in order to conserve the resources in our seas, in our rivers and lakes, and on the land.

For us, the question should no longer be, "Why should we engage in the invasive species battle"; the question is, "When will we fully engage"?

The Colorado Division of Wildlife Helps to Control the Noxious Weed Purple Loosestrife in the Denver Metro Area

David Weber
Colorado Division of Wildlife (Retired)
Denver, Colorado

Purple loosestrife (*Lythrum salicaria*) is a European wetland plant that successfully invaded North America in the early 1800s, becoming a serious problem in marshes of New England, the Midwest and many other parts of the country. By the late 1800s, purple loosestrife had spread across the northeast and Canada. It had developed into a problem along the St. Lawrence River by the 1930s. Since then, it has expanded westward and is invading marshes, river floodplains and other moist soil environments throughout the midwestern and intermountain states. It has become established in several parts of Colorado, including the Denver metropolitan area.

Purple loosestrife is one of the major noxious weeds of North America. It invades shallow water wetlands and riparian areas, and it out-competes native vegetation by gradually shading it out. It will even out-compete cattails and bulrush. It forms dense monotypical stands, and it seriously degrades wetlands as wildlife habitat, drastically reduces biological diversity and clogs irrigation ditches. Purple loosestrife was first discovered in Colorado in 1990 in the Boulder area by Mark Gershman, an ecologist then with the City of Boulder Open Space Department. He and others tried to raise an alarm, but it was felt that its distribution was limited to only a couple of areas at the time, and no one got too interested. In 1992, two employees of the U. S. Fish and Wildlife Service, Dave Soker and Tom Jackson, discovered purple loosestrife growing along Bear Creek, a major drainage on the west side of Denver. On their own time, they raised the alarm, began educating people and organized a seed head cutting project that summer.

I was the Colorado Division of Wildlife (CDOW) habitat biologist for the Denver area in 1992. I got a call from Soker in July 1992, informing me that purple loosestrife had been discovered in the area and that it was a really big threat to wildlife habitat. He asked me to come help cut seed heads the following Saturday. I had never heard of purple loosestrife at the time, but I nevertheless showed up to cut seed heads along with about 80 other people. I learned what loosestrife looked like, started reading up on it and soon realized that this was a very big issue which needed attention.

After their 1992 efforts, Soker and Jackson told us that they had done their bit and that others would have to run with the ball on purple loosestrife from then on. In early 1993, several of us organized an informal Purple Loosestrife Control Committee, which agreed this was a serious problem that should be dealt with. Under the Colorado Weed Law, passed just 2 years earlier, the responsibility for dealing with weed problems fell to city and county governments and ultimately to the landowner. Two things were clear to us.

1. The counties and, especially, the cities involved were not geared up or motivated to aggressively deal with the problem.
2. Because loosestrife occurred in many metropolitan area cities and counties, a central entity was needed to provide leadership and coordination.

As the state wildlife agency habitat biologist for the Denver metropolitan area, I decided that I needed to do something about this problem. Under state law, the CDOW clearly has the legal authority and responsibility to deal with invasive noxious weeds which degrade wildlife habitat. The Colorado revised statutes 33-1-101, which authorizes the CDOW, asserts that it is the policy of the state of Colorado that the wildlife and their environment are to be protected, preserved, enhanced and managed for the use, benefit and enjoyment of the people of this state and its visitors.

I made a presentation to the CDOW staff, successfully convinced them this was a big issue and obtained approval to work on the problem, along with funding to hire a crew during the summer of 1993 to do field work. With CDOW support in place, the Purple Loosestrife Control Committee agreed on this strategy. All public agencies will control purple loosestrife on their own land. (Most purple loosestrife was on public lands.)

1. The CDOW will control loosestrife on private land with the owner's permission.
2. The CDOW will provide organization, training, record-keeping and generally be the leader in keeping things moving.

The strategy was implemented in the summer of 1993. Extensive searches of Denver area wetlands and waterways were made by CDOW personnel in search of additional infestations. Detailed records were kept of every reported sighting. Private landowners were contacted and permission obtained for CDOW personnel to enter their land to kill loosestrife. The CDOW crew killed purple loosestrife all summer, applying the herbicide Rodeo®, using backpack sprayers, mostly on private land. An informative purple loosestrife brochure was developed and distributed. Publication of a Purple Loosestrife Newsletter was begun and a mailing list created.

The strategy was followed for 11 years, through the summer of 2003. The CDOW continued to perform all the tasks mentioned above, and over the years also did the following:

- annually provided training in purple loosestrife identification and control
- held periodic strategy meetings to keep people up to date on the project and on how things were progressing
- investigated sighting reports and followed up as needed
- researched purple loosestrife control techniques
- prodded people or organizations who were falling down on the job
- helped some public agencies control their own purple loosestrife
- created Colorado Purple Loosestrife Fighter lapel pins and awarded them to anyone who helped in any way.

In 2004, the CDOW turned over the task of controlling purple loosestrife on private land to city and county governments, but it continued to perform the coordinating, training and record-keeping duties.

The strategy has been effective, and very good headway has been made in both stopping the spread of purple loosestrife to new wetlands and in reducing its abundance where it was present. In 2003, 258 loosestrife infestations were known. Of those, *no purple loosestrife at all* could be found at 109 sites, 42 percent of the total. Another 84 sites (33%) had less than 50 plants present. Only 14 sites still had over 1,000 loosestrife plants.

We feel that we now have the upper hand, and, with continued diligence for the next few years, we may be able to call loosestrife controlled in the Denver metropolitan area. Only a few new infestations are found each summer, and almost none of them consist of more than a few plants. Very significantly, the number of purple loosestrife seeds which float down the South Platte River from Denver each fall has been drastically reduced by our actions, hopefully preventing further spread to northeastern Colorado and Nebraska.

The CDOW spent, on average, $24,000 per summer to put a crew in the field and to perform the coordinating duties. Most of the funding for CDOW work came from hunting and fishing license fees, but we also obtained funding assistance from these sources:

- grants from the Colorado Noxious Weed Management Fund (state tax money)
- donations from city and county government
- grants from the Colorado Waterfowl Stamp program
- a small grant from the U.S. Environmental Protection Agency.

It was not easy to obtain annual CDOW funding for this project over such a long period of time. Some CDOW administrators were not convinced that this was a high-priority effort, and attempts were made to withdraw funding. This reflects the general lack of realization among many wildlife biologists that invasive plants are not just a minor nuisance, but a major and very serious threat to wildlife habitat across the country.

Why was this effort successful? I believe that a number of factors contributed, some of which follow.

- We picked a clear strategy and stuck to it.
- We spent a lot of time educating people about purple loosestrife and its control.
- We regularly published a newsletter and sent it free to everyone who was involved or should be involved.
- We took the problem very seriously and that rubbed off on other people.
- We had a continuity of personnel, as I was involved with the project from the very beginning.
- The Colorado Purple Loosestrife Fighter lapel pins are extremely popular and serve as an easy way to reward people who helped and impress upon them that this is an important effort.

The CDOW has been nominated for four national conservation awards for our work on this project to date—not actually winning any. We did, however, win four local conservation awards within Colorado over the years. It is very important to say that while the CDOW was the leader in this effort, many other people and organizations helped out in the fight over the years and deserve great credit. About 29 government agencies and other organizations have assisted to date. I suspect that this is one of the most successful cooperative weed management efforts ever attempted in North America.

Our situation in Denver is unusual in that we had a major noxious weed problem within a large metropolitan area—not a common situation. Although, it could happen elsewhere with purple loosestrife along urban waterways. I suspect that seldom would it be necessary for a state wildlife agency to become as involved as we are in battling a specific weed, but it is important that state wildlife agencies aggressively *get involved* in noxious weed problems to help avoid the disastrous degradation of wildlife habitat over large areas that is occurring and will continue if we are not vigilant. Get educated, get involved and make something happen!

Invasive Management on Tribal Lands: Flathead Indian Reservation Partnerships for Restoration

Brian E. Lipscomb
Department of Tribal Lands, Confederated Salish and Kootenai Tribes
Pablo, Montana

Since time immemorial, the Salish, Kootenai and Pend O'reilles Tribal people have relied on Mother Earth to sustain them, both physically and spiritually. The Flathead Indian Reservation, established in 1855 in western Montana by a treaty with the United States, is the geographic center of the tribal people's homeland. It was established to sustain this way of life for these tribal people. The reservation's 1.3 million acres (526,091 ha) are a diverse landscape extending from broad valley floors at an elevation of 2,500 feet (762 m) above sea level to high mountain peaks of just under 10,000 feet (3,048 m) above sea level.

An agrarian U.S. federal policy of the late 1800s was forced upon the tribes of the Flathead Indian Reservation, as well as on other tribes across the country, which affected the allotment and the homesteading of their lands. With this invasion from the dominating society also came the invasion of this society's economy, culture, treatment of the land and, ultimately, its nonnative invasive plants or noxious weeds as they are known in the west.

By 1950, a mere 30 years after the opening of the reservation, noxious weeds had gained a stronghold on the reservation landscape. Spotted knapweed (*Centaurea maculosa*), sulfer cinquefoil (*Ptenttilla recta*), whitetop (*Cadaria draba*) and yellow toadflax (*Linaria vulgaris*) started to make their way across the land. First invading the tilled agricultural lands across the valley bottoms, the weeds were viewed as the farmer's problem. Ther first invasion came where the land had been tilled and where the native vegetation was converted to cropland for profitable small grains, hay and seed potatoes. Easily adapting to the climate and having no natural deterrents, noxious weeds soon spread rapidly to areas far beyond the tilled agricultural land. Along with this rapid spread came the realization that noxious weeds were, and still are today, a real threat to the tribal peoples' way of life.

With chemical treatments bringing with them a host of additional, unknown consequences, and with a diverse array of habitats and ownership of the lands, weed treatment has been and continues to be a partnership in experiments.

The approaches to two distinct and separate noxious weed management scenarios will be examined in the following Microsoft PowerPoint presentation: treatment of purple loostrife (*Lythrum salicaria*) in the extensive wetlands of the valley floor and treatment of the many nonnative invasive species affecting the hundreds of thousands of acres of native palouse prairie found on the reservation. Both of these weed treatments have involved tribal, county, state and federal governments, as well as private individuals and educational institutions. The approaches have used chemical, mechanical, grazing and biological treatments, which have been effective in varying degrees.

Successful treatment of noxious weeds in the future is dependant on resources. The spread of weeds on the Flathead Indian Reservation has reached epidemic proportions, and restoration of the habitats they affect is critical.

Marketing the Message: Passing Successful Invasive Species Legislation in Maine

Ship Bright
Maine Lakes Conservancy Institute
Nobleboro, Maine

In 2000, three citizens and their attorney got together and created what became the basis of Maine's anti-invasive aquatic plant legislation known as the Milfoil Bill. This legislation and the funding mechanism that fuels it has become a notable piece of public policy that many other states have looked at.

The Milfoil Bill was a response to a weak executive branch initiative to induce Maine's reaction to invasive aquatic plants, an action pushed for by Maine's lake resource nongovernment organizations (NGOs) and lake associations. The Milfoil Bill was notable for a number of components.

- Most important was the creation of the Lake and Rivers Protection Fund, which is a dedicated revenue account funded by the sale of inland water boating stickers ($10 for all in-state boats and $20 for out-of-state boats) that is separate from boat registration fees and the interstate reciprocity of boat registration.
- All boats on inland waters must have the sticker, or they face a fine.
- Authority was vested in the Commissioner of Inland Fisheries and the Wildlife and Commissioner of the Department of Environmental Protection to temporarily close down boat ramps in infested areas.
- It created a state aquatic nuisance species task force.
- It embraced public education and outreach.
- It prohibited transport of 11 invasive aquatic plants, and it fines people found doing so.
- A courtesy boat inspection program was created that is funded by a portion of the sticker program proceeds (see appendix).

The bill did not have Administration support when it was introduced, and the official Administration position was neither for, nor against. State agencies spanned the spectrum in their response, ranging from full cooperation and support of the bill to outright hostility and active attempts to kill the bill.

Legislative response was heavily influenced by the use of environmental economic arguments for support of the bill. Studies done showing the negative impact on property values was skillfully messaged and marketed to demonstrate the impacts on:

- municipal budgets and the ensuing diminishment of school funding for rural towns
- tourism and recreational value loss.

Grassroots advocacy included:

- a coordinated write-in and phone call campaign to local elected leaders
- a letter-to-the-editor campaign
- newspaper editorial meetings and endorsements
- media coverage of the issue.

Legislative support and opposition was bipartisan, with some Republican leaders citing the need to protect Maine's economy by keeping invasive aquatic plants out of Maine's lakes. Also, some Democratic leaders opposed the bill because the funding mechanism was felt to unduly tax Maine sportsmen and women.

The bill passed by one vote, with the Administration coming out in support of the bill on the same day, literally during the final vote (which, in this case and by this time, had no affect on the vote).

Since the legislation has been enacted, there has been overwhelming and growing public support for the program with a 92-percent approval rating of the Milfoil Bill's sticker program by Maine's citizens and an 87-percent approval from out-of-state visitors. These figures have shocked opponents of the legislation, but they bolster the arguments of the proponents of the bill who argued that the environment and the economy are inextricably intertwined and that Maine people understand this concept.

In summary, the environment and the economy are inseparable. The use of economic data that drills down to the impact on the individual and to the local level is the foundation of public education. It galvanizes support for natural resource conservation efforts.

Appendix

2004 Courtesy Boat Inspections: Summary Report, Maine Department of Environmental Protection

Background. Recognizing the threat of spreading invasive aquatic plants via boats, trailers and equipment, the state began a program for courtesy boat inspections in 2001. The program just completed its 4th year in 2004. The purpose of the courtesy inspections is to reduce the risk of transporting invasive aquatic plants (IAP) throughout the state by increasing boater awareness of IAP threats to Maine waters. Trained courtesy inspectors demonstrate how to inspect and remove vegetation from boating and fishing equipment and provide educational material to all boaters contacted.

The Maine Department of Environmental Protection (DEP) contracted with Lakes Environmental Association (LEA), in Bridgton, to train volunteers and organize the inspections; the Maine Congress of Lakes Associations trained volunteers in northern and eastern Maine. The majority of courtesy boat inspections were conducted by trained volunteers from lake associations. Additionally, DEP directed money to towns and lake associations to inspect boats at infested lakes.

Courtesy boat inspections are voluntary on the part of the boater. Before launching or after removal, inspectors approached boaters for consent to inspect the boat, trailer or other equipment for plants and asked boaters if they support the Lake and River Protection Sticker fee. This question is very important to the state because it provides policy makers with an understanding of the public's support of the statewide invasive species program.

2004 Courtesy Boat Inspections. Over 300 trained inspectors conducted 30,229 courtesy boat inspections in the 2004 boating season, an astounding 20,000-inspection increase from 2003. Inspectors were asked to inspect boats that were entering or leaving a lake. While the majority (66%) of inspections was conducted on boats being launched into a lake, 34 percent were conducted on boats leaving a lake. Inspectors logged a total of 20,835 inspection hours in 2004, roughly equivalent to 10 full-time employees.

Inspections were conducted at boat ramps on both infested and noninfested lakes. The inspections were done at a total of 65 lakes throughout Maine, an increase of 14 lakes compared to 2003. Ten of these lakes are infested with variable-leaf milfoil (*Myriophyllum heterophyllum*) and one with *Hydrilla verticillata*. Two border lakes on the Maine-New Hampshire line—Balch Pond and Great East Lake—participated in the Courtesy Boat Inspection Program.

Table 1 summarizes the inspection results.

Inspections were done on boats from 39 states. The majority of inspections were conducted on Maine boats (79%); 14 percent were conducted on other New England boats; 2 percent were conducted on boats from all other

Table 1. 2004 CBI Program Results, in percentages

Survey questions	All boats	Maine-registered boats	Non-Maine-registered boats	Unknown registration or nonmotorized boats
Total inspections		79	16	5
Boat has lake and river protection sticker	91	96	73	0
Boater felt stcker fee was reasonable	91	92	87	74
Plant fragments found	2.4	2.5	2.3	0.5

states; 5 percent were conducted on nonmotorized or otherwise unregistered boats.

Compliance with the annual Lake and River Protection Sticker requirement continued to be high and was slightly up from last year, from 86 percent in 2003 to 91 percent in 2004. Ninety-six percent of Maine boats and 73 percent of nonresident boats had the sticker. While inspectors did inspect nonmotorized boats, the figures here are calculated using just the motorized boats since these are the only boats required to have a Lake and River Protection Sticker.

There also continues to be support for the sticker among boaters. Of the boaters who answered the question, "Do you think the sticker fee is reasonable," the majority (91%) answered "Yes." This represents a 5-percent increase from 2003. The inspectors were asked to record any boater comments in response to this question. There were several thousand comments recorded that are impossible to list in this report. However, a recurrent message was that the sticker fee was acceptable *as long as* the money is used for its intended purpose—to address the invasive aquatic species threat—and is not used for other state programs and government costs. Positive comments outnumbered the negative comments 3 to 1. Other frequently cited comments include "all for it," "fine," "it's a little expensive, especially if [you] own more than one motorboat," "the fee should be rolled into the registration,"and "as long as the price doesn't increase."

A total of 2.4 percent of all inspections (709 inspected boats) were carrying plant fragments, slightly lower than the 2.6 percent in 2003. The majority of fragments (591) were found on boats exiting a lake, and 118 fragments were found on boats entering a lake. The transmission rate of plants on exiting boats at other infested lakes ranged from 0.1 percent, at Little Sebago Lake, to 35 percent, at Messalonskee, Route 27 ramp. The next highest transmission rate was 17 percent, at Lake Arrowhead.

Of the 790 boats with fragments, 260 (37%) yielded an invasive plant, primarily variable-leaf milfoil. The vast majority of the variable-leaf milfoil was found on boats and equipment leaving an infested lake; although, 15 boats were recorded as entering an already infested lake.

For the first time in the 4 years of the Courtesy Boat Inspection Program, we have recorded instances of invasive plants, those not established in Maine, being intercepted at boat ramps. These plants are on Maine's prohibited list and, as such, are considered a threat to Maine waters. Eurasian milfoil (*Myriophyllum spicatum*) was intercepted at Great Pond; curly-leaf pondweed (*Potamogeton crispus*) was intercepted at Sebago Lake, Raymond ramp; European Naiad (*Najas minor*) was intercepted at Sebago Lake, Standish ramp. Each of these discoveries was by a courtesy boat inspector affiliated with a larger watershed group that has been inspecting boats since the inception of the CBI Program.

Conclusions. Courtesy boat inspections are an effective method for preventing new invasive plant introductions, as evidenced by the three "catches" by inspectors in 2004. The inspections are also an effective method to educate the public about the threat of invasive plants to our lakes. Inspections provide one-on-one interaction with the public, and inspectors provide immediate responses to the public's questions. In all cases the volunteer inspectors have a vested interest in protecting the lake that they live on and, therefore, are strong advocates for inspecting boats.

Once boaters understood how the money to purchase a Lake and River Protection Sticker was being used, the majority of both in-state and out-of-state boaters were supportive of the state's invasive species program. In the four years that boat inspections have been conducted, there are few instances of boaters refusing to cooperate with the voluntary boat inspections.

The percentage of fragments found on boats and trailers in 2004 did not change significantly from 2003—less than 1 percent. However, the percentage of fragments that were invasive did increase by 17 percent. Likely, this is due to the fact that more infested lakes were involved in the Courtesy Boat Inspection Program in 2004 than in 2003.

Thanks to the dedicated volunteer inspectors and to those who coordinate their organization's boat inspection efforts, the CBI Program works.

The near invasions aborted by observant inspectors displays this, as does the fact that every year since the program's inception, the number of inspections has increased, starting in 2001 with 2,848 inspections. There were more than 6,500 inspections in 2002, more than 10,000 in 2003 and now 30,229 in 2004.

DEP will continue to support courtesy boat inspections in 2005, using a portion of the funds generated by the annual Lake and River Protection Sticker. In addition, DEP will continue to arrange for inspections at public ramps on infested lakes to reduce the risk of spread between Maine waters.

International Association of Fish and Wildlife Agencies: Invasives Species Challenges—Where We Go from Here

Russ Mason
International Association of Fish and Wildlife Agencies
Washington, DC

Introduction

Invasive species threats to wildlife and wildlands, aquatic habitats, agriculture, and human and health and safety continue to increase (Pimental 2004). Reliable estimates suggest that the environmental losses and damage alone amount to more than $120 billion per year, and that there are perhaps as many as 50,000 alien species established in the United States (Pimental 2004). At least 42% of the species on the Threatened and Endangered list are at risk primarily because of invasive species (Wilcove et al. 1998). More than $100 million is spent annually in the control of aquatic weeds (Office of Technology Assessment 1993). Invasive plants are spreading at the rate of approximately 700,000 hectares per year, compromising rangelands and affecting the health and viability of wildlife and domestic livestock (Babbit 1998). Invasive pathogens may cost agricultural producers close to $40 billion annually (Pimental 1997, Pimental 2004). In addition to the probable impact of diseases like West Nile Virus on bird populations, invasive human diseases like influenza and AIDS kill more than 40,000 Americans per year at a health cost exceeding $6 billion (Pimental 2004).

Invasive species could pose a greater threat (and their control and eradication, a greater benefit) to conservation than any other challenge that management agencies face. Not surprisingly, and consistent with the mandates outlined in Executive Order 13112 (Federal Register 1999), first the National Invasive Species Council, Invasive Species Advisory Council, and Aquatic Nuisance Species Task Force, and later a host of other committees and interagency work groups have formed to address a range of critical issues related to the environmental, economic and health-related challenges posed by invasive species. Educational tools have been developed, management actions have been carried out, and there have been calls to formulate strategies that effectively address the overwhelming challenge. Yet despite the fact that prevention, early.

diverse ownership of the lands, weed treatment has been and continues to be a partnership in experiments.

The approaches to two distinct and separate noxious weed management scenarios will be examined in this presentation. Treatment of Purple loostrife (*Lythrum salicaria*) in the extensive wetlands of the valley floor, and treatment of the many non-native invasive species affecting the hundreds of thousands of acres of native palouse prairie found on the reservation. Both of these weed treatments have involved Tribal, County, State, and Federal governments as well as private individuals and educational institutions. The approaches have used chemical, mechanical, grazing, and biological treatments with effectiveness varying in degrees.

Successful treatment of noxious weeds into the future is dependant on resources. The spread of weeds on the Flathead Indian Reservation has reached epidemic proportions and restoration of the habitats they affect is critical. Detection, and attempts to eradicate established invasive populations are underway in every state and territory, success stories are few.

One reason invasive species continue to spread is a pervasive lack of strategic and sustained coordination and communication among the multitude of organizations focused on invasive species concerns. This deficiency is compounded by a chronic lack of funding, and perhaps even more important, a lack of sustained predictable funding, relative to the magnitude of threat. It sometimes appears that organizations addressing invasive species issues are more likely to compete than cooperate. Finally, we do not perceive a clear guiding vision of success, and because of this, we do not believe that there are overarching and widely accepted strategic plans that coordinate the efforts of federal, state, and non-governmental organizations.

One possible approach would be to address the invasive species challenge by developing a comprehensive plan that can be endorsed by all of the state and federal members of the International Association of Fish and Wildlife Agencies (IAFWA). This approach is similar to several comprehensive strategic planning efforts currently underway. One is the ongoing development of the National Fish Habitat Initiative. Another is the effort to address aquatic invasive species. In each case, the approach began with a series of regional workshops that identified and compiled the strategic thoughts of IAFWA members on a national basis. The aquatic invasive species effort was effort funded as a Multistate Conservation Grant. Current planning for the National Fish Habitat Initiative is also funded in part through a multistate grant.

A core working group comprised of state and federal members of the Association in partnership with non-governmental organizations could be tasked to initiate a similar effort directed at the broader invasive species challenge. Existing federal invasive species coordinating bodies could be strong partners in this endeavor and assist other members of the Association in coordinating and conducting regional assessment and planning workshops, and developing a coherent perspective that could include, among other aspects, a prospective ranking of invasive threats, prioritized research on methods development and application, a strategic allocation of resources towards prevention, early detection, rapid response, and management of chronic threats.

The effectiveness of the Invasives Management Initiative efforts might be accelerated by development of a database of successful efforts and effective partnerships. Explicit to our plan would be quantitative measures of success and the evaluation of cost-effectiveness relative to investment. In this regard, there could be strong linkages between the development of an Initiative and the implementation of state comprehensive wildlife plans. One likely objective of many plans is to protect and conserve habitats with high native species abundance and diversity. The best available evidence suggests that such areas also are likely to habor and promote the population growth of invasive plants and animals (T. J. Stolgren, personal communication). The Invasives Management Initiative would provide a central platform for effective advocacy on invasive species issues, and might provide the mechanisms required to obtain the new (and not simply re-directed) funding. Under the direction of the standing committees of the International, the Invasives Management Initiative would provide flexible leadership and a sustained and highly visible profile to meet the growing challenge that invasive species pose to the nation and its natural resources.

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Saltcedar Management in the Southwest: Laying the Foundation for a Successful Control Partnership

Scott J. Cameron
U.S. Department of the Interior
Washington, DC

Background

Tamarisk (*Tamarix* spp.), also known as salt cedar, is an Asian-origin shrub, originally imported into the American Southwest at the turn of the 19th century for erosion control. Since then, it has demonstrated extremely deleterious characteristics and now is generally viewed as an invasive species.

Tamarisk now infects millions of acres across the western states and is found in isolated pockets outside the West. It has deep roots that deplete the water of drought-stricken western reservoirs, taking water away from farmers, city dwellers, fish and wildlife. Its oily sap makes it a fire hazard that burns fiercely, even when the plant is alive and green, making it a public safety and air quality threat along the western riparian areas it prefers, where the rivers wind through urban and suburban areas.

As an invasive, exotic plant, tamarisk displaces native vegetation, such as cottonwoods and willows which are vital habitat for native wildlife. Tamarisk, therefore, degrades the quality of wildlife habitat and is implicated indirectly in the decline of a number of species of wildlife, especially the endangered southwest willow flycatcher.

While there have long been isolated efforts on the parts of federal and state agencies, local governments, tribes, and landowners to deal with tamarisk, what was missing was a coordinated regional approach that transcended human-made boundary lines and that used quantifiable performance metrics as a way of ensuring that ecologically and economically based priorities were being addressed.

Team Tamarisk

An inclusive alliance of cooperating federal, state and local government agencies, Indian tribes, businesses, nonprofits, individuals, and academic institutions across the West have banded together to form Team Tamarisk. Team

Tamarisk was launched in the spring of 2004, at a meeting in Albuquerque, New Mexico, of nearly 400 people from 15 western states and other parts of the country. The vast majority of participants were not federal employees. State governments, local governments, the research community, nonprofits, tribal governments, private landowners and the research community were all represented with at least two dozen people each in attendance.

The Team Tamarisk conference was sponsored by the U.S. Departments of the Interior and of Agriculture, the National Invasive Species Council, Sandia and Los Alamos National Laboratories, the National Association of Counties, the National Fish and Wildlife Foundation, the Nature Conservancy, the Center for Invasive Plant Management, the Tamarisk Coalition, the Metropolitan Water District of Southern California, Mission Springs Water District (in California), the Coachella Valley Water District (in California), and Waste-management Education and Research Consortium (WERC), a consortium for environmental education and technology development (in New Mexico). All the sponsors provided significant financial or contributions in kind to the event.

Secretary of the Interior Gale A. Norton addressed the group by videotape, stressing how her vision of conservation through communication, cooperation and consultation (4Cs) fit naturally with the need to address tamarisk on a strategic regional scale that facilitated cooperative action across all levels of government and land ownerships. U.S. Department of Interior's Assistant Secretary for Land and Minerals Management, Rebecca Watson, was the keynote speaker. Several senior U.S. Department of Agriculture leaders also presented.

The conference included:

- presentations on the economics and science of tamarisk control
- a state government roundtable
- a series of presentations on successful partnerships for tamarisk management
- presentations by U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA) on approaches to developing regional maps of tamarisk distribution and control projects.

Outcomes and Ongoing Work

A self-identified group of volunteer conference participants worked together to produce a draft of Team Tamarisk Guiding Principles (Guiding Principles) that addressed a strategic, results-oriented approach to dealing with tamarisk control and management on a regional scale. Their draft was presented at a plenary session on the final morning of the conference. By a show of hands, roughly 85 percent of those in attendance thought the draft Guiding Principles advanced their ability to collectively make headway on the tamarisk problem. Over the following month this drafting group revised the Guiding Principles, which were subsequently e-mailed to all conference attendees for an e-mail vote. The final Guiding Principles (see appendix) were unanimously approved by those who responded to the e-mail ballot. Secretary Norton subsequently endorsed the Guiding Principles, and wrote to the governors of Arizona, California, Colorado, Oklahoma, Nevada, New Mexico, Texas and Utah, which were the states that were the primary focus of the conference. She encouraged them to embrace the Guiding Principles in their work at the state level and in cooperation with their federal partners. The Office of the Secretary took steps to ensure that its bureaus internally adhered to the Guiding Principles in the conduct of their tamarisk work on federal lands and in cooperation with nonfederal partners on their lands.

At the conference, the USGS unveiled a powerful tool for targeting tamarisk projects and for creating partnerships for tamarisk control. This tool, a Web-based living map of tamarisk distribution, has the capability for users to add and download data over the Internet. The Website, http://www.tamariskmap.org/cwis438/tmap/index.asp, will soon be upgraded to show the locations of control and restoration projects undertaken by Team Tamarisk partners.

Another effort stimulated by the Team Tamarisk conference is the formation of a broad-based working group, under the auspices of the National Invasive Species Council, to perform a comparative economic analysis of alternative management strategies for saltcedar and related infestations of other riparian weeds in the Rio Grande-Pecos and Colorado River basins. Water availability, fire-risk and impact on wildlife habitat will be among the factors addressed in the study, which is expected to be completed by the end of 2005. Four scenarios will be evaluated:

- maintenance of baseline level of activity for tamarisk management
- containment to prevent tamarisk from spreading into new areas
- control of tamarisk across its range
- aggressive control across its range.

Continuing Federal Commitment

President George W. Bush's budget for the fiscal year 2006 includes a $1-million increase in the budget of the U.S. Fish and Wildlife Service to work with partners, consistent with the Guiding Principles, to undertake tamarisk management projects that would help advance endangered species recovery. Several endangered plant and animal species across the West are affected by tamarisk.

The President's budget also includes a joint initiative involving U.S. Department of the Interior's Bureau of Reclamation, the U.S. Bureau of Land Management, the U.S. Fish and Wildlife Service, the U.S. National Park Service, USGS and the U.S. Bureau of Indian Affairs to work with partners in the middle Rio Grande River Basin of New Mexico and Texas to address tamarisk, again consistent with the Guiding Principles.

Other federal agencies are also putting increased resources into tamarisk management in the President's fiscal year 2006 budget; although, the specifics were not available at the time of this writing.

Conclusion

Team Tamarisk is a useful model for bringing together a wide variety of partners to address a serious, common, invasive plant problem on a regional scale across a variety of land ownerships, for taking a strategic approach that incorporates scientific and economic information, and for being results oriented.

Appendix

Team Tamarisk Guiding Principles, April 27, 2004

Team Tamarisk is an inclusive alliance of cooperating agencies, tribes, diverse organizations and individuals devoted to the control of tamarisk (saltcedar, Tamarix spp.) and associated nonnative invasive plants.

Tamarisk and associated nonnative invasive plants cause economic and environmental harm, affect the public health and welfare, and require active long-term management programs with sustainable funding.

Team Tamarisk subscribes to the following guiding principles, in no particular order of importance.

A. Facilitate the prevention and control of tamarisk and associated nonnative invasive plants with the ultimate goal of restoring healthy, productive ecosystems, leadership at all levels should: maximize the spirit of cooperation; foster sharing of information, strategies, tools, and research; leverage funding; and coordinate actions.

B. Public and private partnerships across jurisdictional and watershed boundaries should maximize effective on-the-ground efforts, while respecting private property rights, tribal rights, and local customs and cultures.

C. Actions will comply with established federal, state, tribal and local laws, regulations, and policies.

D. Existing frameworks of funding, technical assistance and expertise should be identified, used and publicized to optimize resources and to maximize local effectiveness.

E. Funding should be directed to proposals and mechanisms that maximize resources on-the-ground while minimizing administrative overhead.

F. Objective criteria must be developed at all levels—local, state, tribal and regional—for control, restoration and monitoring projects that are based on sound science and economics, local community and regional involvement, cultural and traditional values, cost-benefit analysis, and urgency.

G Diverse interest groups should be organized and mobilized to manage the control of tamarisk and nonnative invasive plants for the benefit of healthy, productive ecosystems and of the greater public.

H. To improve management decisions, data from inventories, monitoring, and control actions should be comparable and shared at all levels through a Web-based clearinghouse.

I. Performance measures for control of tamarisk and associated nonnative invasive plants should include quantifiable units (e.g., water quantity and quality, acres treated and restored, fuel reduction), leading to the long-term recovery of healthy, productive ecosystems.

J. The policy makers and public should be informed about tamarisk and associated nonnative invasive plant issues through development of comprehensive educational and outreach efforts.

K. Research efforts should develop innovative tools and technologies to aid in the management and monitoring of tamarisk and for associated nonnative invasive plants in a variety of environments.

L. Proactive management and control strategies for tamarisk and associated nonnative invasive plants should be developed at multiple scales in accordance with recognized planning principles and guidelines, including consensus-based goals and objectives.

Registered Attendance

Alabama

Noreen K. Clough, David C. Hayden, M. N. "Corky" Pugh

Alaska

Douglas G. Alcorn, Dennis E. Bschor, Tina Cunning, Christopher Estes, Herman J. Griese, Winifred Kessler, Robert Leedy, Thomas J. Liebscher, Daniel Logan, Daryl Magnuson, John F. Payne, Tony Payne, Caryn L. Rea, Lou Regelin, Wayne Regelin, Steve Reidsma, Matthew Robus, Kenton P. Taylor, Kimberly Titus

Alberta

Brett K. Calverley, Deanna Dixon, Gary Stewart

Arizona

Dana Bloom, Fred J. Bloom, Robert Broscheid, Donald John Brown, Jim Hessil, Terry B. Johnson, Keith Menasco, Bryan Lee Morrill, James F. Odenkirk, Mike Rabe, Lawrence Riley, Duane L. Shroufe, Linda Shroufe, San Juan Stiver, Bruce Taubert, Bob Vahle, Richard D. Willer

Arkansas

Matthew Bagley, Marilyn K. Bentz, Steven B. Franks, Michael D. Gibson, David Goad, Larry D. Hedrick, Cora Kildow, Sabrina Kirkpatrick, Donald F. McKenzie, Elizabeth Phillips, Gregory P. Turner

British Columbia

Ian M. Barnett

California

Camille Armijo, Sandra M. Baldwin, Bill Berry, Mark Biddlecomb, Timothy A. Burr, Coralie Cobb, Tamara Conkle, Paul Cross, Carolyn E. Curry, Rhys M. Evans, James Fenwood, Bob Frost, Bill Gaines, Dave R. Gibbons, Diane Gibbons, Kelly Hanson, Michael T. Hanson, Jake Hartwick, Bob C. Holmes, Martin Brent Husung, Manuel Joia, Marti J. Kie, Robbie Knight, Mary K. Lamb, Robert T. MacAller, James F. Mercier, Frederic Reid, Rudolph Rosen, Kary E. Schlick, Jim Sedell, Robert Shaffer, Steve Thompson, David Widell, Brian W. Woodward

Colorado

Arthur W. Allen, Tim Balzer, Carol Beidleman, Gary Belew, James Bell, Richard Bruggers, Rick Cables, Jan Carpenter, Len H. Carpenter, John Cornely, Thomas J. DeLiberto, Mallory Dimmitt, David D. Dolton, Tom Dougherty, Peter Dratch, Linda Drees, Matt Dunfee, Michael W. Fall, Paul E. Gertler, Mark Hirvonen, Heather Johnson, David Klute, Mark B. Konishi, Carol A. Lively, Kristie Maczko, Noe Marymor, Bruce McCloskey, Peter McDonald, Loyal Mehrhoff, Brian S. Mihlbachler, Julia Miller, Ralph Morgenweck, Eileen Clair Regan, H. Randall Robinette, Stan Rogers, Bruce Rosenlund, Dave E. Sharp, Gene Stout, Paul Sweeney, Stephen C. Torbit, Jeff Trousil, Jeffrey M. Ver Steeg, Tom Warren, David A. Weber, Victoria Jayne Williams, Melanie Woolever, Michael V. Worthen, Dennis Zachman

Connecticut

Erik Bedan, Frank Briganti, Constance Chase, Cyndi Dalena, Bob Delfay, Chris Dolnack, Edward C. Parker, Sharon Rushton, Melissa Schilling, Jodi Valenta, Steve Wagner

Delaware

Patrick J. Emory, Martha Higgins, Michael Marasco, Rebecca H. Marasco, Eugene Greg Moore

District of Columbia

Kevin R. Adams, Nicole Alt, Daina Apple, Daniel Ashe, Alex Barbarika, Demity Baughman, John Baughman, Rich Bechtel, Sarah Bickel, Rachel Brittin, Richard Bulvinetz, Jack C. Capp, Dave Chadwick, Gabriela Chavarria, Cindy Chotnacky, Ann Claerbout, Jamie Rappaport Clark, Kathleen Clarke, William H. Clay, Greg Clendenning, Sally Collins, Vaughn T. Collins, Sara Comas, Kathryn Conant, Dave Cross, Megan M. Draheim, Jim Dryden, Naomi Edelson, Elizabeth Estill, James D. Felkel, Dwight Fielder, Jaqulin Ford, Guy Foulks, Gary Frazer, Dave Gagner, Robert Glasgow, Randall Gray, Estelle Green, Debbie Hahn, Marc A. Hall, J. Christopher Haney, Bill Hartwig, Tami Heilemann, Heidi Hirsh, Paul Hoffman, Matthew Hogan, Joel Holtrop, Lorraine Howerton, Bengt "Skip" Hyberg, Myra B. Hyde, Chris Iverson, Bart James, Marshall Jones, Stacey Katseanes, Jarrad Kosa, John Kostyack, Donna Beth Lanow, Eric Lawton, Jeff Lerner, Bill Lorenz, Donald MacLauchlan, Jina Mariani, Russ Mason, Thomas O. Melius, Martin Mendoza, Jr., Bruce Menzel, Alan Mitchnick, Jennifer Mock, Pasha Moore, Angela Nelson, Kelly Niland, Maribeth Oakes, Jody Olson, Peggy Olwell, Jim Omans, Ira Palmer, Mamie A. Parker, Richard Parsons, David Pivorunas, Debbie Pressman, Kelly Miller Reed, Kathryn B. Reis, James Rich, Clint Riley, Greg Schildwachter, Nicole Schimpf, Paul Schmidt, Eric Schwaab, Ken Schwartz, Anna M. Seidman, Bart Semcer, Jennifer Sevin, Ed Shepard, Julie Sibbing, Melissa Simpson, Len Singel, David P. Smith, Carol Spurrier, Casey Stemler, Jodi Stemler, Elizabeth H. Stevens, Deanna J. Stouder, Scott Sutherland, Jim Tate, Gary Taylor, Jim Terry, Bill Torgerson, Samara Trusso, Len Ugarenko, Fred Wahl, Jeff Waner, Greg Watson, Steve Williams, Craig Woods, Anne J. Zimmermann

Florida

Edward Barham, Laura Brandt, John W. Bridges, Mike Camardese, Chris Chaffin, Thomas H. Eason, Diane R. Eggeman, R. Wills Flowers, Nat Frazer, Don George, Ken Haddad, Susan Hedrick-Chaffin, Paul Hoover, Fred A. Johnson, Julie L. Jones, Ronald F. Labisky, Marian J. Lichtler, Elizabeth Martin, Ron Masters, Gil McRae, Frank Montalbano, Daniel Nichols, Darrell L. Scovell, Rob Southwick, Theresa Thom, Susan Weaver, Michael Wiwi

Georgia

George Bukenhofer, John R. Fischer, Dan Forster, Sam D. Hamilton, Robert T. Jacobs, Gregory W. Lee, Leslie Parris, Ronald J. Smith, James M. Sweeney, Emily Jo Williams, David Wilson

Hawaii

Paul J. Conry, Diane C. Drigot, William W. Steiner

Idaho

Steve Barton, Susan Bernatas, Bill Burnham, Kevin Frailery, Ric Holmes, Steven M. Huffaker, Kristin Mansfield, Terry Mansfield, Cal McCluskey, Marjorie L. McHenry, Virgil Moore, Terrell D. Rich, Jill Silvey, Jim Unsworth

Illinois

Joel Brunsvold, John Buhnerkempe, Ryan Busby, David Delaney, Dick Gebhart, Heidi Howard, Joe Jordan, Raymond W. Marshalla

Indiana
Gary Armstrong, Dave Case, David Howell, Kyle Hupfer, Chris Kline, Monica Linnenbrink, Jon Marshall, Marti Mitchell, Glen Salmon, Phil Seng, Robert K. Swihart, Gwen White

Iowa
Marion Conover, Dale L. Garner, David L. Otis, Jeff Vonk, Guy G. Zenner

Kansas
Kevin Jones, Joe Kramer, Ron Little, Mike Mitchener, Doug Nygren, Troy Schroeder, Keith Sexson, Chris Tymeson, Roger Wells

Kentucky
Thomas M. Baker, C. Tom Bennett, Mark Cramer, Richard A. Fischer, Jon Gassett, David L. Ledford, Scott Porter

Louisiana
Betsy A. Brien, Billy DeLany, Mark Gates, Gerald A. Grau, Robert Helm, John J. Jackson III, Dwight Landreneau, Craig A. Miller, Michael W. Olinde

Maine
Charles Duncan, Kenneth Elowe, Gino Giumarro, Marcus B. Gray, Elizabeth A. Kintz, Dan McAuley, James T. Nelson

Manitoba
Michael G. Anderson, Rick Baydack, Dale Caswell, Lorne Colpitts, Brian Gray, Jonathan Scarth, Merlin Shoesmith

Maryland
Bruce Abel, Lowell Adams, Paul J. Baicich, Jim Bailey, Sarah K. Ball, John Barczak, Doug Beard, Laura Bies, Peter Boice, Grace E. Bottitta, Christine Bozarth, Amy Brody, Caitlin Burke, Julia K. Burzon, Ann Carlson, Helene M. Cleveland, Steven R. Davis, Jere Dick, Karen Eisenreich, Patricia J. Embrey, Tom Franklin, Al Geis, Dean Geis, Dean E. Goeldner, Reid Goforth, Caleb Gould, Marcio E. Gutierrez, Paul W. Hansen, Ronald R. Helinski, Harry E. Hodgdon, Mary S. Hodgdon, Judd Howell, Jack Kaiser, David M. Kidwell, Jonathan

Kruft, Anthony R. Maranto, Richard E. McCabe, Lisa Anne McGoldrick, Bette S. McKown, Lisa Moll, Jim Mosher, Thomas Owens, Paul A. Peditto, Daniel A. Poole, Dorothy Poole, Kyle E. Rambo, Joanne Rasnake, Gus Rassam, Charlie Rewa, Tim Richardson, James Douglas Ripley, Tom Sadler, Steve W. Sekscienski, Jerry Serie, Jonathan Shaffer, Graham Smith, Jacqueline Smith, Elizabeth L. Stallman, Kay Stratman, Andy Szulinski, Monica Tomosy, Yanin Walker, Bob Wardwell, Thomas Wray II

Massachusetts
Richard O. Bennett, Charles Chester, Joseph J. Dowhan, Ellie Horwitz, Wayne MacCallum, Andrew Milroy, Sherry Morgan, Marvin E. Moriarty, John Organ, Thomas M. Poole

Michigan
Kenneth Ennis, Chris Goddard, James Hammill, Robert D. Hoffman, Rebecca A. Humphries, Alan Marble, William E. Moritz, Gary Rodabaugh, Rodney Stokes, Gildo Tori, Gary E. Whelan

Minnesota
John Christian, Doug Grann, Bruce W. Hawkinson, Rick Horton, Rex Johnson, James R. Kelley, Jr., Mark LaBarbera, Ron Leathers, Eric Daniel McFee, Gene M. Nelson, Harvey K. Nelson, Larry R. Nelson, Sandy Nelson, Dave Nomsen, Barbara J. Pardo, Jim Perry, Paul Richert, Gregory Soulliere, Bill Stevens, Nila Stevens, W. Daniel Svedarsky, Jim Tertin, Robyn Thorson, Howard Vincent, Steve D. Wilds, Rick Young

Mississippi
Ken Babcock, Pamela Bailey, Jim Copeland, Dianne Hackett, Ed Hackett, Myrna Heard, Pete Heard, Bob L. Karr, Richard Lance, Bruce D. Leopold, Ross Melinchuk, Doris J. Miller, James E. Miller, Michael F. Passmore, Keith Polk, Bruce Sabol, Bill Withers, Debbie Withers, John D. Withers, Jr., Thomas Withers

Missouri
Neil Bass, Lorna Domke, Dave Erickson, Ray Evans, Jenny Frazier, Kenneth E. Gamble, Denise Garnier, Thomas F. Glueck, John Hoskins, Dale Humburg, Eric Kurzejeski, Sara Parker, Tony A. Schoonen, John H. Schulz, Chris Scott, Dennis Steward, Dave Tylka, Bill T. White

Montana

Keith Aune, Chuck Bartlebaugh, Dale M. Becker, Barbara Beckes, George Bettas, Don Childress, Janet Clark, Roxanne Falise, Lisa Flowers, Elizabeth Galli-Noble, Jim Gladen, Gillian L. Hadley, Theresa Hanley, Jonathan Haufler, Jeff Herbert, Richard L. Jachowski, Abigail R. Kimbell, Gerald "Skip" Kowalski, Brian Lipscomb, Mike Mueller, David E. Naugle, Jack Reneau, Susan Campbell Reneau, Ralph Rogers, Marc R. Scow, Chris Servheen, Alex Sienkiewicz, A. C. Smid, Chris Smith, Mark Steinbach, Bob L. Summerfield, Land Tawney, Jack Ward Thomas, Kathy Thomas, Tom Toman, Ken E. Wall, Jeffrey M. Warren, Sundi E. West

Nebraska

Rex Amack, Mace Hack, Keith W. Harmon, Helen Jahn, Darlene Lyman, Nick Lyman, Bruce Morrison, Kirk L. Nelson, Steve Riley, John Sidle

Nevada

Sandy Canning, Terry R. Crawforth

New Hampshire

Kathleen O'Brien, Lee E. Perry, Michele Perry, Stephen G. Perry, Dennis Slate, Judy Stokes, Steve Weber, Ray E. Whittemore

New Jersey

Carol Applegate, Jim Applegate, David A. Chanda, Joel Harrington, John G. Joyce, Bob McDowell, Martin McHugh, Robert Panebianco

New Mexico

Donald G. DeLorenzo, Lisa B. Evans, Nancy Gloman, H. Dale Hall, Steve Helfert, Joyce Johnson, Dale A. Jones, Lois Jones, Junior D. Kerns, Gary A. Littauer, Steve Logsdon, David Mehlman, Ruth Musgrave, Jim Ramakka, Terry Z. Riley, Bruce C. Thompson, Lou Woltering

New York

Gerald A. Barnhart, James A. Beemer, Andrew J. Bowman, Daniel J. Decker, Jeffrey A. Gronauer, Shaun Keeler, John Major, Christopher C. Pray, Milo

Richmond, Robert Rockwell, Mark L. Shaffer, Peter Szabo, Leonard J. Vallender, Stephen Vasaka, David Williamson, Paul G. Zang

North Carolina
Charles S. Brown, David Cobb, T. Kevin Crawford, Martin Korenek, James Ronald Linville, Robert Mickler, Robert Montgomery, Scott B. Smith, Craig E. Ten Brink, John R. Townson

North Dakota
Steve Adair, Paul Germolus, Fred Harris, Dean Hildebrand, Michael A. Johnson, Dennis G. Jorde, Randy Kreil, Greg Link, Bob Olson, Jim Ringelman, Ron Stromstad, Dan Svingen, Keith Trego

Ohio
John Beall, Carolyn Caldwell, Tony Celebrezze, Mike Costello, Steve Gray, Roy W. Kroll, Thelma Peterle, Tony J. Peterle, Dave Risley, Pat Ruble, Dave Scott, Rob Sexton, Kendra Wecker

Oklahoma
Stephanie Harmon, Richard Hatcher, Ana E. Hiott, Alan Peoples

Ontario
Lori Bilecki, Robert B. Cahill, Robert Carmichael, Brigitte Collins, George Finney, Cameron Mack, Reginald Melanson, Michael O'Brien, Ken Ross, Barry Turner, John Williamson

Oregon
David B. Allen, Ron Anglin, Robert Anthony, Brad Bales, Brad Bortner, Cindy Burns, Robert P. Davison, William Daniel Edge, Linda Goodman, Grant Gunderson, Roy W. Lowe, Chris McKay, Ronald P. Neilson, Bill Otani, Paul Phillips, Thomas M. Quigley, Hal Salwasser, Bruce Taylor, Robert E. Trost, Sara E. Vickerman, Tim Wigley, Mike Wisdom

Pennsylvania
Douglas J. Austen, Mark E. Banker, Walter F. Bien, Michael A. Dubaich, Calvin W. DuBrock, William H. Goudy, Joseph Hovis, Carol L. Martini, Anika N.

McKessey, David Kennedy McNaughton, William R. Pouss, Ronald M. Smith, James R. Spotila, Michael Zolkewitz

Puerto Rico
Joseph M. Wunderle

Quebec
Luc Belanger, Steve Blight, Patricia M. Dwyer, Lynda Maltby, Trevor Swerdfager, Steve Wendt

Rhode Island
Julie M. McQuade

Saskatchewan
Dean G. Smith

South Carolina
Robert Abernethy, Buddy Baker, Tina Bevington, Bryan J. Burhans, Emily Cope, Dennis Daniel, John E. Frampton, Robert G. Hotchkiss, James Earl Kennamer, Mary Kennamer, Robert Maddrey, Laurel Moore_Barnhill, Yvonne L. Plemmons, Tammy Sapp, John R. Sweeney, T. Bentley Wigley

South Dakota
Larry G. Baesler, John L. Cooper, Doug Hansen, Dan Limmer, Bill Smith, George Vandel

Tennessee
Bruce Batt, Mike Countess, Brooks Garland, J. Jasper Lament, Larry Marcum, Chester A. McConnell, Dottie McConnell, Gary T. Myers, Gregg Patterson, Craig Walker, Alan Wentz, Scott Yaich, Don Young

Texas
Mike Berger, Vernon Bevill, Kirby Brown, Robert D. Brown, Linda Campbell, Kay Drawe, Lynn Drawe, Ronnie R. George, Thomas A. Greene, Josetta Hawthorne, Lynne Lange, Ricky Linex, Larry D. McKinney, Pat Morton, Nova Silvy, Scott G. Summers, Billy M. Teels, Bonnie Tewes, Michael Tewes

Utah

Martin Bushman, Alan Clark, Jim Cole, Mike Conover, Sylvia A. Gillen, Richard E. Griffiths, Sam R. Lawry, Terry Messmer, Miles Moretti, Jack M. Payne

Vermont

Chris Jauhola, Ronald J. Regan, Scot J. Williamson, Steve E. Wright

Virginia

Ross Alston, Robert Anderson, Terry L. Bashore, Erv Bedker, Pamela M. Behm, Lorinda Bennett, Bob Blohm, Deen Boe, Brian Bohnsack, Hannibal Bolton, Paul Brouha, Margaret R. Burks, Tom Busiahn, Robert L. Byrne, Sylvia Cabrera, Joseph J. Campo, Gabrielle Canonico, Rosemary Cecil, Glen Contreras, Gerald H. Cross, Alison Dalsimer, Peter DeMichele, Nick Dilks, Chip Dirth, M. Denise Doetzer, Karen Drews, Mark Duda, Chris Eberly, Robert Ellis, Verl Emrick, Greg Fleming, Robert P. Ford, Ben Fulton, Doug Gentile, Anne Glick, Jason Goldberg, Njambi Good, Lewis E. Gorman III, James Greer, Charles G. Groat, Sharon Gross, Sue Haseltine, Mary Hassell, Michelle Hayward, Helen He, Laura E. Henze, E. Brian Hostetter, Stephanie Hussey, Mark W. Indseth, Doug Inkley, Laura Jerome, Susan Jewell, Michael J. Johnson, Rex Johnson, Priscilla Joyner, Shannon E. Keane, Rick Kearney, Patricia Kerr, Monica Ketcham, Kevin Kilcullen, Terri Killeffer, Mitch King, Bill Kirby, Mary L. Klein, James W. Kurth, Johanna Laderman, Kris E. LaMontagne, Alison Lanier, Jerry Leonard, Michael Lusk, Jack Markham, Pamela Matthes, Bruce Matthews, Jay B. McAninch, Stephanie McManus, Steve L. McMullin, Phil Million, Brian Millsap, Dallas Miner, Pedro Morales, Seth Mott, Mike Munson, Rebecca Murray, Patrick O'Rouke, Donald J. Orth, Laury Parramore, David Pashley, Chris Pease, Carol J. Peddicord, Ronald Peddicord, Shannon Pedersen, Cyndi M. Perry, Genevieve Pullis-Larouche, Jennifer Rahm, Susan Recce, Amy Roberts, Gordon C. Robertson, Kimberly Robertson, Kristi J.K. Robinson, Allyson Rowell, Celeste Ruth, Laurie Schaffer, Rick Schultz, Larry Schweiger, Elizabeth Sellers, Michael G. Serbousek, Maitland Sharpe, Annie Simpson, Jonathan Sleeman, David A. Smith, Gregory J. Smith, Matthew Smith, Judy Soule, Tim Stamps, Michael St. Germain, Marie Strassburger, Robert Szaro, Lee M. Talbot, Marty H. Talbot, Thomas W. Taylor, Billy R. Templeton, Elise Templeton, Christopher Tollefson, Anna Toness, David L. Trauger, Paige Tucker, Benjamin Tuggle, Beatrice Van Horne, Jeff Waldon, David L. Walker, Bill Wall, Meegan M. Wallace, David

Waus, Bruce Weissgold, Jennifer A. Wheeler, Donald Whitaker, Larry Williams, Joshua Winchell, Eric D. Wolf, Robert C. Worrest

Washington

Richard J. Beach, Dave Brittell, John D. Buffington, George R. Carlson, Jim Chu, Bob Everitt, Michael Fraidenburg, Mike Gaffney, Michael Greg, Jan Jarmon, William A. Jarmon, Jr., Gerald T. Johnson, Brian N. Kertson, Matthew Klope, Jeff Koenings, Don Larsen, Dayna R. Matthews, Bob McCready, Bob Nelson, Carey Smith, John Thielbahr, Mimi Welch, Karen Zirkle

West Virginia

Jacob B. Faibisch, Olivia B. Ferriter, Dwight E. Guynn, Sally F. Guynn, Scott Hartman, Anne Johansen, Paul R. Johansen, Suzette M. Kimball, John R. Lemon, Melissa L. McCormick, Randy Rutan, Curtis I. Taylor

Wisconsin

Rebekah Berger, Jimmy Christenson, Dan Dessecker, Leslie A. Dierauf, Milton Friend, Scott Hassett, Tom Hauge, Diane Lueck, Butch Marita, J. Kim Mello, Michael Meyer, Tom Niebauer, Laurie Osterndorf, Bryan Richards, Jeff Schinkten, Kelly Stockwell, Christine Thomas, Ollie Torgerson, Darrel Vanderzee, Norm Weiland, Arleen Wurman, Leonard H. Wurman, Barb Yogerst, Norb Yogerst

Wyoming

Terry Cleveland, Rick Danvir, Steve DeCecco, Matthew Holloran, John Kennedy, Larry L. Kruckenberg, Jay Lawson, Raymond Lee, Levi Martin, Robert Model, Mandy M. Scott, Steve Sharon, Bettina Sparrowe, Rollin D. Sparrowe, Mike Stone, Scott Talbott, Jennifer Vollmer, Bill Wichers

James Earl Kennamer Receives Distinguished Service Award

Dr. James Earl Kennamer, senior vice president of the National Wild Turkey Federation (NWTF), received the Wildlife Management Institute's 2005 Distinguished Service Award. This award is tribute to a person who has dedicated his or her career to conservation, and whose significant achievements have been largely unsung. During a quarter century of leadership with NWTF, Dr. Kennamer is credited with helping to resurrect turkey populations nationwide, doubling the numbers of turkey hunters and ensuring viable turkey populations in 49 states.

Arizona Game and Fish Department's Water Development Program Receives Presidents Award

The Water Development Program of the Arizona Game and Fish Department (AZGFD) received WMI's 2005 Presidents Award, which recognizes conservation work of a local, state, provincial, federal or other agency. The Water Development Program created water catchments—even in remote areas—so that deer, elk, bighorn sheep and other wildlife have access to water. WMI commended AZGFD not only for mapping, prioritizing, scheduling, building and monitoring water developments, but also for its emphasis on communication and involvement with external customers and stakeholders.

U.S. Fish and Wildlife Service and National Cattlemen's Beef Association Receive Touchstone Award

The U.S. Fish and Wildlife Service and the National Cattlemen's Beef Association fostered mutual understanding among their ranks through the "Walk a Mile in My Boots" exchange program. Leaders from both organizations received the Wildlife Management Institute's 2005 Touchstone Award, given to conservation entities in the public or private sector. The exchange program allows ranchers and resource managers to switch roles and experience each other's everyday work world. Bringing these people together has improved communication and has enhanced understanding about their respective roles and responsibilities. What participants have discovered most is a shared commitment to land stewardship.